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Insurtech, Proptech & Fintech Environment

Sustainability, Global Trends and Opportunities

Edited by
Salvador Cruz Rambaud and Joaquín López Pascual

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Cover image courtesy of Salvador Cruz Rambaud

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About the Editors

Salvador Cruz Rambaud

Salvador Cruz Rambaud was born in Cádiz, Spain in 1957. He received a degree in Mathematics from the University of Granada, Spain in 1981; later, he received a degree in Economics and a PhD degree in Economics and Business from the Open University, Madrid, Spain in 1991 and 1994, respectively. In 1992, he joined the Department of Accounting and Finance, University of Almería as a lecturer, where he became an Associate Professor in 1996 and a Professor in 2010. His current research interests include anomalies in intertemporal choice, the mathematical analysis of financial operations, and the elicitation of new statistical distributions in finance.

Joaquín López Pascual

Born in Madrid, Joaquín López Pascual has received a PhD in Economics and Business Management, a masters in Financial Management, and a Bachelor of Law from the Universidad Complutense de Madrid. He joined the Board of Directors of BFA-Bankia as a nonexecutive member. He was a chairman of the audit committee between 2015 and 2019. He has acted as Counsellor for the "Colegio de Economistas" and as the General Advisor of the Spanish Economic Association (2011-2015). He has been General Secretary at the Colegio Universitario de Estudios Financieros (CUNEF) and Board Secretary at Patronato CUNEF (2007-2014). He has been a Representative of the Spanish Ministry of Education in Brussels for the 2020 Universities Working Group Digital and Online Learning (2014-2015). Also, he is currently a Full Professor of Accounting and Financial Economics at the Universidad Rey Juan Carlos (Madrid), which he has been since 2002. He has served as a Professor at the Universidad Complutense and Universidad Carlos III (Madrid), CUNEF, Instituto de Estudios Bursátiles, Full Professor at Universidad de Extremadura, Senior Visiting Scholar at Regent's University of London, and Senior Visiting Researcher at Dublin Business School.

Preface to "Insurtech, Proptech & Fintech Environment: Sustainability, Global Trends and Opportunities"

The relationship between fintech and sustainability and the different areas of collaboration between fintechs and sustainable finance were the main focus of this publication, highlighting how fintechs may play pivotal roles in the pathway towards a sustainable future.

As a result of transformation in the traditional banking and finance industry because of fintech disruption, many new opportunities have been created. Thus, banks are investing heavily in technology to implement real-time payment systems, partnering with fintech firms to do so.

The opportunities for growth and development are endless, and the potential for high rewards is great. Fintech companies are moving to the forefront of emerging technologies and working in this sector can provide access to the latest innovations. Due to those new opportunities and global trends pointed out in this publication, the financial industry will likely not be the same anymore.

Salvador Cruz Rambaud and Joaquín López Pascual
Editors

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Editorial

Insurtech, Proptech, and Fintech Environment: Sustainability, Global Trends and Opportunities

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The Special Issue "Insurtech, Proptech, and Fintech Environment: Sustainability, Global Trends and Opportunities" is focused on the InsurTech, PropTech, and FinTech environments. It is well known that "FinTech" comes from the union of two words, "Finance" and "Technology", "InsurTech" is the union of the words "Insurance" and "Technology", and PropTech is the use of technology in the real estate industry to make transactions more efficient. This sector is probably one of the most relevant new markets in recent years, with a great potential to generate collaborations with financial institutions and the insurance world, and jointly grow towards a more innovative business model.

This sector features investors who seek to detect the best investment opportunities without intermediaries and with all those companies which want to collaborate with different products and services related to the technological, legal, marketing, and human resource departments, among others.

This objective implies an advanced business model which adopts emerging technology and pays special attention to the digital transformation of the financial industry and its effect on sustainability. Analysis and research on the opportunities, challenges, and global trends in this sector may contribute directly and indirectly to the achievement of a sustainable development industry. Therefore, we consider that there is great potential to make further contributions on this topic.

Thus, papers published in this Special Issue have covered some of those topics from a wide range of views and fields such as financial, technological, digital, management, international business, and quantitative analysis, including sustainable businesses. Moreover, the contributions included in this Special Issue have not been limited to academics, but also to practitioners who have been very welcome.

In summary, this Special Issue has included original contributions demonstrating the significant advancements, innovations, relevance, and potential growth of this sector in the forthcoming years. This Special Issue has also focused on the main forms of interaction between banks and FinTech companies.

After describing the main characteristics of the Spanish companies belonging to the FinTech, InsurTech, and PropTech sectors, the main objective of [1] was to analyze whether their B2B/B2C business models were related to the existence of sustainability plans. Specifically, this manuscript analyzed whether the existence of a sustainability department is a determining factor for the business model adopted by the Spanish FinTech, InsurTech, and PropTech companies. By using the multinomial logit regression, other factors such as the current closeness of companies to the sustainable development goals (SDGs), the sensitivity to domestic and European FinTech/InsurTech regulations, and the perception of FinTechs about such European regulations were discussed before conclusions.

In [2], the role of digital technostress and self-efficacy in digital marketing research is seldom discussed and even more rarely examined among Gen Z consumers. This

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manuscript investigates the relationships between four sub-dimensions of technostress (complexity, overload, invasion, and uncertainty), digital technology self-efficacy, and FinTech usage intention. Data from a total of 266 Chinese Gen Z consumers were used in a multiple-regression analysis. The results of this study support that all sub-dimensions of technostress were negatively related to FinTech usage intention. Related to the moderating effects of digital technology self-efficacy on the relationship between the four sub-dimensions of technostress and FinTech usage intention, significant interaction effects with complexity and overload were found.

