

# Sustainable Financing Architecture for Digitalised International Trade: The Transformation of the Banking Sector

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## Abstract

This study aims to examine, within a conceptual and analytical framework, how the digitalisation of international trade is reshaping the sustainable financing architecture and the structural impacts of this transformation on the banking sector. The transformation of global trade through digital platforms, electronic document systems, blockchain-based trade finance applications, and data-driven risk assessment mechanisms is changing the nature of financial intermediation. In this process, banks are moving beyond being merely institutions that finance trade; they are transforming into strategic actors in the fields of data analytics, sustainability measurement, and risk pricing. This study examines the interaction between digitalisation and sustainable finance within the context of corporate transformation, credit allocation mechanisms, environmental, social, and governance (ESG) based risk management, and the regulatory framework. The analysis is based on a literature-based conceptual synthesis and examines the potential impacts of digital trade infrastructure on banks' balance sheet structure, risk perception, and financing composition from a holistic perspective. Furthermore, the study evaluates new areas of vulnerability that digital inequalities, data security, cyber risks, and international regulatory non-compliance may pose to the sustainable financing process. In conclusion, the study provides a conceptual framework to the literature by systematising the relationship between digitised international trade and sustainable finance within the banking sector; develops theoretical implications regarding the transformation of financial architecture; and offers a holistic assessment for policymakers concerning regulatory compliance, green finance standards, and digital infrastructure investments.

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## 1. Introduction

The global economy has undergone a two-pronged transformation over the last two decades, driven by both digitalisation and sustainability. The structure of international trade is being reshaped by electronic document systems, online trading platforms, blockchain-based smart contracts, and data-driven supply chain monitoring mechanisms. In particular, interbank consortia and digital platforms developing blockchain-based solutions in global trade finance are transforming traditional financial intermediation functions. Within this framework, applications based on distributed ledger technology are increasing transparency, speed, and transaction security in trade finance, while digital trade rules and standards developed by the International Chamber of Commerce (ICC) are popularising the use of digital documents in cross-border transactions. On the other hand, the concept of sustainable finance refers to the restructuring of the financial system in line with environmental and ESG criteria. Climate change, carbon neutrality targets, and the sustainable development agenda are transforming the credit allocation processes and risk pricing models of financial institutions. This transformation not only means an increase in the diversity of financial products but also requires the redesign of banks' balance sheet structures, capital adequacy assessments, and portfolio compositions (BIS, 2021). This intersection between digitalisation and sustainability is of strategic importance, particularly in the field of international trade finance.

The digitalisation of international trade is shifting banks from their traditional intermediary role to a data-driven strategic position. Electronic bills of lading applications, digital letters of credit systems, and smart contracts are reducing transaction costs, shortening transaction times, and minimising operational risks. Furthermore, big data analytics and AI-powered credit scoring systems are making risk assessment processes in trade finance more dynamic and predictable. In this context, banks are transforming from merely financing institutions into actors that process data, measure sustainability performance, and reprice risks in accordance with ESG criteria (UNEP FI, 2020). However, the relationship between digital trade infrastructures and sustainable financing architecture is generally addressed within separate disciplines in the literature. While studies focused on digitalisation primarily concentrate on the efficiency and cost advantages of financial technologies, the sustainable finance literature focuses on ESG risks, green bonds, and climate finance. Studies examining the combined and structural impacts of these two transformation dynamics on the banking sector within the context of international trade from a holistic perspective are limited. However, digital infrastructures facilitate sustainability measurement, and through elements

such as carbon footprint tracking, supply chain transparency, and real-time data verification, they increase the accuracy of sustainable finance decisions.

