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Can Fintech Promote Sustainable Finance? Policy Lessons from the Case of Turkey

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Abstract: This study contributes to sustainable finance literature by exemplifying promotion of sustainable finance through fintech solutions for emerging market economies by presenting the case of Turkey. Turkey is one of the largest emerging market economies in the world with a strong banking system and high adoption of technology, so it has great potential to benefit from fintech solutions to boost sustainable finance. For the case analysis, the data used came from a research platform for a Turkish start-up ecosystem, Turkish regulations, and documents released on Turkey's sustainable finance strategies by Turkish and international institutions. We found that Turkey has made remarkable progress in increasing financial inclusivity for underbanked individuals and SMEs via providing contactless payment and contract systems and microfinance by mobile carriers and other online platforms. Turkey was also able to promote the responsible consumption goal for sustainable development by improving fintech solutions on payment systems with educational content on this goal. With upcoming developments such as the sandbox environment in Istanbul Financial Center, fintech solutions using Big Data, AI, and blockchain could emerge much faster with collaboration between banking and fintech sectors and regulatory institutions to better assess climate-related financial risks and form a national carbon trading mechanism.

Keywords: sustainable finance; fintech; Turkey; emerging economies

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1. Introduction

Sustainable Development Goals (SDG) were set by the United Nations (UN) and came into force in 2016. Over 190 UN member states, including Turkey, have signed them. These goals focus on three main objectives: to end economic poverty around the world, to preserve the planet, and to ensure peace and wellbeing of all people. These objectives are very important for all countries, and climate change is one of the main issues needing immediate action considering SDG. To achieve SDG, one necessity is that environmental, social, and governance (ESG) considerations should form the main principle in making investment decisions in the financial sector. Environmental considerations might include climate change mitigation and adaptation, biodiversity preservation, and circular economy; social considerations might include addressing inequality, inclusiveness, and human rights considered under governance and collaboration of public and private institutions. Making financial decisions with this perspective would lead to increased support for sustainable projects and help eliminate investing in harmful activities to the planet.

This study aims to contribute to the broad topic of sustainable finance from a specific and significant perspective by exemplifying adoption and promotion of sustainable finance through fintech solutions for emerging market economies by presenting the case of Turkey. Since these countries do not have sufficient capital, resources, and technology to sustain their production processes, sustainable finance becomes very critical to support

ESG principles in decision making. It presents an extreme challenge to change these countries' economic models and production systems. For instance, in Turkey, many companies operate with very low levels of working capital and are in constant need of financing to survive. Under these restraining conditions, it becomes an even bigger challenge to adapt the production systems to be environmentally friendly.

In Turkey, the main source of financing are bank loans. Thus, the banking system is instrumental in regulating and conducting sustainable finance transactions. Moreover, 99.8% of the enterprises in Turkey are SMEs in need of financing to survive [1]. Hence, via loans and credits, banks can allocate funds with more favorable conditions to produce low-impact-on-climate goods, commodities, and services.

On the other hand, climate change has an intense effect on banks' credit policies due to potential damage and value loss in collaterals for loans. According to World Bank, Turkey is "highly susceptible to climate-related financial risks, especially in relation to water scarcity, natural hazards, and the high share of fossil fuel in its energy consumption" and that the country is exposed to climate and environment migration more than other countries "due to its geopolitical position" [2]. According to [3], there is a clear upward trend in the annual climate-related events recorded in Turkey between 1971 and 2019.

Commercial banks account for more than 90% of total assets of the financial sector in Turkey, and the growth of the banking sector has been supported by the increase in the participation of the state in the sector, particularly due to balance sheet expansion of state-owned banks [4]. As of September 2022, there are 51 banks in Turkey; 35 of these are deposit banks and 16 of them are development and investment banks. Both categories include state-owned banks, private banks with national capital, and private banks with foreign capital. The total number of bank branches within Turkey's borders is 9663, so the average number of bank branches is approximately 190 per bank nationwide, located over 81 provinces [5]. Hence, most banks in Turkey heavily adopt traditional banking, i.e., with physical presence and branch operations. For Turkey, with the banking sector as the pillar of the financial system, lacking the ESG perspective in making financial decisions would create irreversible damage to economic indicators and can cause the system to collapse. Awareness of this critical situation prompted Turkey to create the national sustainable banking strategic plan for 2022–2025 [6].

At the same time, Turkish financial system has been adapting to global updates on regulations for financial activities such as Payment Systems Directive 2 (PSD2) and has been passing several very important regulations to empower the legal structure in adapting to the use of new technologies such as electronic money and digital banking. Enabling technology to provide new banking and financial solutions under a carefully planned legal structure boosted the fintech sector in Turkey starting with the Law on Payment Systems passed in 2013. These two streams of simultaneous developments in sustainable finance and fintech could empower each other if directed well, and this paper aims to present the case of Turkey, providing a detailed analysis of past and potential future accomplishments.

This study pertains to two research streams, sustainable finance (see [7] for a comprehensive review of literature) and fintech solutions. Since sustainable finance requires an effective legal infrastructure, a major part of the literature on this important topic is dedicated to legal and regulatory framework and its development. One of the most recent updates on the legal structure of sustainable finance with a global effect is the EU taxonomy. Developing a taxonomy takes precedence over many actions to empower the financial system for sustainability applications. It provides the means to a better Environmental Impact Assessment as it helps to detect whether a project inadvertently contributes to an action that is harming the environment [8]. The EU Taxonomy is anticipated to change the mindset of decision making by simultaneously supporting sustainable actions and the "Do No Significant Harm" principle at the same time [9]. Taxonomy development is seen as an important tool for achieving SDG, and the United Nations Development Programme (UNDP) also announced SDG finance taxonomy [10]. In addition, World Bank released a guide on developing a national green taxonomy [11]. Forming a taxonomy is included

within the first set of targets with the highest precedence in Turkey's strategic plan on sustainable banking [6], and regulations are anticipated to answer this need for the Turkish financial ecosystem.

Another research topic within sustainable finance has been the assessment of feasibility of applying sustainability and ESG perspectives in existing banking and finance applications (e.g., for home loans [12]). These studies demonstrate the factors preventing effective adoption of ESG principles in finance. Since a major set of such factors is ineffective risk assessment and management, analysis and categorization of financial risks related to climate change and other sustainability aspects has been the focus of many studies (see [13] for a comprehensive review on climate-related prudential risks in banking).

Addressing financial risks and analyzing related data is also included in the main targets of Turkey's sustainable banking strategic plan [6]. Risk assessment and other data-oriented necessities of sustainable finance requires technological solutions, created by talented and innovative human capital to respond to the needs of customers of the financial system. These necessities led to the growth of the fintech sector in many countries including Turkey. As fintech ecosystems form one of the pillars to successfully apply sustainable finance, this mutually strengthening relationship has been the focus of recent studies (see [14] for a preliminary assessment of green fintech and sustainable digital finance in achieving environmental goals).

Moreover, Turkey's financial system includes participation (Islamic) finance, and there has been widely adopted successful fintech applications applying ESG principles to participation finance in Turkey that are discussed in the following sections. Since many emerging economies also adopt participation finance, Turkey presents a more representative example of analyzing the role of fintech in promoting sustainable finance for such economies (see [15] for an evaluation of fintech ecosystem in Turkey in terms of financial markets and financial stability).

For reasons stated above, leveraging the mutual relationship between sustainable finance and fintech is very important for emerging economies. This study focuses on achieving this objective in the case of Turkey regarding the recently announced strategic initiatives and planned developments for the financial system. To our knowledge, such an analysis has not been provided in the literature yet, and the study presents important insights and examples on managing the transition to a sustainable financial system in an emerging economy via benefiting from fintech solutions.

As main contributions, the study demonstrates the steps traced by Turkey in terms of regulations and forming the start-up ecosystem to develop its fintech sector to its current level. Then, it emphasizes the strategic action plans Turkey is aiming to execute for sustainable finance. Then, a through discussion is provided on how these two simultaneous development processes are streamlined to promote sustainable finance via fintech. Namely, we present the underlying trends and specific fintech solutions such as contactless payment and contract systems and microfinance provided by mobile carriers and agricultural loans with more favorable terms to underbanked farmers that helped Turkey achieve a high level of financial inclusivity and an increasing trend in promoting responsible consumption and production. Then, from the findings on upcoming developments in Turkey's financial and fintech ecosystem such as opening of Istanbul Financial Center, a discussion is provided on the potential fintech solutions needing to be prioritized to increase the effectiveness of the fintech sector in promoting sustainable finance for Turkey. More specifically, the emphasis will be on increasing the use of new generation technologies such as Big Data, Artificial Intelligence, and blockchain to aggregate data from various resources on climate change and combine it with the current data collected in Turkey's fintech system such as insurance databases to improve climate change-related risk assessment and management for green loans and to form the basis for a national carbon trading mechanism. Such solutions could help improve the progress made by the banking system in increasing loans for renewable energy and other sustainability projects and comply with upcoming international regulations such as carbon border adjustment mechanism.