In [3], the technology effectiveness was examined for industry demand in which artificial intelligence (AI) is applied in the financial sector. This study examined bank revenue methodologically and assessed the impact of customer service and chatbot on bank revenues through customer age classification. The results indicated that new product-oriented funds or housing subscription savings were more suitable for purchase through customer service than through chatbot. When classified by age, purchases by the majority age group in the channel positively affected bank profits. Finally, it was shown a tendency to process small banking transactions through the chatbot system, which saves transaction and management costs, positively affecting profits.

The aim of [4] was to assess telematics technology acceptance for insurance purposes. This study was based on the Unified Theory of Acceptance and Use of Technology (UTAUT). By interviewing 502 new car buyers, the factors affecting the potential usage of telematic devices for insurance purposes were tested. The results indicated that facilitating conditions are the main predictor of telematics use. Moreover, privacy concerns related to the potential abuse of driving behavior data played an important role in technology acceptance. Although novel insurance technologies are mainly presented as user-driven, users (drivers and insurance buyers) are often neglected as an active party in the development of such technologies.

In [5], the main goal was to answer whether FinTechs are more similar to traditional banks or trendy technological firms. This study focused on analyzing the differences between FinTechs and traditional banks in market valuation, showing the potential for digital interaction and the cross-pollination of complementary business models. The main contribution of this paper was that the appraisal approaches of FinTechs follow those of technological startups, having a revenue model much more scalable than that of a typical bank. FinTechs may so provide a solution for sustainable finance with microfinance and crowdfunding, among others.

The FinTech phenomenon from an ecosystem point of view is analyzed in [6]. In effect, this study explored the FinTech ecosystem composition in order to understand better business model innovation based on underlying ecosystem dynamics whilst focusing on the specific role of cross-sector actors. Adopting a comparative case study method by considering the China-based Alibaba Group and Tencent, the study's findings indicated that novel business model developments based on strong technological expertise and scale-based resources by cross-sector Fintech render a functional perspective on the fast-developing FinTech industry less practical. Thus, this manuscript contributed to the scant literature on FinTech ecosystems and their sustainable development.

Entrepreneurship through digital innovation in the financial market as well as investors' influence on digital technology-based entrepreneurs' funding decisions was the subject of [7]. This research attempted to analyze the decision-making criteria for funding financial technology companies (FinTechs), hybrid companies which combine digital entrepreneurship, technology, and banking. Through developments in digital technology, banks have shifted from traditional money-lending activities (i.e., debt-financing) to becoming stakeholders in FinTechs and, hence, equity investors.

The achievement of the development and sustainable growth of Fintechs was the main topic addressed in [8]. This study focused on two relevant issues: uncertainty and information technology (IT) quality, exploring the relationship between uncertainty and IT quality, both of which significantly affect FinTech continuance intentions. The

results demonstrated that system quality is negatively related to perceived risk, whereas information quality is positively related to trust. Service quality was the most important quality factor for controlling uncertainty and encouraging the continued use of FinTechs.

The relationship between FinTech and sustainability, and the different areas of collaboration between FinTech and sustainable finance was the main goal of [9]. In this paper, two FinTech initiatives (clarity AI and Pensumo) were described, as well as several proposals to improve the detection of greenwashing and other deceptive behavior by firms. The results led to the conclusion that sustainable finance and FinTech have many aspects in common, and that FinTech can make financial businesses more sustainable overall by promoting green finance.

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Article

Business Models and Sustainability Plans in the FinTech, InsurTech, and PropTech Industry: Evidence from Spain

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Abstract: After describing the main features of the Spanish companies belonging to the FinTech, InsurTech, and PropTech sectors, the main objective of this study is to analyze whether their B2B/B2C business models are related to the existence of sustainability plans. Specifically, this paper analyzes whether the existence of a sustainability department is a determining factor for the business model adopted by the Spanish FinTechs, InsurTechs, and PropTechs. By using the multinomial logit regression, other factors such as the current closeness of companies to the sustainable development goals (SDGs), the sensitivity to domestic and European FinTech/InsurTech regulations, and the perception of FinTechs about such European regulations are debated before conclusions are drawn for a future research agenda.

Keywords: FinTech; InsurTech; sustainable development goals; sustainability performance; logit regression

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1. Introduction

The financial industry is constantly coining new terms to label and categorize emerging concepts, ideas, technologies, and activities such as 'FinTech', 'PropTech', 'InsurTech, 'RegTech', or 'WealthTech' (see Figure 1). Consequently, the 'Tech family' continuously increases, with new relevant neologisms by adding the –Tech suffix to a prefix which quickly becomes part of trend reports [1]. However, although almost self-explanatory, sometimes these terms can be a bit confusing.

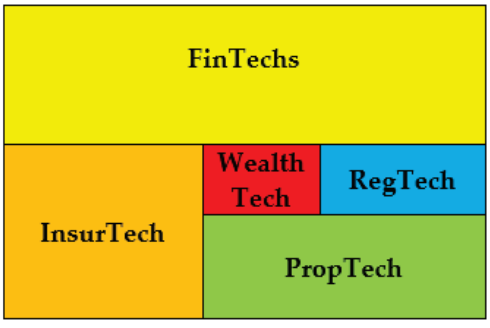

Figure 1. FinTechs. Source: own elaboration.