The main research question of this study is formulated as follows: How is the digitalisation of international trade reshaping the sustainable financing architecture, and through what mechanisms does this transformation affect the structural characteristics of the banking sector? In line with this question, the study aims to examine, within a conceptual and analytical framework, the effects of digital trade infrastructures on banks' credit allocation mechanisms, risk perception, balance sheet composition, and regulatory compliance processes. The study's contribution to the literature can be evaluated in three dimensions. Firstly, it offers an interdisciplinary synthesis by systematising the interaction between digitalisation and sustainable finance within the context of international trade. Secondly, it analyses the restructuring of the financial architecture by examining the transformation of the banking sector not only from a technological adaptation perspective but also within the context of ESG-based risk management and regulatory frameworks. Thirdly, it creates a holistic assessment platform for policymakers by discussing new areas of vulnerability, such as digital inequalities, cyber risks, data security issues, and international regulatory non-compliance from a sustainable finance perspective. Within this framework, the study relies on a literature-based conceptual synthesis method; it analyses the potential impacts of digital trading platforms, blockchain applications, and data analytics-based credit models on the risk structure of the banking sector. As a result, it is argued that the reciprocal interaction between digitised international trade and sustainable finance is transforming the banking sector at operational, structural, and strategic levels. This transformation necessitates a redefinition of the financial intermediation function, evolving banks into data-centric, sustainability-focused institutions with high regulatory compliance capacity.

## **2. Literature Review**

The international trade and banking literature, transformed by digitalisation and sustainability, has become a rapidly expanding, multi-dimensional research area in recent years. Studies, particularly those focusing on blockchain-based trade finance applications, digital document systems, AI-powered risk analytics, and ESG-based credit allocation mechanisms, reveal that the financial architecture is undergoing a structural transformation. However, studies that comprehensively address digital trade infrastructures and sustainable finance applications within a holistic framework are limited in the literature. Existing studies generally focus either on the efficiency and cost advantages of digital finance technologies or on the environmental and social risk dimensions

of sustainable finance. This study chronologically examines research in the national and international literature on this topic and systematically classifies its key findings. Summary information on these studies is provided in Table 1 below.

*Table 1. Literature Review*

| Author(s)                | Subject                                      | Country / Sample | Period    | Method                       | Results   |
|--------------------------|--|------------------|-----------|------------------------------|---|
| Ahmed & Zhao (2021)      | Blockchain and Risk Pricing                  | Asian Banks      | 2018–2020 | Econometric Model            | Blockchain improves risk pricing.   |
| El-Sayed (2021)          | Digital Trade Documents and Sustainability   | Global Trade     | 2015–2020 | Document Analysis            | Digital documents support sustainability.   |
| Ioannou & Demirel (2022) | Blockchain and Supply Chain Finance          | International    | –         | Systematic Literature Review | Blockchain reduces transaction costs.   |
| Ojo (2022)               | Digital Financial Inclusion                  | Africa           | 2010–2021 | Descriptive Analysis         | Digital finance increases financial inclusion.  |
| Chen, Gupta & Tan (2020) | ESG and Credit Allocation                    | Global Banks     | 2012–2018 | Panel Regression             | ESG criteria influence credit decisions.  |
| Keskin (2022)            | Sustainable financing of climate change.     | International    | 2022      | Descriptive Analysis         | Green and climate finance provide investors with returns while also achieving environmental benefits. |
| Unal & Aysan (2022)      | FinTech and Islamic Finance                  | International    | –         | Conceptual Analysis          | FinTech integrates with sustainable finance.  |
| Lopez & Ruiz (2022)      | Digital Certificates and Trade Finance       | Latin America    | 2017–2021 | Mixed Methods                | Digital certificates reduce trade risk.   |
| Smith & Lee (2023)       | Digital KYC and Risk Reduction               | US and EU Banks  | 2018–2022 | Panel Data Analysis          | Digital KYC reduces operational risks.  |
| Keskin (2023)            | Green banking products                       | Türkiye          | 2023      | Descriptive Analysis         | Green banking is a necessity for sustainable finance.   |
| Çetin (2023)             | Digitalisation of foreign trade transactions | Türkiye          | 2023      | Qualitative analysis.        | Digitalisation increases the speed of foreign trade.  |
| Altundağ (2023)          | E-commerce and Financial Sector              | Türkiye          | 2015–2022 | Quantitative Analysis        | E-commerce transforms the banking structure.  |