In the following sections, review of the literature and the materials and methods used in the case study are presented, then an analysis of development and structure of the fintech sector in Turkey and its sustainable finance strategies is provided. Based on these analyses, a discussion will be provided on the status and agenda of fintech on promoting sustainable finance in Turkey including past and potential future accomplishments. Finally, a summary of the findings and policy recommendations as well as recommendations for future empirical studies are included in the conclusion section.

2. Review of the Literature

The emerging literature on the domain of fintech and sustainable finance can broadly be summarized under three major strands, namely innovation, green finance, and digitalization. Propositions put forward by the leading studies in these key areas are summarized in Table 1. While a comprehensive review of the literature is beyond the scope of the present article, the propositions put forward with respect to the relationship between green finance and fintech by some studies are noteworthy.

For instance, regarding the commercial and competitive impact of fintech on banking, Elsaid (2021) argues that fintech firms could take some market share away from banks, and could even substitute banks, which necessitates banks to adopt innovations and advanced technologies [16]. The author also suggests that both fintech firms and banks can benefit from strategic partnerships and cooperation. This important proposition has been shared by many other authors in the existing literature (See, inter alia, [17,18]).

Regarding the supportive impact of fintech on sustainable finance, Cen and He (2018) explain that fintech supports sustainable finance by reducing transaction costs and improving capital efficiency, lowering information asymmetries, and enhancing risk management, and by making green finance more inclusive [19]. Mejia-Escobar et al. (2020) also emphasize that sustainable financial products flourish in the fast-improving fintech ecosystem, especially from a social and financial inclusivity perspective in the Latin American context [20]. Likewise, regarding the role fintech plays in facilitating the development of green finance, Yang (2020) explains that fintech does this by decreasing bank credit risk, enhancing the regulation level, stimulating product innovation, and the perfection of the information-sharing mechanism [18]. Moro-Visconti et al. (2020) also lends support to these propositions by explaining that fintech will lead to greater access to finance and investment through improved financial inclusion [21].

Financial inclusion is one of the main benefits particularly relevant to developing countries since not only individuals but many SMEs contributing to production need access to financial services due to lack of capital. For green finance to be effectively within the main principles of allocating funds to practices in line with SDGs, it is critical to include and tend to economic and social needs of as many companies as possible in the financial system. Tseng et al. (2018) found that economic and social aspects of sustainable supply chain finance have an impact on the environmental aspects [22]. For inclusion of financially disadvantaged individuals contributing to production, Anshari et al. (2018) provide design of a fintech-enabled digital marketplace empowering farmers with crowdfunding and payment systems [23].

On the other hand, some authors focused on the cumulative impact of fintech and sustainability on the financial services industry, arguing that they are concurrently causing a major transformation in finance. For instance, Hommel and Bican (2020) discuss that collaboration between fintech and traditional institutions comprise partnering, outsourcing, or investment as venture capitalists [24]. While this is a valid argument, Puschmann et al. (2020) investigate this partnership from a different perspective, arguing that "green FinTech" remains under-researched, but digitization and sustainability are clearly the core drivers of a change in the financial services industry [25]. The authors particularly discuss that green fintech has an impact along the entire value chain of financial services including customer-to-customer, business-to-customer, and business-to-business service areas. Similarly, Chueca Vergara and Ferruz Agudo (2021) conclude that sustainable finance

and fintech have many aspects in common, and that fintech can make financial businesses more sustainable overall by promoting green finance [26].

From the review of the relevant literature, it can be concluded that the existing studies in this new domain are characterized by a specific focus on isolated aspects of innovation, green fintech, and digitalization. Therefore, it can be argued that the existing literature falls short of providing a comprehensive perspective yet. While the literature includes a plethora of studies attempting to explain the relationship between fintech and sustainable finance, the existing literature can be criticized on the grounds that it lacks case studies examining country experiences reflecting different financial and regulatory systems and different levels of advancement in sustainable finance practices.

New generation technologies (e.g., blockchain) are not mature, and their development needs to be followed closely in different country-specific examples. Turkey sets an important example uniting participation (Islamic) finance with fintech that could help achieve SDGs. As Aysan and Bergigui (2021) states, the potential of participation finance in accelerating the transition to circular economy could be realized by scaling up the use of blockchain for participation finance services [27]. As further examples, pilot studies are conducted to design the best use of these new generation technologies such as profiling individual risk preferences to prepare for robo-advising in Hong Kong [28] and Germany [29]. Rizwan and Mustafa (2022) investigate the factors determining the decision to fund in a crowdfunding platform in Pakistan [30]. Each country has different dynamics for forming regulations; therefore, the joint development of fintech revolution and sustainable finance may progress with different trends, justifying the need for presenting different examples from different countries in anticipation of global compatibility needs for the future.

The present article aims to contribute to the literature via responding to the research gap of case studies examining country experiences for advancement of sustainable finance through fintech by reviewing the case of Turkey. Given Turkey is one of the largest emerging market economies in the world (ranked 19 in 2021 by gross domestic product [31]) with a strong banking system and high adoption of technology, this country-specific experience with fintech adoption can serve as a case study for other emerging economies and developing countries alike.

Table 1. Review of the selected literature.

Authors	Findings/Propositions
George and Schillebeeckx (2021) [32]	• Authors conclude that digitalization and sustainability are converging and that new digital technologies will empower novel sustainability solutions.
Cen and He (2018) [19]	• Authors' main proposition is that fintech promotes both green finance and sustainable development and has redefined financial services.
Mejia-Escobar et al. (2020) [20]	• Authors emphasize fintech ecosystem provides more opportunities for financial inclusion and digitalization of financial services, increasing agricultural and other activities conducted with the ESG perspective.
Anagnostopoulos (2018) [33]	• Among many other arguments, the author explains that disruptive innovation has reputational gains for the financial services industry.
Nikolaou (2018) [34]	• Author highlights the existing challenges with respect to fintech and points out that there are various considerations and barriers that need to be addressed to achieve green finance.

Table 1. *Cont.*

Authors	Findings/Propositions
Palmié et al. (2019) [35]	• Among many other interesting arguments, authors explain that fintech ecosystem has disrupted the financial services industry.
Malamas et al. (2020) [36]	• Authors particularly emphasize that green bonds issuance can benefit from a block-chain-enabled issuance architecture.
Acar and Citak (2019) [17]	• Authors focus on banks and discuss that fintech integration and external collaboration mitigates risks in banks.
Puschmann et al. (2020) [25]	• Authors' main argument is that green fintech can alleviate the impact of climate change as it has an impact along the whole value chain of financial services.
Rose (2020) [37]	• Author discusses that mechanisms like distributed ledgers and other financial technologies may increase trust and reduce transaction costs in traditional finance.
Yang (2020) [18]	• Author explains that fintech can facilitate the development of green finance by decreasing bank credit risk, enhancing the regulation level, stimulating product innovation and the perfection of the information-sharing mechanism.
Babarinde et al. (2020) [38]	• One of the key arguments presented is that the banking industry should try to keep pace with the digital innovations.
Moro-Visconti et al. (2020) [21]	• Authors discuss that fintech will reshape the financial industry by cutting costs, improving the quality of financial services, and creating a more diverse and more stable financial landscape.
Tseng et al. (2018) [22]	• Authors found economic and social aspects of sustainable supply chain finance to have a significant impact on the environmental aspects.
Anshari et al. (2018) [23]	• Authors provide a digital marketplace model emphasizing financial inclusivity of farmers and agricultural sustainability via crowdfunding and digital payment systems.
Chen and Volz (2020) [39]	• Authors' main proposition is that fintech can complement conventional capital markets and help mobilize financial resources for sustainable infrastructure investments.
Deschryver and Mariz (2020) [40]	• Authors review the existing challenges with respect to fintech and conclude that the full potential of green bonds to finance sustainability goals has not been achieved.
Kabulova and Stankevičienė (2020) [41]	• Explaining how fintech can transform the financial sector, authors discuss that it can achieve this by making traditional financial intermediation process more transparent, secure, and less expensive.
Varga (2018) [42]	• Author provides a conceptual overview of the key value drivers behind fintech and their business models and emphasizes how they help fill the lack of access to financial services by the underbanked.
Gálvez-Sánchez et al. (2021) [43]	• Authors provide a comprehensive review on financial inclusion practices and emphasize digital money as an instrument to promote it.