Recently, some scholars (e.g., [2]) highlighted that, after the 2007–2008 global financial crisis, research flourished on entrepreneurship through digital innovation in the financial market as well as on investors' influence on digital technology-based entrepreneurs' funding decisions. Despite the high expectation generated, some scholars [3] consider that the expected growth has not been reached in the real world because FinTech is innovative but inherently unpredictable. This means that customers are still hesitant to adopt and use FinTech, which ultimately affects its growth.

On the other hand, InsurTech is a phenomenon comprising innovations of one or more traditional or non-traditional market players exploiting information technology to deliver solutions specific to the insurance industry [4]. This application of new technologies to the insurance sector has not only had a great revitalizing effect on a traditionally stable and oligopolistic sector but has also prompted a redefinition of the roles of insurance companies and greater prominence has been given to consumer needs, adapting the offer towards more attractive products where the user seems to occupy the center of the business model [5], fostering value co-creation patterns.

Finally, PropTech is going to have an increasing impact on the real estate sector in the future due to the potential disrupting of the world's oldest and largest industries, starting from the registry that can be validated with blockchains. We expect to see PropTech also playing an increasingly important role in financial, commercial and residential real estate.

Within this introductory **framework**, the **main objective** of this study is to analyze whether the B2B/B2C business model followed by the Spanish companies of FinTech, InsurTech, and PropTech is related to the existence of sustainability plans in such companies. Specifically, this paper analyzes whether the existence of a sustainability department is a determining factor for the business model adopted by the Spanish FinTechs, InsurTechs, and PropTechs. However, RegTech, WealthTech, and other peculiar FinTechs recalled in Figure 1 will not be treated in this paper, leaving space to further research. **Methodologically**, we will use the multinomial logit regression to relate some categorical variables concerning the implementation of sustainability measures in FinTechs with the consumers' demand for financial products (which determines the business model). The **findings** reveal that the growing demand for financial products from other companies (B2B operations) can be identified with a higher presence of sustainability departments in Spanish FinTechs.

To do this, the **organization** of this paper is as follows. After this introductory section, Section 2 illustrates the literature review. Section 3 is dedicated to the materials (sample questionnaire) and the methodology employed in this paper. Section 4 displays the results, followed by a discussion (Section 5). Finally, Section 6 summarizes and concludes.

2. Literature Review

Existing research papers have focused on FinTech, InsurTech, and PropTech from different perspectives. Some scholars emphasize the relation between **FinTech** and technology-enabled financial solutions, as the new marriage of financial services and information technology combined words (Fin+Tech) are considered [6]. FinTechs are considered a disruptive, competitive, and sustainable industry [7]. This line of research has been well developed in recent years with numerous publications addressing the topic. Digital financial and FinTech services have emerged as a part of the fourth industrial revolution [8]. These services, generally supported and welcomed by consumers, have now reached a stage that lets them disrupt traditional financial structures, disintermediating old-fashioned supply chains. Cortina and Schmukler [9] point out that the period since the credit crunch of 2008 has been characterized by the emergence of a broad set of tech-driven financial companies (i.e., FinTechs), acting in parallel with traditional banking services. A taxonomy of the main FinTech functions is represented in Figure 2.

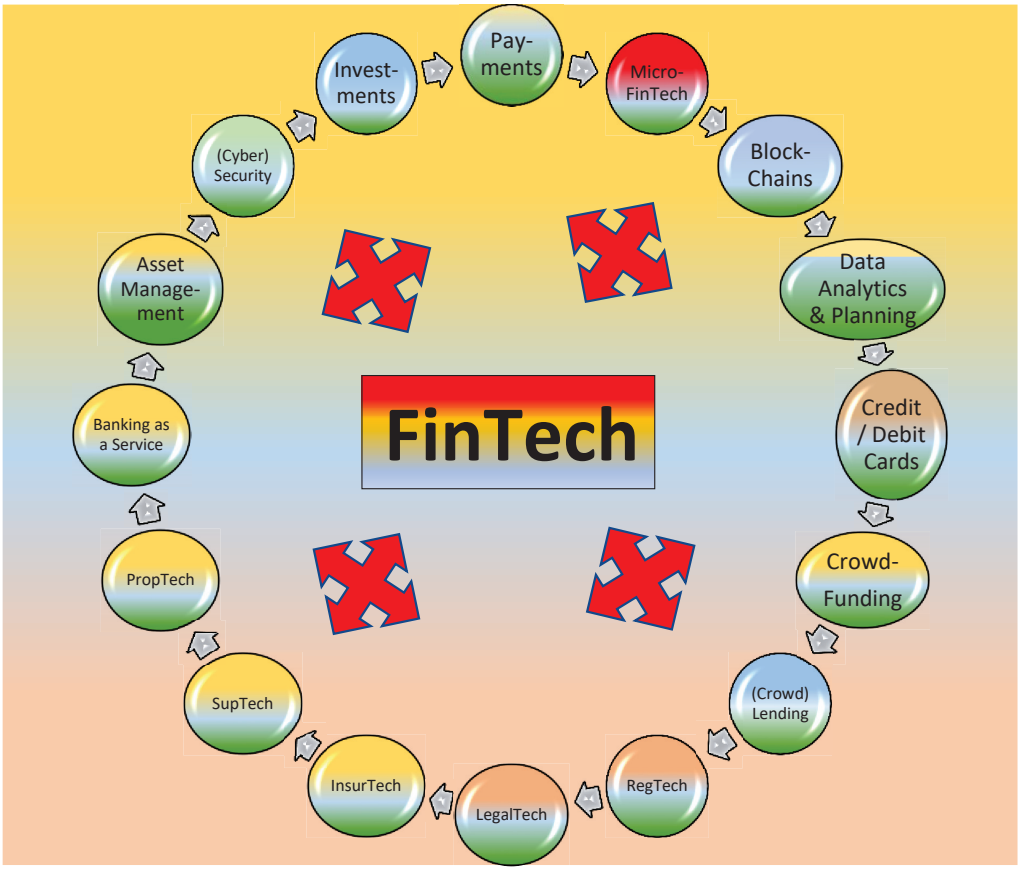

Figure 2. FinTech taxonomy. Source: adapted from [10].