| Author(s)                       | Subject  | Country / Sample             | Period    | Method                       | Results   |
|---------------------------------|--|------------------------------|-----------|------------------------------|---|
| Chen, Li & Zhang (2023)         | ESG Risk Management and Bank Performance   | Chinese Banks                | 2015–2022 | Multiple Regression          | ESG performance affects bank profitability.   |
| Keskin, (2024)                  | Analysis of factors influencing individual investors' tendency towards green investments | Türkiye Individual Investors | 2023-2024 | Conceptual analysis          | Environmental awareness and return expectations increase the tendency towards green investments.                  |
| O'Malley & Fernandez (2024)     | FinTech and Bank Governance  | Global                       | 2016–2023 | Empirical Analysis           | Digitalisation influences governance mechanisms.  |
| Bakry et al. (2024)             | Digital Finance and Sustainable Development  | 52 Developing Countries      | 2010–2019 | IV-GMM Panel Analysis        | Digital finance reduces CO <sub>2</sub> emissions.  |
| Basdekidou & Papapanagos (2024) | Blockchain and FinTech   | Global                       | –         | Systematic literature review | Blockchain accelerates financial innovation.  |
| Müller & Hartmann (2024)        | ESG Measurement Systems  | European Banks               | 2020–2023 | Literature Analysis          | ESG measurement transforms banking strategy.  |
| Keskin (2024)                   | Digital Turkish Lira Studies   | Türkiye                      | 2024      | Systematic Review            | The Central Bank of the Republic of Turkey (TCMB) continues its comprehensive tests for the Digital Turkish Lira. |
| Xu (2024)                       | Artificial Intelligence and ESG  | Global Banks                 | 2024      | Industry Analysis            | AI enhances ESG data analytics.   |
| Kapکارa Kaya & Işık (2025)      | Digitalisation and Bank Profitability  | Turkish Banks                | 2007–2024 | ARDL Panel                   | Digitalisation increases long-term profitability.   |
| Tağtekin (2025)                 | Digitalisation and Sustainability in Banks   | Türkiye                      | 2025      | Conceptual Modeling          | Digitalisation contributes to sustainability ratings.   |
| Waliullah et al., (2025)        | Cyber Risks and Digital Banking  | Global                       | 2015–2024 | Systematic Review            | Cyber risks impact digital banking growth.  |
| Garcia, Novak & Singh (2025)    | Digital Risk and Regulation  | International                | 2021–2024 | Meta-analysis                | Regulatory compliance is critical in digital risk management.   |

### 3. Conceptual Framework of Digitalisation in International Trade

Digitalisation in international trade means not only integrating technological tools into commercial transactions but also redefining the organisational structure of trade, transaction costs, contractual relationships, and financing processes. The management of global value chains through digital platforms, the widespread adoption of electronic document systems, and the strengthening of data-driven decision-making mechanisms are transforming the logic of international trade. This transformation requires a new conceptual framework that goes beyond classical trade theories, one that prioritises the information economy and network-based structures. The impact of digitalisation on international trade was first examined in the context of the widespread adoption of information and communication technologies (ICT). It is argued that digitalisation not only accelerates trade but also expands its scope and enables the inclusion of new actors (OECD, 2019). In this context, digitalisation reduces asymmetric information problems in commercial transactions, lowers transaction costs, and facilitates the coordination of cross-border activities. Applications such as electronic data interchange (EDI), e-bill of lading, and digital customs systems, in particular, provide time and cost savings in international trade. One of the conceptual dimensions of digitalisation is the “platform economy” approach. Global trade is increasingly conducted through digital platforms. These platforms bring buyers and sellers together directly, reducing intermediation costs and increasing transparency. It is emphasised that digital platforms create a new way of value creation in global trade and facilitate access to international markets, especially for SMEs (UNCTAD, 2021). However, this situation also brings with it new structural problems, such as data monopolisation and digital inequality.