Table 1. *Cont.*

Authors	Findings/Propositions
Appiah-Otoo and Song (2021) [44]	• Authors provide evidence from China that fintech and services such as third-party payment and credit help reduce poverty.
Chueca Vergara and Ferruz Agudo (2021) [26]	• Authors discuss how fintech can make financial businesses more sustainable overall by promoting green finance.
Elsaid (2021) [16]	• Author explains that while fintech firms would take some market share away from banks, it is not expected that fintech firms would substitute banks completely.
Hommel and Bican (2020) [24]	• Focusing on the advantages of fintech, authors explain that it has technological advantage over traditional financial institutions through "customer-centricity" and enhanced efficiency.
Aysan and Bergigui (2021) [27]	• Authors conclude that scaling up blockchain-based fintech solutions in participation finance could benefit transition to circular economy.
Arner et al. (2020) [45]	• Authors argue that fintech is the key driver for financial inclusion; and sustainable development and digital identity, interoperable electronic payments systems, electronic provision of government services and payments, and design of digital financial markets and systems are the four pillars for an economy to leverage fintech for sustainable development.

While contributing to the existing broader literature on sustainable finance, the present analysis deviates from other similar case studies. According to a comprehensive review of the earlier case studies in the literature by Puschmann et al. (2020), existing country-specific studies focus on specific aspects of green fintech, lacking a comprehensive perspective [25]. The authors themselves provide a case study of Switzerland reviewing the role of green fintech startups as well as the services offered by the incumbents.

The existing literature comprises only a few other country-specific studies which focus on different aspects of sustainability. For instance, Tao and Azhgaliyeva (2018) study the role of green fintech on economic and financial development in the case of Singapore [46], Deng et al. (2019) explore the role of fintech on sustainable development in the case of China [47], and Lee and Kim (2015) study the fintech industry in Korea [48]. To our knowledge, there is no other study that reviews the role of fintech from a comprehensive perspective. In particular, the existing studies do not review policy developments with the aim of providing policy recommendations and implications for other countries.

Our analysis is somewhat similar to the case study by Puschmann et al. (2020) on Switzerland in terms of the countries' environmental footprints and the importance of their financial services industries in their economies [25]. However, our case study offers a novel contribution in the sense that we go one step further, focusing more on policy aspects and providing policy lessons for other countries.

More precisely, we provide a comprehensive review of the recently announced strategic initiatives and policies. This is in line with the recommendations set forth in the earlier studies (see, inter alia, Puschmann et al. (2020) [25]) that future analyses should focus on country specific policy developments. We believe that this is indeed a novel and important contribution as alignment of national fintech laws around the world will depend on policy lessons and country-specific experiences.

3. Materials and Methods

For this case study, a thorough analysis of Turkey's fintech sector was conducted via first reviewing the laws, secondary legislations, and other regulations entered into force to form the legal infrastructure of the fintech sector. Web links to all these documents

are provided in the references including the ones that are written in Turkish. English translations of the titles of the web pages are provided for readers to note and follow if required. Then, research conducted and reported by government offices such as Finance Office of the Presidency of Turkey and private auditing companies such as KPMG and EY were reviewed to further report on the characteristics of Turkey's fintech sector and details of planned developments such as Istanbul Financial Center.

To review and present details of contribution of current Turkish fintech companies to sustainable finance, more detailed information such as company value propositions, descriptions, and level of experience were collected via subscription to Startups.watch. Startups.watch is a research platform serving as Turkish Startup Ecosystem Intelligence providing a database of over 8000 startups on different sectors including fintech, artificial intelligence, insurtech, and edutech. The platform verifies all transactions forming the data with the chamber of commerce data and provides publicly accessible reports such as snapshots of Turkish fintech ecosystem. Whenever possible, links were provided within the text to these freely available reports, and the platform was noted as the source for numerical data and examples of value propositions of Turkish fintech companies when discussed in the text.

In Turkey, regulations and strategies for the national finance ecosystem are determined by different government entities, namely, Central Bank of Turkey, Banking Regulation and Supervision Agency (BRSA), Capital Markets Board of Turkey, Insurance and Private Pension Regulation and Supervision Agency, Ministry of Treasury and Finance for the Republic of Turkey. Each government office and ministry oversee different parts of the finance ecosystem; for instance, payment systems are governed by Central Bank of Turkey, and sustainable banking strategies has been formed mainly by BRSA. In terms of regulatory and supervisory practices, Turkish regulators are among the first 20–25 countries in the world to take climate-related prudential risks into account (see [13]).

As green loans and bonds to support renewable energy investment and other projects has been implemented mainly by traditional banks, the banking sector and the regulatory body governing it had been tasked with forming the national strategic action plan for sustainable banking in Turkey. To review and analyze the progress of Turkey in sustainable finance, reports and statistics provided by the government offices above were also analyzed, and where applicable, other governing offices' action plans have been reviewed. For example, since the EU Green Deal includes Carbon Border Adjustment Mechanism (CBAM), the Green Deal Action Plan of Turkey was formed and announced by Ministry of Trade, and the titles and web links for all these reports were referred to within text and listed in references with English translations where required.

Turkey's potential for sustainable finance and existing strong banking system merits analysis and valuable recommendations from global institutions such as the World Bank; where applicable, reviews from these institutions were also included in discussions on Turkey's potential in developing its sustainable finance strategies further. These reports and data from Turkish and global resources were used to conduct the case study in the role of fintech in promoting sustainable finance in Turkey, presenting the accomplished achievements so far, and the potential to be realized.

4. Fintech Sector and Sustainable Finance Strategies in Turkey

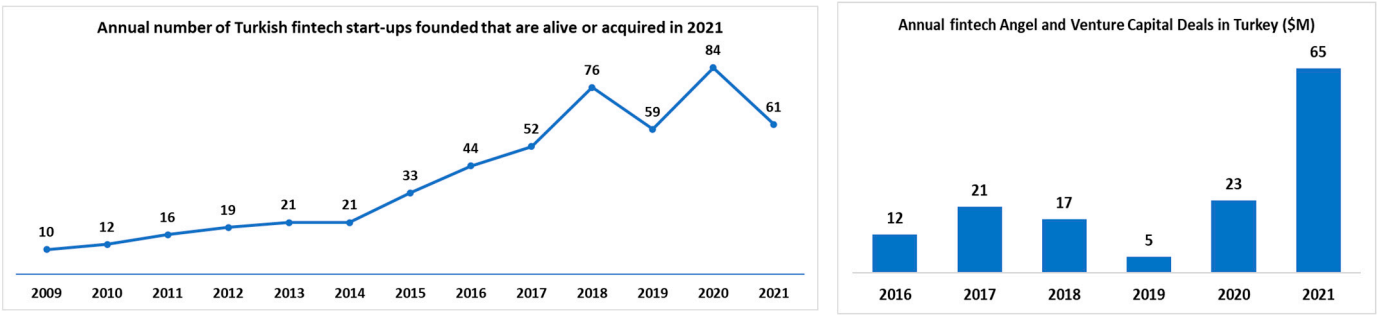
This section will present the development and structure of the fintech sector along with the announced strategies for strengthening sustainable finance in Turkey to provide an analysis on the role of fintech in promoting sustainable finance in Turkey.

4.1. The Development and Structure of Fintech Sector in Turkey

Turkey has a high and young population with median age of 33.1 in 2021 [49]. This young population has a high adoption rate of smartphones and other internet devices, which creates a very favorable environment for the fintech sector to thrive. The fintech sector has gained momentum in Turkey in recent years, and the turnover for some fintech

services has reached significant volumes. For instance, contactless payment and money transfer activities reached a turnover of 956 M TL in 2020 (this amounts to 54 M USD as of July 2022). The pandemic has caused a 41% increase in contactless transactions in Turkey, which has been another impetus for the fintech sector [50]. The funds received by the sector from angel investors and venture capitals increased dramatically with these factors, already reaching 65 M USD in the first half of 2022 [51]. This amount equals the total deal size acquired in 2021, so the fintech ecosystem is growing in Turkey at an accelerated pace.