At work in our times, three aspects of the FinTech Revolution have been suggested by Gomber et al. [11]: technology innovation, process distribution, and services transformation. Furthermore, some scholars (e.g., [12]) consider that the increasing focus on the FinTech sector is a global phenomenon as the mass emergence of new, non-bank players and start-ups can be observed in both developed and developing markets.

Despite the rising wave of FinTech and its aggressiveness in taking place in the global financial and banking system, traditional banks have not yet exhausted the possibilities for improvements [13]. According to Gulamhuseinwala et al. [14], FinTech products—financial services developed by non-bank, online companies—offer alternative ways of accessing a variety of services, from money transfers to financial planning. However, the financial services sector is in the nascent stage of digital disruption [15,16] as its main functions are the same today as they were yesterday—people use financial services to exchange money, save or invest, finance, or insure against risk.

On the other hand, the connection between finance and technology is producing a collaborative spirit in both sectors that is blurring the traditional business lines [17]. Thus, FinTech covers digital innovations and technology-enabled business model innovations in the financial sector [7,18]. Such innovations can disrupt existing industry structures and facilitate strategic disintermediation (e.g., through decentralized blockchains used with cryptocurrencies), and democratizing access to financial services, but also create significant privacy, regulatory, and law enforcement challenges [19]. For instance, regulators are facing new challenges which involve ensuring a level playing field for the different players and

protecting users [20]. Tight regulation is typical in the financial industry (as mushrooming RegTechs or SupTechs evidence) and what works in Spain is most likely applicable within the EU.

In summary, although the world of finance, in particular the banking sector, has proven to be of outstanding importance in the daily lives of people around the globe [21], three suggested external factors are driving FinTech adoption and continued use [22]: cost savings, customer friendliness, and ease of access. Information technology (IT) is the magic word behind these three forces.

Concerning insurance technology (**InsurTech**), the internet and related advances in information technology significantly affect financial services, in general, and insurance markets and institutions, in particular [23]. Coupled with other important trends such as globalization and regulatory reforms, these changes force far-reaching changes upon the insurance industry and make it more competitive. The modern insurance business, including developing countries, is associated with the introduction of innovations [24]. Moreover, insurance companies have some of the highest overhead costs, which often are transferred to customers as premiums for insurance products [25]. Whereas companies are adopting digital innovation to reduce expenses by optimizing their operational functions, not all are ready for the digital transformation journey, which risks their routine existence.

However, the insurance process is still quite tiring and tiresome with numerous inefficiencies [26]. To put an end to this, InsurTech startups intend to use disruptive technologies such as big data, the internet of things (IoT), technology mobile, artificial intelligence (AI), and data validating blockchain. In effect, insurance providers intend to use all these technologies to help them add value to the consumer and build loyalty from the customer to the brand. In addition, InsurTech startups aim to offer information to the consumer about the risks of being able to create customized insurance [27], and exploit smart contracts.

Emerging economies with a growing middle class and low insurance penetration rates may present exceptional opportunities over more mature economies. Some of them, including highly populated India, Singapore, Hong Kong, the United Arab Emirates (UAE), and many others, are proactively encouraging InsurTech ecosystems.

Bernardino [28] points out that the insurance sector is facing many challenges whilst the rapidly changing business environment also provides several opportunities. As insurers, regulators and supervisors navigate the digital revolution, the challenges of cyber risk and corresponding opportunities of cyber insurance, the risks associated with a prolonged low yield environment, and the opportunities of taking a stewardship approach to sustainable finance, it is essential that policyholders' interests remain a priority. After all these reflections, by considering the rapid evolution and penetration of technology in the financial sector in general, and more specifically in the insurance sector, FinTech and InsurTech are destined to affect the scope and the implementation of applicable regulation [29].

According to Gramegna and Giudici [30], Insurtech, which is based on the application of AI methods to (big) data retrieved from users' engagement via smartphones, can close the gap between non-life insurance providers and consumers, thereby improving the protection and resilience of our societies. The advantage of using AI applications is, in a nutshell, the capability for insurance companies to better understand consumer needs, listen to their preferences, as expressed by smartphone-generated data, and the possibility for insurance consumers to receive insurance coverage that is well suited to their needs. AI fosters self-fulfilling improvements, with scalable opportunities.

Additionally, Vargas [31] claims that the irruption of technology in an industry as traditional as insurance brings significant challenges for insurers, but it also represents great opportunities for innovation and the development of business models based on customer needs. Directly linked to the topic of big data, AI is a technology that has great potential in insurance, particularly in claims management and fraud detection [32]. Blockchain's use in insurance is also, reportedly, constantly growing and therefore showing great potential in the initial stage, in commercial lines, in the reinsurance business, and intra-group

transactions. Peer-to-peer (P2P) insurance arguably includes a business innovation stronger than the technological one, mainly digital P2P platforms.

In synthesis, InsurTech innovation can help stitch together capabilities across the insurance value chain, so carriers are better able to meet the needs of consumers, agents, and brokers [33].