Another important aspect of digitalisation in international trade is the integration of blockchain technology into trade finance. Thanks to its distributed ledger structure, blockchain ensures that transactions are recorded securely, transparently, and immutably. Especially in letter of credit transactions and supply chain finance, blockchain applications accelerate document verification and reduce fraud risk (Tapscott & Tapscott, 2016). Similarly, it is emphasised that digital trade finance tools can alleviate access to finance, especially in developing countries (ITC, 2018). The digitalisation process has also placed the concept of the data economy at the centre of international trade. Today, trade is organised through data flows rather than the movement of physical goods. It is observed that the contribution of global data flows to the world economy is beginning to surpass traditional goods trade (McKinsey Global Institute, 2016). In this context, data is considered a new factor of production. For banks and financial institutions, this situation makes it possible to more

accurately measure credit risk by analysing large datasets related to commercial transactions. The conceptual framework of digitalisation in international trade is closely related to the sustainability dimension. Digital technologies provide significant advantages in areas such as carbon footprint monitoring, supply chain transparency, and ESG performance measurement. In particular, the ability to monitor environmental and social standards throughout the supply chain supports the development of sustainable trade finance practices (World Bank, 2020).

Conceptually, digitalisation can be evaluated along three main axes: process digitalisation, platformization, and data-driven financial integration. Process digitalisation refers to the transfer of traditional commercial documents to electronic media and the automation of transactions. Platformization encompasses conducting trade through digital interfaces and the formation of multilateral network structures. Data-driven financial integration involves integrating trade data into financial decision-making processes. These three axes are transforming both the operational and financial dimensions of international trade. However, the digitalisation process is not progressing homogeneously. Differences in digital infrastructure are creating a new “digital divide” between countries. It is noted that developed countries have made significant progress in their digital trade infrastructures, but many developing countries are struggling to adapt to this transformation (UNCTAD, 2021). This situation leads to a redistribution of competitive advantages in international trade. Finally, the regulatory dimension of digitalisation is an important element of the conceptual framework. Cross-border data flows, cybersecurity risks, and data protection regulations directly affect the sustainability of digital trade. In particular, the European Union’s data protection regulations and digital trade standards are creating new compliance costs for global traders (European Commission, 2020). In this context, digitalisation is not only a technical transformation but also a process of legal and institutional restructuring.

Digitalisation in international trade represents a multifaceted transformation process that reduces transaction costs, increases transparency, and strengthens financial integration. Blockchain, artificial intelligence, big data analytics, and digital platforms are restructuring both the operational and financial aspects of trade. However, this transformation also brings with it new areas of vulnerability, such as digital inequalities, cyber risks, and regulatory compliance issues (Tapscott & Tapscott, 2016; McKinsey Global Institute, 2016; ITC, 2018). Therefore, digitalisation should be considered a central conceptual category in understanding the sustainable financing architecture of international trade.

#### 4. Transformation in the Sustainable Finance and Banking Sector

Sustainable finance, as a holistic approach that refers to the restructuring of the financial system in line with ESG criteria, brings about a structural transformation in the banking sector. In this transformation process, banks are evaluated not only by their financial performance indicators but also by their environmental and social impacts. Indeed, environmentally friendly banking practices and green financing tools directly affect banks' credit policies and product development processes (Keskin, 2023:2-15).

In the context of climate change, carbon neutrality targets, and sustainable development, there is a growing consensus that financial institutions should be evaluated not only on their financial performance but also on their environmental and social impacts. This transformation directly affects the banking sector; credit allocation mechanisms, risk pricing models, and balance sheet composition are being reshaped from a sustainability perspective. The concept of sustainable finance developed particularly after the global financial crisis as a result of the search for ensuring the long-term stability of the financial system (Schoemaker & Schramade, 2019). This approach promotes a banking model that prioritises long-term value creation over short-term profit maximisation.