Turkey has a total of 574 "alive" start-ups as of June 2022 [50]. As can be seen in Figure 1 below, a steady increase has been observed in the annual number of founded Turkish fintech start-ups and angel and venture capital deals received.



(**a**) (**b**)

Figure 1. Development of fintech Sector in Turkey (**a**) Annual number of Turkish fintech start-ups founded that are alive or acquired in 2021; (**b**) Annual fintech Angel and Venture Capital Deals in Turkey ($M). Source: Analysis by the authors based on [52].

The Law on Payment and Securities Settlement Systems, Payment Services, and Electronic Money Companies No. 6493, which entered into force in 2013 has been one of the major accelerators to achieve this rising trend [53], and it has been followed by several others as the result of regulatory bodies' efforts to provide a boosting ecosystem for fintech in Turkey. Main triggers for these regulations were Payment Systems Directive 1 and 2 (PSD 1 and PSD 2), which resulted in the early efforts of the Turkish fintech sector to concentrate on payment systems and electronic money services. The major fintech-related regulations in Turkey and their contributed impacts are summarized in Table 2 below.

Table 2. Major fintech-related regulations in Turkey and their contributed impacts.

Regulation	Year	Contributed Impacts
Revenue Administration of Turkey Communiqué No. 426 on Tax Procedure Law	2013	Required mandatory use of Point of Sale (POS) devices for all vendors; fintech start-ups started to increase in Turkey to respond to the needs of vendors
Law on Payment and Securities Settlement Systems, Payment Services and Electronic Money Companies No. 6493	2013	Provided the legal framework to establish payment and electronic money companies; led to many highly adopted fintech applications in Turkey such as electronic payments and money transfers, issuance of loyalty cards, digital wallets, and installment plans on credit cards
Secondary Legislation on Equity-Based Crowdfunding by Capital Markets Board of Turkey	2019	Allowed technology or production start-ups to raise capital for equity in crowdfunding platforms; this created more opportunities for renewable energy and agricultural technology start-ups to raise capital for equity; five equity-based crowdfunding platforms had been initiated and approved within two years of this legislation

Table 2. *Cont.*

Regulation	Year	Contributed Impacts
Amendment to Law on Payment and Securities Settlement Systems	2019	Included open banking applications within the scope of payment services; enhanced the ecosystem for start-ups offering open banking applications to customers for payment services such as online platforms offering consolidated information processing for multiple accounts and online collection
Amendment to Electronic Communication Law	2020	Allowed financial institutions to contract with their customers digitally, which significantly increased financial inclusion and feasibility of trade in the pandemic environment as well as other potential future crises
Secondary Legislation on TR QR Code Use and Standardization in Payment Services by Central Bank of the Republic of Turkey	2020	Allowed payments to be processed via QR code, increasing speed and contactless payment options for customers
Initiation of Centralized Instantaneous Fund Transfer System (FAST) by Central Bank of the Republic of Turkey	2021	Allowed money transfers to be completed instantaneously and 24/7 to further increase the speed of financial transactions
Secondary Legislation on IBAN (international bank account number) provision by Central Bank of the Republic of Turkey	2021	Allowed non-banking payment services providers to issue IBAN to their customers, which enhanced the value proposition of such start-ups in Turkey
Secondary Legislation on Equity-Based and Debt-Based Crowdfunding by Capital Markets Board of Turkey	2021	Enhanced the types of crowdfunding applications to be regulated by including debt-based crowdfunding
Secondary Legislation on Banks' Information Systems and Electronic Banking Services by Banking Regulation and Supervision Agency	2021	Electronic payment systems' regulations were updated, and the legal infrastructure for open banking was established based on PSD2
Secondary Legislation on Digital Banking and Banking as a Service (BaaS) by Banking Regulation and Supervision Agency	2021	Provided the legal infrastructure on how to conduct digital banking and BaaS services in Turkey's fintech ecosystem, which is expected to enhance the ecosystem greatly in the following years

Sources: [53–56].

The game-changing regulation for the Turkish fintech ecosystem has been the Law on Payment and Securities Settlement Systems, Payment Services, and Electronic Money Companies No. 6493, which entered into force in 2013 (Table 2). With this regulation, the fintech companies providing payment services were required to apply for license to offer such services, and this also provided these companies with rights and legal acknowledgement. After the law has been passed in 2013, more than 100 new fintech start-ups emerged in payment and electronic money services [57]. This number is expected to increase as Turkey has several techno parks currently under construction, as well as a "regulatory sandbox" close to completion in the Istanbul Financial Center (see [55]).

As can be seen from Table 2, the effect of the pandemic on increasing the demand for online and contactless financial transactions has been reflected on Turkey's regulations as many fintech solutions have been added to the legal infrastructure of financial ecosystem since 2019. It is currently possible to open an account online in Turkey within minutes with the existing fintech services. Even before these regulations entered into force in 2019, anticipation on compliance with EU open banking and PSD2 led to establishment of more than 30 Turkish fintech start-ups working on open banking services. The latest legislations are expected to start a new era in Turkey's financial system as they have the potential to increase financial inclusivity via digital onboarding and other digital banking services, as well as providing opportunities for many fintech start-ups to raise capital (via crowdfunding) and collaborate more with traditional banks (e.g., open banking or BaaS) to increase the scope of services they provide. For instance, BaaS will allow the consumers

to access banking services via an e-commerce website they are shopping from, and given Turkey's e-commerce market's volume (ranks 18th globally, with a revenue of $16.3 billion USD in 2021 [58]), one can envision the scale of increase in penetration of banking services with these enhancements. With digital banking regulations passed in 2021 as listed above, next-generation digital banks are expected to join Turkey's fintech ecosystem. As the scope of banking services offered to the customers become more comprehensive, it would increase the demand, further enriching the financial system from both directions of supply and demand.

Fintech companies in Turkey currently include start-ups founded by entrepreneurs, start-ups affiliated to traditional banks (e.g., Yapı Kredi Teknoloji, affiliated to Yapı Kredi Bank, founded in 1980), and start-ups affiliated with mobile service providers (e.g., Vodafone Pay, founded in 2015, offering digital wallet services; TT Odeme, affiliated to Turk Telekom, founded in 2013, offering mobile payment services) [52]. Turkish banks cooperate strongly with fintech start-ups, and many Turkish fintech start-ups has received investments from Turkish banks; some of these start-ups and the services provided by them are:

- open-source online accounting software and other accounting solutions (Akaunting and Bizim Hesap);
- remittance for e-commerce (ComPay);
- supply chain financing and dynamic discounting (Figopara);
- commission-free investing and banking (Invstr);
- prepaid restaurant cards (Midas);
- real-time Payment Card Industry Data Security Standard (PCI-DSS) monitoring, consulting and documentation (PCI Checklist);
- bank account aggregation (Vomsis).

Furthermore, there have been Turkish fintech start-ups acquired by Turkish banks (e.g., Isbank acquiring Moka), and some Turkish banks support venture capital funds as limited partners (e.g., Fibabanka and QNB Finansbank) [52,55]. The positive and supportive approach from traditional banks provides a nurturing ecosystem for fintech start-ups in Turkey.

The distribution of Turkish fintech start-ups, with respect to the service categories they provide, and examples of their value propositions are presented in Table 3. Payment services has been among the top three most frequently offered value proposition by newly founded Turkish fintech start-ups for 2016–2021 [51] as well as most widely adopted by the consumers [57]. This is due to these services being the first fintech service provided with a legal structure in Turkey, and the recent legislations (Table 2) passed on crowdfunding, open banking, BaaS, and digital banking suggest these services will increase in popularity both for fintech start-ups and consumers [55].

Table 3. Distribution of Turkish fintech start-ups with respect to their service categories and examples of their value propositions.