Finally, **PropTech** is a generic term referring to property technologies in the real estate industry, traditionally a slow-moving asset class [34]. Data-driven markets are often characterized by a winner-takes-all competition between firms that offer platform business models centrally focused on providing digital services for users, who pay in providing more user data. Real estate is, once more, not known as an industry that readily embraces change [35]. The nature of the asset class, which comprises large heterogeneous assets traded in a large private market, is perhaps a good reason for this. Homes can be too much of a part of a private portfolio to take risks with the process by which they are traded, held, or valued. In current times, we are witnessing a battle for market share between traditional advisors and a discernible second wave of technology-based innovation. As [36] states, "thousands of extremely clever people backed by billions of dollars of often expert investment are working very hard to change the way real estate is traded, used, and operated. It would be surprising, to say the least, if this burst of activity—let us call it PropTech 2.0—does not lead to some significant change. There is beyond any doubt that many PropTech firms will fail, and a lot of money will be lost, but there will be some very successful survivors who will in time have a radical impact on what has been a slow-moving, conservative industry".

Despite being generally slow to embrace change, the real estate industry can no longer shut itself off from fundamental technological innovations [37]. Although individual areas such as the housing industry have so far been spared by disruptive business models, companies such as Zillow, Airbnb, and WeWork prove that the impact of such business models can be huge. Different market players will need to address the issues in their way. However, these developments challenge the real estate establishment and may force real-estate agents to look for other ways to add value to the consumer [38] that could otherwise look for disintermediated value chains, where digital platforms directly connect sellers and buyers. Information technology may, in turn, provide a means (e.g., data visualization, broadband telecommunications, interactive communications, dispersion of jobs and work, relationship marketing, and use of intelligent agents) to make this possible.

3. Materials and Methods

3.1. Sample and Data

Consistently with the research question, a questionnaire of 21 items (see Appendix A) was administered to all partners of the Spanish Association of FinTech, InsurTech and, PropTech (AEFI) which currently has 186 members. As the **data collection** was online, the questionnaire was designed by considering the following **steps**:

1. The **potential participants** in the research were all members of AEFI.
2. The technique used in this research was **probabilistic sampling** because all members of the population had the same probability of being selected.
3. **No segmentation** has been applied in this research.
4. The research was conducted during the **second half of the year 2021**, and it was necessary to submit the questionnaire several times to obtain a significant number of potential respondents.
5. The questionnaires were administered by using the well-known platform **Google Forms**. To do this, the questionnaire was adapted to the internet in the following way:
    (a) It was concise.
    (b) It avoided duplicate questions.
    (c) All possible alternatives were included among the answers.
    (d) The time to answer the questionnaire was moderate.
    (e) It was easily accessible from an electronic device.

6. The **privacy** of personal data was guaranteed.
7. The obtained data were **shared** with AEFI.

As a result, the number of valid responses was 55 (29.57% of associated companies), mostly provided by FinTech and InsurTech companies with head offices in Madrid (45), Barcelona (3), Valencia (2), Zaragoza (1), Munich (1), and Colombia (3).

Finally, the questionnaire was not previously validated due to the small size of the population. Therefore the questionnaire was based on that of KPMG and Funcas [39].

3.2. Methodology

The analysis follows the so-called multinomial logit regression, the methodology developed by Agresti [40,41], Agresti and Franklin [42], and Greene [43]. This method is a known extension of the binary logit. It starts from n independent observations with p explanatory variables, where the qualitative response variable has k categories. To construct the logits in the multinomial case, one of the categories must be considered the base level and all logits must be constructed relatively to it. Any category can be ta n as the base level. Since there is no order category, k can bejthen as the base level. Let π_j denote the multinomial probability of an observation falling in the j-th category. The relationship between this probability and the p explanatory variables, $X_1, X_2, \ldots, X_p$, the multiple logistic regression model is defined by:

$$\log \frac{\pi_j(x_i)}{\pi_k(x_i)} = \alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \cdots + \beta_{pj}x_{pi},$$

where $j = 1, 2, k-1$ and i = 1, 2, ... , n. As the sum of all π is 1, one has:

$$\log\ \pi_j(x_i) = \frac{\exp(\alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \cdots + \beta_{pj}x_{pi})}{1 + \sum_{k=1}^{p-1} \exp(\alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \cdots + \beta_{pj}x_{pi})}.$$

For each j = 1, 2, ... , $k-1$, the model parameters are estimated by the method of maximum likelihood. As indicated, in the multinomial logit regression model, the estimate for the parameters can be identified in comparison to a baseline category. If x denotes a matrix or a vector, let $\pi_j(\mathrm{x}) = P(Y = j|\mathrm{x})$ at a given setting x of explanatory variables, where obviously $\sum_{j=1}^{k-1} \pi_j(\mathrm{x}) = 1$. Assume that k counts all the categories of Y, with probabilities, $\pi_1(\mathrm{x}), \pi_2(\mathrm{x}), \ldots, \pi_k(\mathrm{x})$. In this context, logit models pair each response category with a baseline category:

$$\log \frac{\pi_j(\mathrm{x})}{\pi_k(\mathrm{x})} = \alpha_j + \beta_j'\mathrm{x},$$

where $j = 1, 2, \ldots, k-1$, simultaneously describes the effects of x on these $k-1$ logits. As the effects vary according to the response paired with the baseline, these $k-1$ equations determine parameters for logits with other pairs of response categories. Finally, the Pearson Chi-square statistic χ^2 and the likelihood ratio Chi-square statistic G^2 goodness-of-fit statistics provide a model check when data are not sparse [42].