One of the most prominent elements of sustainability-based transformation in the banking sector is the integration of ESG criteria into credit assessment processes. While traditional credit analyses largely rely on financial ratios and collateral structures, today, environmental risks (e.g., carbon intensity), social risks (labour standards, supply chain conditions), and governance indicators are becoming an integral part of credit risk analysis (BCBS, 2021). In this context, sustainable finance necessitates a redefinition of risk management in banking. The impact of sustainable finance on the banking sector is not limited to risk management alone. There is also a significant transformation in the diversity of financial products. Instruments such as green bonds, sustainability-related loans, and social impact financing are creating new items in banks' balance sheet structures. It has been observed that sustainability-related financing instruments improve firms' environmental performance and reduce their financing costs (Flammer, 2021). This strengthens the tendency of banks to direct their loan portfolios towards sustainable projects. The institutional framework for sustainable banking is also developing at the international level. In particular, the "Principles of Responsible Banking" developed by the United Nations Environment Programme Finance Initiative (UNEP FI) encourage banks to align their business models with sustainable development goals (UNEP FI, 2019). Similarly, integrating climate risks into the banking

supervisory framework is considered essential for the effectiveness of sustainable finance practices (ECB, 2020). The transformation of the banking sector by sustainable finance also has significant consequences in terms of capital adequacy and the regulatory framework. The inclusion of climate risks in stress tests, the evaluation of loans to carbon-intensive sectors with higher risk weights, and the development of incentive mechanisms for sustainable investments constitute the regulatory dimension of this transformation (NGFS, 2021). However, the impact of sustainable finance practices on the banking sector also includes controversial aspects. While some studies show that ESG criteria have positive effects on bank performance, some research suggests that they may lead to increased costs and reporting burdens in the short term (Friede et al., 2015). The lack of standardisation and data quality issues in sustainability reporting create uncertainties in practice. Another dimension of transformation in the banking sector emerges at the intersection of digitalisation and sustainability. Big data analytics, artificial intelligence, and blockchain technologies are making the measurement and verification of ESG performance more reliable. Real-time monitoring of carbon emissions and ensuring supply chain transparency increases the accuracy of sustainable financing decisions. This makes digital infrastructure investments an integral part of sustainable banking. Sustainable finance is not merely an innovation that increases product diversity in the banking sector; it is a structural paradigm shift that transforms risk management approaches, credit allocation processes, and corporate governance structures. The integration of ESG criteria into financial decision-making processes is reshaping banks' balance sheet structures and strategic orientations. However, this transformation also brings challenges such as regulatory compliance, data standardisation, and short-term cost pressures. Therefore, sustainable finance should be considered a comprehensive corporate restructuring process in the banking sector, aimed at achieving long-term stability and creating social value.

## 5. The Intersection of Digital Commerce and Sustainable Finance

The relationship between digitalisation and sustainable finance constitutes a strategic intersection within the context of the transformation of international trade. While digital trade infrastructures reshape financial decision-making processes through accelerated data flows, automation of transaction processes, and increased transparency, the sustainable finance approach integrates environmental and social responsibility dimensions into these processes. In this context, the banking sector is moving beyond being merely a facilitator of financing; it is transforming into a strategic actor that creates value through digital data production, ESG measurement, and risk modelling (WTO, 2020;

IMF, 2022). Within this framework, the intersection of digital trade and sustainable finance is particularly evident in the areas of credit allocation mechanisms, ESG integration, and risk management.

### **5.1. Credit Allocation Mechanism**

Digital trade infrastructures are making banks' credit allocation processes more data-driven and dynamic. While credit assessment in traditional trade finance practices is mostly based on financial statements and collateral structures, digitalisation integrates supply chain data, real-time transaction records, and platform-based performance indicators into credit analysis. This reduces information asymmetry and allows for more accurate measurement of credit risk. It is known that incomplete information increases risk premiums in markets, and digital trade platforms reduce this asymmetrical structure, enabling the development of more cost-effective and inclusive models for credit allocation (Akerlof, 1970; World Trade Organisation, 2020). From a sustainable finance perspective, the credit allocation mechanism relies not only on financial risk assessment but also on environmental and social risk measurement. Methodological differences between ESG ratings can lead to inconsistencies in credit allocation, but the verifiable data flows provided by digital trade infrastructures make it possible to make more objective, sustainable credit decisions (Berg et al., 2022).