Fintech Service Category	Number of Turkish Companies *	Examples of Value Propositions
Payment	228	Collective payments from different banks integrated with ERP systems, cross-border payments, mobile payment apps, electronic money provision, blockchain payment gateway, QR code payments, POS payment solutions, cryptocurrency exchange and payment systems, payment solutions for B2B, B2C, and P2P segments, open banking payment solutions, integrated fraud management, invoicing and payment solutions for freelancers, payment system that integrates with the vehicle recognition system and provides instant discounts on every fuel purchase

Table 3. *Cont.*

Fintech Service Category	Number of Turkish Companies *	Examples of Value Propositions
Banking Technologies	81	Online collection and open banking service, bank account aggregator, digital banking, commission-free investing and banking, software as a service (SaaS) and banking solutions
Cryptocurrency, Blockchain	79	Mobile cryptocurrency wallet, cryptocurrency trading platform, cryptocurrency payment gateway and ICO platform, cryptocurrency mining platform, blockchain and big data technologies, decentralized credibility, and microcredit platform with blockchain technology
Corporate Finance	60	Online company establishment, financial and accounting processes, Finance-as-a-Service, financial processes with artificial intelligence and decision support system, finance and regulation technology, commercial credit analysis and monitoring for financial institutions, financial management to SME's and startups, financial infrastructure solutions, bringing SMEs together with financial institutions, supply chain finance solutions to enterprises, financial management platform for dealers in agriculture
Insurance	57	AI-based risk pricing tools for the insurance industry, online insurance comparison, network management software systems and key-ready solutions for insurance organizations, embedded insurance service that integrates insurance companies and digital businesses end-to-end, online accident report filing
Financing	45	Financing solution for agriculture, housing financing solution
Trading, Investing	29	Automated trading platform for Forex, crypto trading exchange, predictive sentiment data feeds for traders
Scoring, Identity, Fraud	28	Real-time credibility scoring for individuals and corporates, identity management system provider, AI-powered identity management, identity verification, biometrics, anti-money laundering and digital contract platform, integrated fraud management suite that provides enhanced monitoring
Crowdfunding	19	Equity-based crowdfunding, discovering, mentoring, and investing in start-ups
Personal Finance Management	16	Financial robo-advisor
Money Transfer	15	Money transfer service for underbanked, international money transfer solutions
Wealth Management	8	Asset and wealth management solutions

* Numbers and data are as of 23 July 2022. Source: [52].

An upcoming development for Turkish fintech sector is the opening of Istanbul Financial Center, planned for the second half of 2022. Fintech represents one of the two main strategic foci for the center, and due to their anticipated momentum in gaining importance, digital banking and open banking services are both listed as separate headings within the center's main areas of activity. Green finance is also another main area of activity, to be empowered by enhanced fintech services provided at the center to the Turkish and global finance sector [59]. The incubators in the center will support fintech start-ups, and the center will help establish a network of entrepreneurs and investors to help entrepreneurs share their experiences and get matched with investors. The center will also provide a regulatory sandbox environment for fintech companies to gain real-time experience and for regulatory authorities to detect regulatory needs and improvements [55].

Considering the current legal infrastructure summarized in Table 2 and value propositions in Table 3, Turkish fintech ecosystem is comprised of the below four main stakeholders

and can thrive with strong collaboration and communication between them to reach its full potential.

- Financial customers: Turkish customers of financial services prefer cashless transactions. Moreover, there is a very high adoption rate for new technological advances, and these two factors increase the penetration likelihood of fintech solutions that are not effectively provided by traditional banks and easy to understand and execute by the customers. Fintech companies providing such solutions will increase financial inclusivity of the underbanked population. For instance, prepaid cards offered by traditional banks in Turkey were not successful in gaining market share; on the other hand, similar products offered via business models of Turkish fintech companies were successful [57]. Turkish fintech companies also provide extended financial solutions such as credibility scoring for individuals and P2P payments; such solutions will increase interactions of customers with the ecosystem and help enhance it further.
- Regulatory institutions: Financial stability and data security are the two main topics in which Turkish fintech companies could benefit from legal infrastructure the most. As open banking and other PSD2 compliant regulations would allow fintech companies to manage all banking accounts of a customer from one platform, data security becomes a prominent topic needing determination of rights and responsibilities of all parties involved. Fintech services provided continue diversifying, and similar licensing regulations as were performed for payment services providers would be needed to establish requirements for financial stability of fintech companies.
- Fund Providers: These institutions include traditional banks, venture capitalists, and angel investors as well as public funds and crowdfunding platforms. As the fintech sector is regulated more heavily, fintech companies require higher amounts of capital to comply with regulations. Support from public funds and traditional banks could help enriching the availability of funds, especially for applications promoting sustainable finance and other publicly beneficial purposes.
- Human Resources: Financial institutions and universities are the main sources of human capital for the Turkish fintech sector. However, human capital raised from universities have been found insufficient by Turkish fintech managers [57], and traditional financial institutions may be reluctant to direct their employees to work on fintech solutions with fear of losing them to fintech companies. For the Turkish fintech sector to improve, collaborations between all stakeholders are needed to help raise new talent and help existing ones to realize their potential. For example, the Istanbul Financial Center aims to provide this nourishing environment to help raise human capital for Turkish fintech sector.

4.2. Structure of the Turkish Banking Sector and Sustainable Finance Strategies

The financial sector in Turkey is comprised mostly of commercial banks that account for over 90% of total financial sector assets as of the end of 2020. On the other hand, asset management companies form roughly around 5% of total financial sector assets. Remaining financial institutions include leasing, factoring, insurance, and finance companies. The sector can be characterized by large state participation, with state-owned banks holding over 40% of total banking sector assets [4].

As of September 2022, the banking sector consists of 35 deposit banks and 16 development and investment banks. Of the deposit banks, three are state-owned banks, and three of the development and investment banks are also state-owned banks. There are a total of 9663 branches nationwide, and 71 of them are of development and investment banks [5].

Turkey's strategies for sustainable finance focuses on two main purposes: stabilizing the financial system under ever-changing global and national conditions and circumstances and adapting to the climate change and transition to circular economy by leveraging the financial system. The global and national conditions and circumstances affecting the financial system mainly comprise of natural and political events. As an example of natural events, the floods and landslides that occurred on 11 August 2021 in the West Black

Sea region of Turkey caused 82 deaths, and many residences became uninhabitable [60]. Extreme weather events such as this occurring globally and the growing threat of climate change led to the strong need to adapt to and mitigate climate change and transition to circular economy especially in the second half of last century, which was followed by political agreements such as the Paris Agreement on Climate Change and the European Green Deal. These agreements intend to shape the business environment and economic actions, and the financial system needs to be adapted to and at the same time used as a leverage to accelerate this transition. Turkey is one of the countries signing the Paris Climate Agreement and committed to reducing its Green House Gas (GHG) emissions by 21% until 2030 [61], and Turkey has a substantial level of exports to EU as detailed below [62]. Thus, the agreements above will be within the defining factors to determine the future of sustainable finance practices in Turkey.

Preserving the stability of Turkey's financial system requires concentration of efforts with this purpose on loans provided by banks to SMEs and individuals. As an emerging economy, bank loans are central to SMEs in Turkey, which form the category of corporate actors with the highest percentage in Turkey's economy [1]. Similarly, it is not possible for most of the population to make an expense such as buying a house or a car without relying on a mortgage or a bank loan in Turkey. Thus, there are millions of mortgages and bank loans, of which capability of loan payback and collateral associated with could be affected by climate change. Hence, Turkish banks need to monitor and update the payment plans especially of the existing loans given to SMEs and individuals. Part of these efforts could include preparing heat maps for effect of climate change on sectors, categorizing SMEs and other companies based on these heat maps, and monitoring the business models and business plans of companies that are under high risk of not being able to pay their loans back. Monitoring the values of collaterals for home loans regarding potential future extreme weather events as mentioned above would also be essential. These efforts require a data infrastructure and accompanying credit risk management, monitoring, and control policies, forming one of the targets in the strategic plan for sustainable banking in Turkey prepared by BRSA for 2022–2025 [6]. Developments in the fintech sector in Turkey will be particularly beneficial to provide data infrastructure and analytics.

While the targets mentioned above are triggered by the long-term prospect of extreme natural events, important stimulating factors for sustainable finance strategies also arise from political agreements to increase the speed of adaptation to and mitigation of climate change and transition to circular economy. Important such developments for Turkey's mid-range strategies are the EU Green Deal and Carbon Border Adjustment Mechanism (CBAM). Turkey currently does not have a national carbon pricing mechanism and market, so trade from Turkey to EU does not reflect any carbon offsetting costs for the importers in EU. The GHG emissions of such exports for the prioritized sectors of cement, fertilizers, aluminum, steel, and electricity will be reported by the importers in EU as of 2023. Then, CBAM will become fully operational in 2026 in trades with EU; and importers in EU will need to purchase carbon certificates to offset any pricing difference due to lack of carbon pricing mechanism in Turkey unless Turkey develops one as soon as possible [63]. Since EU represents 32% of Turkey's exports in these five prioritized product groups, Turkey needs to form a national carbon pricing mechanism soon via development of taxonomy and measurement and analysis mechanisms for GHG emissions. Forming a taxonomy is one of the main targets of the strategic plan for sustainable banking by BRSA, and establishing a national carbon pricing mechanism is the focus of the Green Deal Action Plan by the Turkish Ministry of Trade [62].