3.3. Variables

To justify the variables, we are going to use in our study, Figure 3 shows the number of companies in the sample arguing each reason why sustainable finance is relevant. Observe that the items "Development of B2B new products and services" and "Portfolio management based on ESG criteria" compose 52.73% of responses. On the other hand, the item "Development of B2C new products d services" represents 20% of responses. These percentages coincide with the global figures, 52% and 34%, corresponding to B2B and B2C operations, respectively [39].

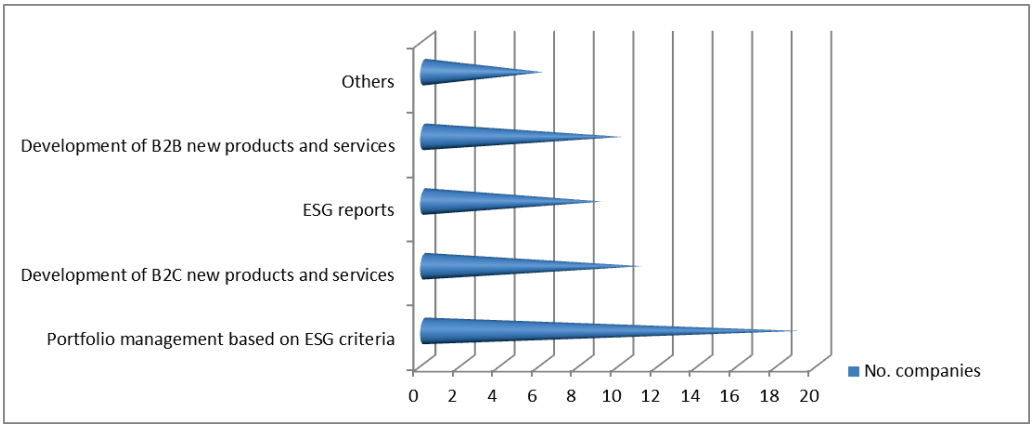

Figure 3. Number of companies arguing each reason for the relevance of sustainable finance. Source: own elaboration.

Most specialists on the issue of FinTech support the idea that the worry about sustainability is related to the fact that most FinTechs have reversed their strategy of providing services to final consumers (B2C) to provide financial services which satisfy the needs of other companies (B2B). In effect, as formerly indicated, the business model of Spanish FinTechs is changing from B2C to B2B products and services. Carbó et al. [44,45] show that most Spanish FinTechs are focused on offering their financial solutions to other firms (B2B). Thus, their business model is composed of 56.48% of B2B solutions (by obtaining revenues through commissions), 33.55 % B2C products and services, and 9.97% of mixed B2B and B2C. This is because B2B startups are more appreciated by Banks, whilst B2C are considered competitors. More FinTech startups are considered the main disruptors, but most of them have changed to B2B models to provide platforms to financial institutions [46].

Considering the closeness of FinTechs to SDGs and ESG criteria, it is logical that, in this paper, we wonder whether this change in the business model is due to the fulfillment or not of sustainability principles. In this way, item #15 of the survey offers four possible answers:

1. Sustainable products and/or services for the consumer.
2. Environmental, social, and good governance reports.
3. Products related to environmental, social, and good governance criteria.
4. Sustainable products and/or services for the company.
5. Other.

The first and fourth can be identified as B2C and B2B products and services, respectively. Observe also that the results of the survey have been reinforced by the options of the immediately previous item (#14) which serves as validation. In effect, the possible answers to item #14 are the following:

- Portfolio management based on environmental, social, and good governance criteria.
- Development of new products or services for the consumer.
- Improve reputation.
- The development of new products or services.
- Others.

Observe that these answers correspond to those of item #15 and that one of the possible answers is "Portfolio management based on environmental, social, and good governance criteria" and indeed these portfolios are designed mostly to be offered to other companies.

Therefore, the null hypothesis to be tested is the following:

Hypothesis: *"The business model (B2B or B2C) followed by the Spanish Companies of FinTech, InsurTech, and PropTech is related to the existence of Sustainability plans in such companies".*

To do this, we are going to use the variables in the questionnaire which are related to sustainability. Therefore, in our study, we will consider the following ordinal variables:

- X_1: "Implementation of sustainability plans or sustainable measures" (corresponds to item #7). Its possible values are 0 (if the answer is "No") and 1 (if the answer is "Yes").
- X_2: "Existence of a sustainability department in the company" (corresponds to item #9(d)). Its possible values are 0 (if the answer is "No"), 2 (if the answer is "Yes"), and 1 (if the answer is "Don't know/No answer").
- X_3: "Relevance and implementation of the future European regulation" (corresponds to item #18). Its possible values are 0 (if the answer is "No level of relevance" or "Long term: more than 5 years"), 1 (if the answer is "A low level of relevance" or "Medium/high term: between 3 and 5 years"), 2 (if the answer is "A good level of relevance" or "Medium/low term: between 1 and 3 years"), and 3 (if the answer is "A high level of relevance" or "Short term: less than 1 year").
- X_4: "Perception about the regulation of the European Union on Sustainable Finance" (corresponds to item #19). Its possible values are 0 (if the answer is "It is an expense/cost"), 2 (if the answer is "It is an opportunity"), and 1 (if the answer is "Don't know/No answer").
- Y: "Identification of the business model (B2B or B2C) followed by the FinTech company" (corresponds to item #15). Its possible values are 0 (if the answer is "Sustainable products and/or services for the consumer"), 1 (if the answer is "Environmental, social and good governance reports"), 2 (if the answer is "Products related to environmental, social and good governance criteria" or "Other"), and 3 (if the answer is "Sustainable products and/or services for the company"). This dependent variable reflects the degree of the business model (B2B or B2C) of the service provider among the companies in the sample.