### **5.2. ESG Integration**

One of the strongest intersections of digital commerce and sustainable finance is ESG integration. Integrating ESG criteria into financial decision-making processes is a fundamental pillar of sustainable finance. However, the measurement and verification of ESG performance have been limited for many years due to a lack of data. Digital commerce infrastructures are becoming a significant tool in solving this problem. The necessity of a transparent and comparable data infrastructure for guiding the financial system towards sustainable investments is emphasised, and digital platforms and blockchain-based monitoring systems enable the monitoring of carbon emissions and social standards throughout the supply chain (European Commission, 2018). Thus, sustainability performance becomes based not only on declarations but also on verifiable data. It has been observed that carbon-intensive firms face higher capital costs, and thanks to digital commerce infrastructures, the carbon footprint and environmental performance of firms can be measured in real time (Bolton & Kacperczyk, 2021). This situation ensures that ESG integration has a direct impact on credit pricing and gains a more operational character thanks to digitalisation. In this context, digitalisation acts as a

catalyst accelerating the integration of ESG criteria into banking practices, and transparency, verifiability, and standardisation become fundamental elements that enhance the effectiveness of sustainable finance.

### 5.3. Risk Management and Data Analytics

Risk management is one of the most critical areas at the intersection of digital commerce and sustainable finance. While traditional risk management models are largely based on historical financial data, digitalisation is transforming risk modelling with real-time data streams and big data analytics. New types of risks, particularly climate risk and transition risk, require more comprehensive analytical methods in the banking sector. Financial institutions are developing scenario analyses to measure and report climate risks, and digital commerce infrastructures enable the analysis of production and logistics data (TCFD, 2017). Big data analytics and artificial intelligence applications are increasing the accuracy of credit risk and market risk models; the use of digital data sources in risk measurement strengthens financial stability, but also increases cyber risks (BIS, 2022). This situation reveals the dual impact of digitalisation: while risk measurement capacity increases, new types of operational risks also emerge. Risk management and data analytics hold a strategic position at the intersection of digital commerce and sustainable finance. Banks are increasing their digital infrastructure investments to measure ESG-based risks and are making data analytics a fundamental element of sustainable lending policies. However, issues such as data security, model risk, and regulatory compliance constitute areas of vulnerability in this transformation.

The interaction between digital commerce and sustainable finance is redefining all fundamental functions of the banking sector, from credit allocation to risk modelling. This transformation is paving the way for the financial architecture to evolve into a more data-intensive, transparent, and sustainable structure.

## 6. Financial Architecture and Regulatory Dimensions

Digitalised international trade and sustainable finance practices are driving not only the internal transformation of the banking sector but also the restructuring of the global financial architecture. Financial architecture is a multi-layered structure encompassing regulatory bodies, international standards, supervisory mechanisms, and market practices. The proliferation of digital trade infrastructures, increased cross-border data flows, and the growth of ESG-based financing instruments necessitate updating the existing regulatory framework. In particular, climate risks and digital operational risks require new regulatory approaches to protect financial stability (FSB, 2022).

Within this framework, the financial architecture is being reshaped along the axes of digitalisation and sustainability.

### **6.1. International Standards**

The increasing digitalisation in international trade and the spread of sustainable finance practices have increased the need for globally harmonised standards. The stability of the financial system depends on regulatory harmonisation between countries and common reporting frameworks. In particular, capital adequacy, liquidity requirements, and risk management standards in the banking sector are determined at the global level. While Basel III regulations aim to increase the resilience of the financial system, the integration of climate risks into the regulatory framework has recently come to the forefront. It is stated that the inclusion of climate risks in macroprudential policy instruments is critical for financial stability (BIS, 2023). In the context of digital trade, the legal validity of electronic documents and the regulation of cross-border data flows are gaining importance. The model law on the legal recognition of electronically transferable records supports the international acceptance of digital trade documents (UNCITRAL, 2017). Furthermore, the International Sustainability Standards Board (ISSB) has been established within the IFRS Foundation to harmonise global reporting standards in the field of sustainable finance, aiming to create a global basis for sustainability reporting (IFRS Foundation, 2023). Thus, international standards form the institutional foundation of a digitalised and sustainability-based financial architecture.