The importance of these targets for the stability of the financial sector in Turkey is further strengthened as Turkish banks were strongly recommended by BRSA to analyze their existing customers of corporate loans on whether: the company is producing one of the five CBAM-prioritized products, exporting to EU, or collecting any data on GHG emissions. If the emissions are exceeding the threshold stated for CBAM, then the banks need to determine whether the company has any projects to decrease their emissions [64].

Based on these analyses, Turkish banks were further recommended to adjust the credit ratings of these customers.

Another important perspective for keeping the stability of the financial system is adopting the "Do No Significant Harm" principle where banks are disincentivized from providing loans to sectors, companies, and businesses emitting high levels of GHG emissions [9]. This brings the need for taxonomy and categorization of projects and businesses with respect to their effect on the climate. The EU taxonomy and standards from and studies by institutions such as Basel Committee on Banking Supervision (BCBS), Network of Central Banks and Supervisors for Greening the Financial System (NGFS), and Sustainable Banking and Finance Network (SBFN) are expected to further stimulate forming a national taxonomy in Turkey; and this is also one of the actions included in the national sustainable banking strategic plan for 2022–2025 [6] along with establishing data infrastructure, monitoring, and control for risk analysis. Together, these sets of actions will create a national system of climate-change-focused financial risk management.

Adapting to the climate change and transition to circular economy by leveraging the financial system is especially challenging for emerging economies since macroeconomic factors impede long-range planning for all businesses; and sustainability-oriented projects mostly require higher levels of financing and longer payment terms. While long-term financing instruments as bonds are most appropriate for funding sustainability projects, due to the challenges of long-term financing in Turkey, there have not been significant developments in issuing these financial instruments. Turkey's financial sector has started issuing green bonds in the last decade, in 2016 by Industrial Development Bank of Turkey at the amount of 300 M USD with the payment term of five years [65].

The initiatives for financing sustainability projects focused more on channeling funds from international organizations such as International Finance Corporation (IFC), European Bank for Reconstruction and Development (EBRD), and European Investment Bank (EIB) and using them for renewable energy, sustainable agriculture, and women entrepreneurs. Forming a national taxonomy that is compatible with international standards is also important for continuing and easing access to these funding opportunities. Furthermore, incentivizing loans for sustainability projects through mechanisms such as lower interest rates and longer payment terms would be accomplished with higher rate of success with a taxonomy. Thus, continuous and easier access to international funds as well as incentivizing loans nationwide for sustainability projects form the other main targets in the strategic plan on sustainable banking in Turkey 2022–2025, to be executed following the formation of a national taxonomy [6].

Finally, acknowledging the multidisciplinary nature of these targets and the current governmental actors in decision-making for the financial sector in Turkey, e.g., Capital Markets Board, Banking Regulation and Supervision Agency, Insurance and Private Pension Regulation and Supervision Agency, etc., all with different roles and responsibilities leads to the last set of targets in strategic plan on sustainable banking in Turkey, i.e., increasing collaboration between stakeholders in sustainable finance.

Besides these top-down approaches to promote sustainable banking, many banks in Turkey have been taking initiatives on this topic. For instance, the number of banks with corporate-level policies on sustainability increased from 21 in 2018 to 26 in 2021, and the number of banks reporting on the sustainability of their practices increased from 14 to 15 in the same period [3,65]. As of 2021, 16 Turkish banks had reported their memberships in sustainability-related national or international platforms, and 15 banks practice environmental and social risk assessment for large-scale corporate lending [3]. Most of these banks have a market share higher than 5% or 1%–5% based on the size of their assets; hence, they are "large-scale" or "medium-scale" banks in the financial sector of Turkey [65], comprising 60%–80% market share in total applying the above mentioned sustainable banking practices [3].

In Turkey, the banking sector has also taken the initiative to assume a pivotal role in promoting fintech through establishing their own technology subsidiaries and exploring

new financial technologies. Several banks also sponsor incubators and accelerators to support emerging fintech startups, as well as establishing a multitude of venture funds and investing in fintech. Furthermore, banks have started providing open banking products, which is expected to support the growth of fintech businesses by making their application programming interfaces (APIs) available. Table 4 below presents the list of Turkish banks actively promoting and developing the fintech sector via establishing fintech-oriented tech subsidiary, incubators/accelerators, and/or corporate venture capital funds.

Table 4. The Role of Turkish Banks in Promoting Fintech.

Bank	Tech Subsidiary	Incubator/Accelerator	Corporate Venture Capital Fund
İş Bankası	X	X	
Akbank			X
Albaraka Türk	X		X
QNB Finansbank	X	X	X
Ziraat Bankası			
Garanti BBVA	X	X	
Vakıf Katılım			X
Denizbank	X	X	X
Yapı Kredi	X	X	
Fibabanka			X
Kuveyt Türk	X	X	X
TEB		X	

Source: Compiled by the authors from [55].

The next section will discuss how the fintech sector in Turkey can support Turkey's finance sector to achieve these targets for banking activities and other action plans to accomplish sustainable finance.

5. The Current Status and Agenda of Fintech in Promoting Sustainable Finance in Turkey

We will first discuss how the fintech sector in Turkey helps promoting the sustainable banking action plan (2022–2025) and can do more on this as this plan is the main sustainable finance strategy document of Turkish banking ecosystem which involves the Turkish fintech ecosystem. As the first set of objectives aim to establish a data infrastructure for assessing climate change related financial risks, brief descriptions of these risks will be provided in Table 5 below.

Transitional risks arise from the actions needed to be executed during transition to a low-carbon economy. Many fintech contributions for assessment and management of these risks would also help Turkey execute its "Green Deal Action Plan", and the emphasis will be on how these contributions could help address this action plan as well. Then, a discussion will be provided on how fintech sector in Turkey helps promoting social sustainability in finance.

5.1. The Current Status and Agenda of Fintech Sector in Turkey in Assessing Climate Change Related Physical Risks

Existing value propositions by Turkish fintech start-ups include AI-based risk pricing tools for the insurance industry, "data as a service" focused on risk, marketing, and operations solutions, and insurance and claims management platform. Physical risks are closely associated with insurance, and insurance has been one of the top five most preferred categories for areas of activity among Turkish fintech companies since 2016 [52]. Insurance Law No. 5684 entered into force in 2007 [53], so the insurance sector in Turkey

has been operating under a legal infrastructure for almost two decades. This history brings a significant amount of data available for analysis, especially with new generation technologies such as Big Data and AI.

Table 5. Climate change related financial risks.

Physical Risks	• Damage to physical assets and disruption of operations • Increase in customer defaults • Damage to loan collaterals • Increased claim amounts
Transitional Risks	• Decrease in customers' repayment capacity • Depreciation of assets and collateral • Cancellation of licenses • Quotas and other limitations • Tax regulation updates • Changes in consumer and investor preferences
Loss of reputation	• Public reaction due to the financing provided for projects that harm the environment

Source: [13,66].

As Turkish fintech start-ups as the above listed ones continue to emerge with a focus on risk assessment and management via these new generation technologies, Turkish fintech sector could provide analysis of insurance data, cross-reference of it with current climate change effects around the world and provide scenario analysis and simulations for monetary valuation of climate change related physical risks. These analyses could further enhance value propositions of Turkish fintech companies focused on credit scoring.

Banking technology has also been among the top five most preferred areas of activity for Turkish fintech companies since 2016 [51], and it is essential to form a data infrastructure for reflecting the effect of climate change-related risks on balance sheets of banks and account for these risks in capital adequacy ratio calculations to increase the financial stability of Turkey's banking sector via fintech sector [66]. Many significant effects of climate change can be analyzed with such data. For example, a statistically significant relationship was found between delays in loan repayment for agricultural, energy, food, and lumber production loans in Antalya, Turkey (located on the south coast of Turkey) and extreme weather events as well as deviation in rainfall and average temperature [67].