A summary of the just-defined variables, divided into explanatory and explained, can be seen in Table 1.

Table 1. Defining the variables to be considered in the analysis. Source: own elaboration.

	Explained Variable
Y	Identification of the business model (B2B or B2C) followed by the FinTech company
	Explanatory Variables
X_1	Implementation of sustainability plans or sustainable measures
X_2	Existence of a sustainability department in the company
X_3	Relevance and implementation of the future European regulation
X_4	Perception of the regulation European Union on Sustainable Finance

By applying the methodology described in Section 3.2, we must test the following null and alternative hypotheses:

$$\begin{cases} H_0: \log(\text{odds}) = b_0 \\ H_1: \log(\text{odds}) = b_0 + b_1 X_1 + \cdots + b_p X_p \end{cases}$$

where, at least, a coefficient b_k is different from zero.

4. Results

4.1. Descriptive Results

Table 2 displays the current position of respondents in the company.

Table 2. Distribution of the questionnaire respondents. Source: own elaboration.

Founder	CEO	CFO	CTO	CCO	Other
14	9	1	1	1	29

Concerning the oldness of the companies participating in the analysis, we must highlight that most of them were created in 2013 and 2017. Figure 4 represents the number of companies created each year from 2003 to 2019.

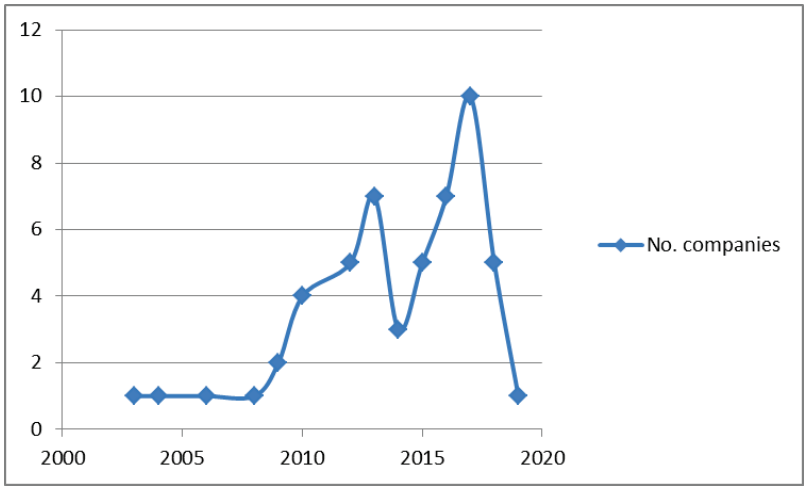

Figure 4. Number of companies according to their year of creation. Source: own elaboration.

Figure 5 shows that the size of these companies (measured by the number of employees) is extreme (mostly with less than 10 and more than 100 employees).

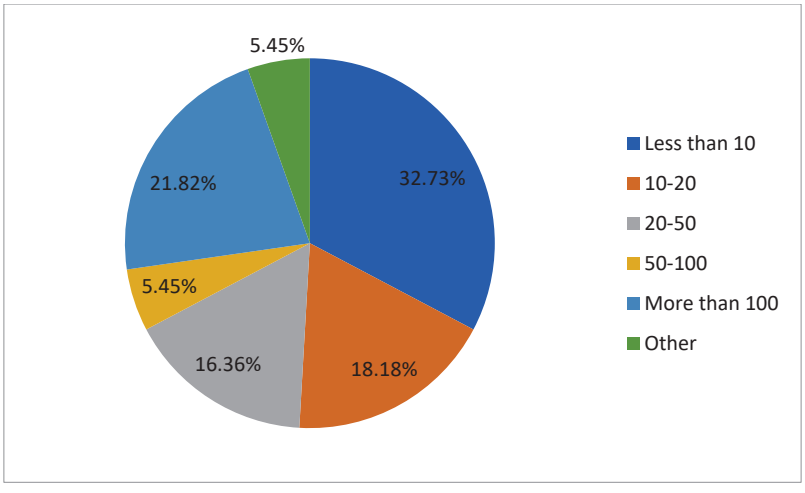

Figure 5. Size of the companies participating in the study. Source: own elaboration.

Figure 6 exhibits the number of companies according to different percentages of the presence of women in such companies. The positive skewness of this distribution shows a higher presence of men in the companies involved in the analysis.

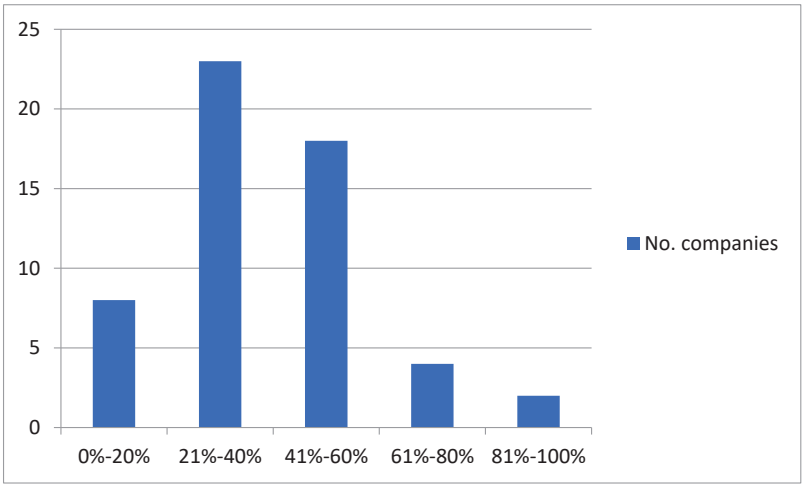

Figure 6. Number of companies according to the presence of women (in %). Source: own elaboration.