### **6.2. Digital Commerce and ESG Integration**

Digital commerce supports the integration of ESG criteria, a cornerstone of sustainable finance, into financial decision-making processes. While the measurement and verification of ESG performance has been limited for many years due to a lack of data, digital commerce infrastructures are becoming a crucial tool in addressing this problem. The necessity of a transparent and comparable data infrastructure to guide the financial system towards sustainable investments is emphasised, and digital platforms and blockchain-based monitoring systems enable the tracking of carbon emissions and social standards throughout the supply chain (European Commission, 2018). It is observed that carbon-intensive firms face higher capital costs, and thanks to digital commerce infrastructures, firms' carbon footprint and environmental performance can be measured in real time (Bolton & Kacperczyk, 2021). This situation ensures that ESG integration has a direct impact on credit pricing and gains a more operational character thanks to digitalisation. Digitalisation acts

as a catalyst, accelerating the integration of ESG criteria into banking practices, and transparency, verifiability, and standardisation become fundamental elements that enhance the effectiveness of sustainable finance. Thus, digital commerce enables the use of ESG-based risk management, credit allocation, and data analytics processes as a strategic tool.

### **6.3. Green Finance and Digital Infrastructure**

Green finance refers to financing tools for projects that support environmental sustainability. Renewable energy investments, energy efficiency projects, and low-carbon transportation systems are considered within this scope. The growth of green finance markets is leading to the formation of new asset classes in the balance sheet structure of the banking sector (Climate Bonds Initiative, 2022). However, the effectiveness of green finance depends on verifying whether the projects actually provide environmental benefits. Digital infrastructures play a critical role in this regard. Digital monitoring systems and blockchain applications make it possible to transparently track the use of funds for green projects (World Economic Forum, 2022). This shows that there is a complementary relationship between green finance and digital infrastructure. However, digital infrastructure investments entail high costs and can increase the risk of financial inequality, especially in developing countries. Therefore, the integration of green finance with digitalisation should be supported by inclusive policy frameworks. The financial architecture is undergoing a multi-layered transformation process along the axes of digitalisation and sustainability. Harmonisation of international standards, institutionalisation of ESG integration, and support of green finance with digital infrastructures stand out as fundamental elements determining the future structure of the banking sector. This transformation requires aligning the maintenance of financial stability with the Sustainable Development Goals.

### **7. Opportunities, Risks, and Structural Vulnerabilities**

The integration of digitalised international trade with sustainable finance creates both significant opportunities and new risk areas for the banking sector. This transformation increases the efficiency of financial intermediation activities while simultaneously altering the nature of systemic vulnerabilities. The integration of digital technologies into trade finance reduces transaction costs, increases transparency, and accelerates credit allocation processes. However, data-intensive structures, cyber risks, and regulatory non-compliance pose new threats to financial stability. In this context, a holistic assessment of the opportunities and risks arising at the intersection of digital trade and sustainable finance is necessary.

**Opportunities:** One of the most important opportunities offered by digitalisation is increased financial inclusion. Digital platforms and alternative data sources facilitate access to trade finance for small and medium-sized enterprises (SMEs) (World Bank, 2022). This allows banks to complement their traditional collateral-based credit models with data-driven risk analysis. In the context of sustainable finance, digital technologies facilitate the measurement and reporting of environmental and social impacts (NGFS, 2023). This development supports banks in restructuring their loan portfolios according to carbon intensity and environmental risk indicators. Furthermore, blockchain and distributed ledger technologies increase trust in trade finance by reducing document forgery. Such technological applications shorten transaction times and reduce operational costs. Thus, banks can both increase their profitability and provide more effective financing for projects that meet sustainability criteria.

**Risks:** Despite the opportunities offered by digitalization, the financial system faces new types of risks. In particular, cybersecurity threats and data breaches are transforming the operational risk profile of the banking sector (IME, 2021). Furthermore, algorithmic credit rating systems can create risks related to data quality and model errors. Incorrect or incomplete ESG data can lead to mispricing of credit risk, paving the way for financial bubble formation. Warnings are being issued that climate risks could cause sudden corrections in financial asset prices (ESRB, 2022). Moreover, reliance on digital infrastructure creates fragility in terms of operational continuity. System failures or cyberattacks can disrupt trade finance transactions, leading to disruptions in global supply chains. These types of risks demonstrate that the interaction between the financial system and the real economy has become more delicate.