5.2. The Current Status and Agenda of Fintech Sector in Turkey in Assessing Climate Change Related Transitional Risks

With the development of a taxonomy to categorize different actions from the perspective of climate change and sustainability, carbon emissions could be measured systematically and can be included with climate events to calculate trade losses as well as financial losses due to transitional risks. For instance, lack of a carbon pricing mechanism would impose additional costs for exports to EU due to CBAM and could also cause loss of trade altogether because of competition from other countries for trade. Even before establishment of a national carbon pricing mechanism and market, through the Turkish fintech sector, it could be possible for Turkish exporters to EU to benefit from international climate markets via Distributed Ledger Technology or Blockchain. Climatecoin in Switzerland offers a carbon credit market represented by tokens to compensate for carbon emissions via contributing to climate change mitigation projects [14]. There are currently more than 20 Turkish fintech companies providing blockchain technology-oriented solutions [52], which would allow Turkish producers to connect to international markets and perform carbon trading.

As discussed in the above example for physical risks, agriculture is one of the sectors that could be significantly affected by climate change. For instance, climate change and the resulting rise in temperatures will lead to higher evaporation, lower rainfall, and hence

higher irrigation needs in Mediterranean regions [68]. They may also make growing some fruits in these regions infeasible. These changes will affect farmers' repayment capacity and values of their collateral, and fintech solutions could help mitigate potential financial losses by careful risk assessment and resulting recommendations made to farmers on their financing decisions. Some Turkish fintech companies that are focusing on agricultural financing solutions offer seed, feed, and fertilizer sales via loans, rural agricultural insights, and financial management solutions for farmers and dealers in agriculture [52].

Transitioning to a circular economy emphasizes lifecycle impact assessment for products, rather than measuring the impact on the climate during the production phase only. To achieve this, AI, Big Data analytics, and blockchain technologies can be combined by fintech companies' services to process large amounts of data for measuring lifecycle impact of a product to the climate and to increase pricing accuracy and reliability [14]. Turkey has been monitoring and reporting installation-level Green House Gas emissions since 2015 for energy and industry sectors (e.g., coke, metals, cements, chemicals) [2]. Enhancing this monitoring and reporting system could affect investor preferences favorably as well as provide evidence on the causes of any changes observed. Since payment systems has been the dominant area of activity for the Turkish fintech sector and there is high adoption rate for electronic payments, Turkish fintech companies already have vast amounts of data created in real time on changes in consumer preferences and can incorporate any promotional campaigns via many payment products such as reward or bonus programs on card payments.

As financial consequences of climate change-related risks are assessed through fintech solutions involving high amounts of data processing from various disparate sources such as weather reports and government and academic databases, applying the "Do No Significant Harm" principle of EU taxonomy would be more achievable, and this would help avoid loss of reputation risks on loan and other financial decisions.

5.3. The Current Status and Agenda of Fintech Sector in Turkey in Increasing Sustainable Loans and Funds and Strengthening Collaboration of Stakeholders in Sustainable Finance

In line with the second set of objectives in BRSA's strategy document, Turkey needs to increase green loans provided and funds made available for sustainability-oriented projects and activities. Turkey has made significant progress in providing loans for renewable energy. Turkish Development and Investment Bank (TKYB) issued Turkey's first green/sustainable bond in the international capital markets in 2016, and Garanti BBVA followed in 2019. Sekerbank provided a green loan (EKOkredi) to finance energy efficiency projects of SMEs, individuals, and industrial and agricultural enterprises. In 2020, 40% of the loans extended by Turkish banks to the energy sector were used for renewable energy projects. Thus, the Turkish banking sector continued to contribute to increasing the share of renewable energy in the energy sector.

Turkey also has made significant progress in Participation (Islamic) finance. Islamic finance is a powerful tool to support sustainable finance, and Islamic fintech solutions provided by the Turkish fintech sector could boost loans provided for renewable energy and other sustainability projects. Islamic banks could help form Islamic fintech companies in Turkey; for instance, Kuveyt Turk has opened Architect, an Islamic financial technology company, and its fintech solutions have been adopted both in Turkey and abroad [69]. Istanbul Financial Center (IFC) will focus on Islamic finance as the other core strategic foci along with fintech, and it is expected to accelerate Turkey's growth on providing fintech solutions in sustainable finance [2]. IFC is expected to transform Istanbul to a financial hub, providing a nurturing ecosystem not only for fintech, but all stakeholders of Turkey's finance ecosystem.

Forming a comprehensive data source with data extracted from multiple sources combining climate related and financial data, processed via AI, Big Data, blockchain, and other new-generation technologies could help Turkey increase use of public funds for sustainability projects such as Sustainable Cities Program for ILBANK, which is a state-

owned development and investment bank. As an example, this project provides funds for renewable energy and waste management [2].

5.4. The Current Status and Agenda of Fintech Sector in Turkey in Increasing Social Sustainability

Turkish fintech companies contributed significantly to increase financial inclusivity. Such Turkish fintech solutions helped increase financial literacy and guide consumer behavior towards a savings rather than consume-and-waste perspective (e.g., Manibux), these solutions are usually combined with payment services via a card provided. As payment services are the fintech solutions where Turkey's fintech ecosystem has the greatest strength, there is significant potential in socially sustainable fintech applications. This and similar projects contribute to the Sustainable Development Goal "Responsible Consumption and Production".

Turkish fintech solutions contributed to financial inclusivity from the supply side as well, by providing payment-oriented fintech solutions such as developing mobile apps to use cell phones as POS devices and allowing SMEs to benefit from financial services and connect with consumers who prefer to use credit cards instead of cash [55]. The fintech solutions for agricultural loans discussed above also contribute to increase financial inclusivity by allowing farmers access loans with favorable rates and payment terms. Turkish fintech solutions on payment systems further contribute to decrease operational and other expenses for SMEs and increase their access to financial resources better than traditional banking solutions. In this regard, Turkish fintech companies demonstrated significant growth and contributed to the Turkish financial system greatly.

As telecommunication and Participation (Islamic) finance are other strong aspects of the Turkish financial system, there have been fintech solutions provided with collaboration between them in microfinance. Since cell phone usage is highly adopted in Turkish consumer segments of all levels of earning, microfinance applications diffused via mobile service providers could help promote financial inclusivity and social sustainability (e.g., Financell provided by Turkcell).

We finalize the discussion with Table 6 below which summarizes the past and potential future accomplishments of the Turkish fintech sector particularly pertaining to promoting sustainable finance.

Table 6. Past and Potential Future Accomplishments of Turkish Fintech Sector Pertaining to Promoting Sustainable Finance.

Past and Potential Future Accomplishments of Turkish Fintech Sector	Role in Promoting Sustainable Finance
Provided many highly adopted fintech applications in Turkey such as electronic payments and money transfers, issuance of loyalty cards, digital wallets, and installment plans on credit cards	Increased financial inclusivity by easing access to financial services and decreasing their cost at the same time; with a taxonomy adopted, these systems will also help measure carbon footprint of individuals and companies to form Environmental Impact Assessment
Provided payment-oriented fintech solutions such as developing mobile apps to use cell phones as POS devices and allowing SMEs to benefit from financial services and connect with consumers who prefer to use credit cards instead of cash	Increased financial inclusivity for underbanked SMEs
Provided fintech solutions for agricultural loans to be offered with more favorable conditions in terms of credit pricing and payment term compared to traditional banking	Increased financial inclusivity for underbanked farmers
Provided microfinance solutions diffused via mobile service providers	Increased financial inclusivity for underbanked individuals by easing access to financial services and decreasing their cost at the same time

Table 6. *Cont.*

Past and Potential Future Accomplishments of Turkish Fintech Sector	Role in Promoting Sustainable Finance
Provided online systems for financial institutions to contract with their customers digitally	Increased financial inclusivity via digital onboarding and other digital banking services especially at times of crisis such as a pandemic
Provided solutions that helped increase financial literacy and guide consumer behavior towards a savings rather than consume-and-waste perspective	Contributed to Sustainable Development Goal "Responsible Consumption and Production"
Provided crowdfunding services for production start-ups to raise capital for equity in crowdfunding platforms	Created more opportunities for renewable energy and agricultural technology start-ups to raise capital
Expected to provide BaaS services to allow the consumers to access banking services embedded in many online transactions such as e-commerce	Could help increase the diffusion of green loans and purchases of products with lower impact on the climate by easing the application for such a loan at the time of online transaction or purchase, it could also increase traceability of such activities for environmental impact assessment
Expected to provide a sandbox environment in Istanbul Financial Center for fintech companies to gain real-time experience and for regulatory authorities to detect regulatory needs and improvements	Could help improve the legal infrastructure to promote sustainable finance with fintech solutions via providing access to demand and regulatory bodies in a protected environment for fintech companies
Expected to provide opportunities for companies to connect to international markets and do carbon trading via blockchain and other new generation technologies for compliance with CBAM and other trade regulations	Could help companies to offset their carbon imprint and compete internationally for export

Source: Created by Authors.