**Structural Vulnerabilities:** The integration of digital commerce and sustainable finance also creates areas of structural vulnerability in the long term. The first of these is digital inequality. While developed countries can use sustainable finance instruments more effectively thanks to strong digital infrastructures, developing countries may experience a disadvantage in accessing finance (UNCTAD, 2021). Secondly, regulatory inconsistencies create legal uncertainty in cross-border transactions. Differences in ESG definitions and reporting standards across countries reduce the comparability of financial products (FSB, 2023). Thirdly, the rapid growth of sustainable finance brings with it the risk of “greenwashing.” Labelling projects with limited environmental impact as sustainable can undermine investor confidence. Therefore, digital verification mechanisms and international standards need to be strengthened.

The integration of digital commerce and sustainable finance presents significant opportunities for the banking sector, including increased efficiency, new financing models, and improved risk measurement capabilities. However, this same process also brings with it structural vulnerabilities such as cyber risks, data-driven model errors, regulatory non-compliance, and digital inequalities. The sustainability of the financial architecture depends on managing these opportunities and risks within a balanced policy framework.

## 8. Conclusion and Recommendations

This study systematically examines the transformation occurring in the banking sector at the intersection of digitalised international trade and sustainable finance. The analyses show that digital trade infrastructures, blockchain-based trade finance, data-driven credit allocation mechanisms, and ESG integration profoundly affect banks' balance sheet structure, risk perception, and credit policies. Digitalisation is transforming banks from mere intermediaries providing financing into strategic actors in data analytics, ESG performance measurement, and risk pricing. The findings of this study parallel those of Chen et al., (2023) and Berg et al., (2022), which suggest that digital data and ESG integration play a critical role in financial performance and risk management. Tapscott and Tapscott (2016) and ITC (2018) indicate that blockchain and digital trade infrastructures increase transaction efficiency. In this respect, the study contributes to the literature by conceptualising the effects of digitalisation and sustainable finance holistically within the banking sector. However, the study also addresses vulnerabilities in the sustainable finance process stemming from digital inequalities, cyber risks, and international regulatory non-compliance. These areas explain structural vulnerabilities and digital-financial interactions that are discussed only to a limited extent in the literature. The opportunities offered by digital commerce increase financial inclusion, reduce transaction costs, and make banks' credit allocation processes more data-driven (World Bank, 2022). Thanks to ESG integration and digital data infrastructures, measuring and reporting environmental and social impacts is facilitated, and blockchain applications increase trust by reducing the risk of "greenwashing" (NGFS, 2023; World Economic Forum, 2022). On the other hand, cyber risks, data-driven model errors, regulatory non-compliance, and digital inequalities are creating new areas of vulnerability in the financial system (IMF, 2021; FSB, 2023; UNCTAD, 2021). In this context, policymakers, banks, and international regulatory bodies should prioritise regulatory compliance and international standardisation when managing the integration of digital commerce and sustainable finance. Harmonising ESG reporting standards and increasing digital infrastructure investments will make

banks' credit allocation and risk management processes more transparent and sustainable. Cybersecurity measures, data verification systems, and crisis management plans will minimise digital risks. Furthermore, the effectiveness of green finance should be supported by verifiable infrastructures such as digital monitoring systems and blockchain, and inclusive policies should be developed to reduce digital inequalities.

Suggested areas for future research include examining the empirical impact of digital trade and ESG integration on banks' performance and credit risks; comparisons between developed and developing countries; digital risk and regulatory compliance analyses; and case studies on supply chain-based ESG measurement. These studies will allow for practical testing of the conceptual framework and a better understanding of the sustainability of the digitalised financial ecosystem. In conclusion, the integration of digitalised international trade with sustainable finance presents significant opportunities for efficiency, risk management, and credit policies in the banking sector, while also necessitating the management of structural vulnerabilities. Therefore, digital infrastructure, ESG integration, and regulatory compliance should be considered key strategic elements that strengthen banks' sustainable financing capacity.

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