6. Conclusions, Discussions, and Recommendations

In this study, we presented the case of Turkey for the status and agenda of fintech in promoting sustainable finance. Turkey is one of the largest emerging market economies in the world [31] with a strong banking system and high adoption of technology, so it has great potential to benefit from fintech solutions to boost sustainable finance. The study provided a detailed presentation of the development and structure of the fintech sector in Turkey and its current strategic action plans for sustainable finance from various sources of data including a research platform for Turkish start-up ecosystem intelligence, many reports, statements of regulations from Turkish governmental offices and auditing companies, and documents released on Turkey's development on sustainable and green finance by global institutions.

A detailed discussion was then presented on the status and agenda of fintech in promoting sustainable finance in Turkey. We found that Turkey has made a high level of progress in increasing financial inclusivity for underbanked individuals and SMEs. Turkey was able to provide contactless payment and contract systems and microfinance by mobile carriers and other online platforms to complete transactions such as opening an account in minutes to increase access of disadvantaged consumers and companies to the financial system. Turkey was also able to promote the responsible consumption goal for sustainable development by improving fintech solutions on payment systems via adding educational content to the applications.

Based on this analysis, several policy recommendations and implications have emerged, which are broadly in line with the propositions of earlier studies in the literature. To begin with, as our analysis has clearly shown, the Turkish financial services sector has already started benefiting from converging digitalization and sustainability. As discussed by George and Schillebeeckx (2021) [32], new digital technologies are expected to further empower novel sustainability solutions. This has already been happening in Turkey. By adopting PSD2 and putting in force the Law on Payment Systems, policy makers have paved the way

to the adoption of new technologies with respect to payments (Table 2). Policymakers in other countries should follow suit to be able to reap the full benefits of financial innovation.

As Babarinde et al. (2020) [38] suggests, it is vital that the banking industry keeps pace with the digital innovations. In Turkey, the banking sector started supporting and promoting fintech through establishing their own technology subsidiaries and exploring new financial technologies. Other countries should also note that several Turkish banks have also started to sponsor incubators and accelerators to support emerging fintech startups, while others have started establishing venture funds and investments in fintech (Table 4).

Furthermore, with the new regulations on open banking and BaaS, Turkey is expected to benefit from its high level of e-commerce turnover to increase access to loans and at the same time better measure the impact of them on the environment by providing instantaneous data collection on the purchases they are used for. A key finding of the present analysis is that fintech has started to redefine the financial services sector in Turkey. Our analysis therefore lends support to Palmie et al. (2019) [35] who argue that the fintech ecosystem has disrupted the financial services industry.

Our analysis on the Turkish experience with fintech is in line with the proposition of Elsaid (2021) that fintech firms are expected to steal some market share away from banks but are not expected to substitute banks completely [16]. Our analysis particularly lends support to Moro-Visconti et al. (2020) [21] and Kabulova and Stankevičienė (2020) [41], who discuss that fintech is expected to reshape the financial industry by cutting costs, improving the quality of financial services, and creating a more diverse and more stable financial landscape.

Turkey has made significant progress on increasing financial inclusivity through fintech-based online payment and loan applications pertaining to underbanked groups such as farmers since many Turkish fintech companies work on this for their value propositions (Table 3). This is well aligned with the emphasis in the recent literature on: providing more opportunities of financial inclusivity via digitalization to increase agricultural and other activities conducted with the ESG perspective (Mejia-Escobar et al. (2020) [20]); filling the lack of access to financial services by the underbanked (Varga (2018) [42]) through emphasizing digital money (Gálvez-Sánchez et al. (2021) [43]); and using interoperable electronic payments systems as one of the pillars for an economy to leverage fintech for sustainable development (Arner et al. (2020) [45]).

With the Secondary Legislation on Equity-Based and Debt-Based Crowdfunding by Capital Markets Board of Turkey passed in 2021, Turkey will be able to align the use of crowdfunding more effectively with other fintech applications such as digital payment to enhance its digital marketplace for financial inclusivity of farmers and agricultural sustainability to realize the models proposed in the literature (Anshari et al. (2018) [23]). As financial inclusivity is especially important for emerging economies, Turkey's progress in this aspect via first strengthening the legislative structure with consecutive regulations as well as amendments to the previous ones for compatibility with global regulations such as PSD2, and then having the banking sector and other strong stakeholders supporting the fintech start-ups (Table 4) to achieve innovative solutions represents an effective roadmap for other emerging economies.

As discussed by Hommel and Bican (2020) [24], fintech has a technological advantage over traditional financial institutions through "customer-centricity" and enhanced efficiency. Our analysis is particularly in line with Rose (2020) [37], who explains that mechanisms such as distributed ledgers and other financial technologies may increase trust and reduce transaction costs in traditional finance. Malamas et al. (2020) [36] emphasize the potential benefits of a blockchain-enabled issuance architecture for green bonds, and Deschryver and Mariz (2020) [40] conclude that the full potential of green bonds to finance sustainability goals has not been achieved.

Coupled with Aysan and Bergigui's (2021) [27] conclusion on the benefit of the use of blockchain in participation finance for adapting to climate change and transition to

circular economy, we believe an important milestone for Turkey to promote sustainable finance with fintech would be extending the use of blockchain in fintech. There are currently 79 fintech start-ups with blockchain in their value propositions whereas there are 228 payment-oriented fintech start-ups (Table 3); thus, we expect the share of blockchain-oriented companies to increase in Turkey's fintech sector as well as other countries, especially the ones applying participation finance. Our analysis has emphasized the importance of increasing the use of new-generation technologies such as Big Data, Artificial Intelligence, and Blockchain to combine data from various resources on climate change with the existing data in the Turkish fintech ecosystem. Certainly, this applies to other countries as well.

It is also clear that fintech and innovation will present reputational gains for the financial services industry as suggested by Anagnostopoulos (2018) [33]. Other benefits include risk mitigation, which is also discussed in detail by Acar and Citak [17]. Our analysis lends support to Yang (2020) [18], who discusses that fintech can facilitate the development of green finance by decreasing bank credit risk, enhancing the regulation level, stimulating product innovation, and the perfection of the information-sharing mechanism. It is noteworthy that some Turkish banks have started providing open banking products to support the growth of fintech businesses by making their APIs available. It is recommended that banking sector regulators adopt similar policies particularly with respect to banks' APIs.

Our analysis also concurs with Cen and He (2018), who explain that fintech promotes both green finance and sustainable development [19], and Chueca Vergara and Ferruz Agudo (2021) [26] who discuss that fintech can make financial businesses more sustainable overall by promoting green finance. Our analysis is therefore also aligned with Chen and Volz (2020) [39] who discuss that fintech may help to mobilize financial resources for sustainable infrastructure investments. Likewise, our analysis also lends support to Puschmann et al. (2021) [25] who argue that "green fintech" can also alleviate the impact of climate change as it has an impact along the whole value chain of financial services. For a country with an upward trend in the annual recorded climate-related events, this is a particularly important point to consider. Policy makers in other countries would be well-advised to take these points into consideration.

It is evident that there are challenges with respect to development of fintech and there are various considerations and barriers that need to be addressed to achieve green finance as discussed by Nikolaou (2018) [34]. In Turkey, some banks have tech subsidiaries, incubators/accelerators, and/or corporate venture capital funds. Looking forward, with the upcoming developments such as the sandbox environment to be built in Istanbul Financial Center, such fintech solutions could be developed much faster with collaboration between banking and fintech sectors and regulatory institutions. Turkey, therefore, is set to serve as an inspiring role model for other countries in terms of adopting the related regulations and forming a start-up ecosystem to facilitate the development of their fintech sectors.

Finally, limitations and future directions related to this article can serve as guidelines for researchers about what can be explored further in future research. For instance, due to data availability issues with respect to fintech and innovations, we have not been able to carry out an empirical analysis. Due to the lack of time series data, we have not been able to carry out an econometric analysis to explore the impact of fintech on the banking sector. Likewise, the existing studies lacked empirical findings based on which we could come up with policy lessons for Turkey. Researchers would be advised to collect cross-sectional data on the adoption of fintech by using relevant proxies to be able to carry out econometric research.

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