Finally, Figure 7 displays the distribution of business areas of the companies included in the sample.

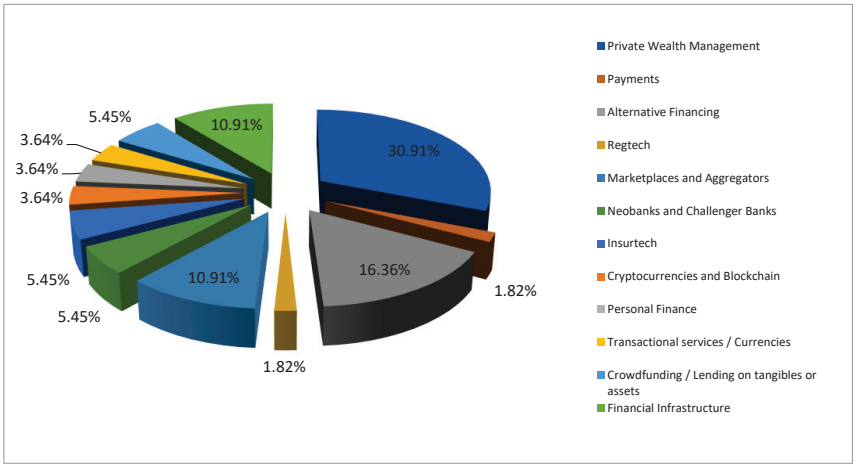

Figure 7. Business areas of respondents. Source: own elaboration.

4.2. Results from the Multinomial Logit Regression

In this paper, multinomial logistic regression was performed to create a model of the relationship between the predictor variables ("Implementation of sustainability plans or sustainable measures", "Existence of a sustainability department in the company", "Relevance and implementation of the future European regulation", and "Perception about the regulation of the European Union on Sustainable Finance") and membership in the four groups ("Sustainable B2C products and services", "ESG reports", "Portfolio management based on ESG criteria", and "Sustainable B2B products and services"). The fit between the model containing only the intercept and data improved with the addition of the predictor variables: χ^2 (12, N = 55) = 15.01, Nagelkerke R^2 = 0.24.

In this model, the coefficients relating categories 1, 2 and 3 to 0, are shown in Tables 3–5, respectively.

Table 3. Coefficients relating category 1 to category 0. Source: own elaboration.

Odds $\frac{P(Y=1)}{P(Y=0)}$	Coefficient	S.E.	*z*-stat	Lower Bound C.I.	Upper Bound C.I.	Exp(b_k)	*p*-Value
b_0	−1.3150	1.4917	−0.8815	−4.2388	1.6087	0.2685	0.3780
X_1	0.8424	1.4075	0.5985	−1.9162	3.6010	2.3219	0.5495
X_2	0.1107	0.7297	0.1518	−1.3194	1.5409	1.1171	0.8794
X_3	−0.1926	0.6716	−0.2868	−1.5089	1.1237	0.8248	0.7743
X_4	−0.4724	0.7556	−0.6252	−1.9533	1.0085	0.6235	0.5318

Table 4. Coefficients relating category 2 to category 0. Source: own elaboration.

Odds $\frac{P(Y=2)}{P(Y=0)}$	Coefficient	S.E.	*z*-stat	Lower Bound C.I.	Upper Bound C.I.	Exp(b_k)	*p*-Value
b_0	−4.0707	1.9357	−1.7268	−7.8646	−0.2768	0.01707	0.03547 (*)
X_1	−1.2328	1.0011	0.3139	−3.1949	0.7294	0.2915	0.2182
X_2	1.1891	0.5863	1.1043	0.0400	2.3381	3.2840	0.04254 (*)
X_3	0.9979	0.6358	1.2119	−0.2482	2.2440	2.7126	0.1165
X_4	0.7538	0.6134	0.5718	−0.4483	1.9560	2.1251	0.2191

* Significant at 5% level. S.E.: standard error.

Table 5. Coefficients relating category 3 to category 0. Source: own elaboration.

Odds $\frac{P(Y=3)}{P(Y=0)}$	Coefficient	S.E.	*z*-stat	Lower Bound C.I.	Upper Bound C.I.	Exp(b_k)	*p*-Value
b_0	−2.3398	1.3550	−1.7268	−4.9955	0.3159	0.09635	0.08420 (**)
X_1	0.2765	0.8807	0.3139	−1.4497	2.0027	1.3185	0.7536
X_2	0.5115	0.4632	1.1043	−0.3964	1.4194	1.6679	0.2695
X_3	0.6145	0.5071	1.2119	−0.3793	1.6084	1.8488	0.2255
X_4	0.2875	0.5028	0.5718	−0.6980	1.2730	1.3331	0.5675

** Significant at 10% level. S.E.: standard error.

However, the coefficients relating categories 1 and 3 to category 0 are not significant (Tables 3 and 5), whereby their interpretation has been omitted. The information contained in Table 4 can be interpreted as follows:

- When all the values of predictors (X_j) are zero, the odds of 2 in comparison to 0 are 0.01707.
- One-unit increase in X_1 will decrease the odds of 2 in comparison to 0 by 70.9% (i.e., the odds will be multiplied by 0.2915).
- One-unit increase in X_2 will increase the odds of 2 in comparison to 0 by 228.4% (i.e., the odds will be multiplied by 3.2840).
- Etc.

The following three equations summarize the outputs of the applied model:

$$t_1 = -2.3398 + 0.2765X_1 + 0.5115X_2 + 0.6145X_3 + 0.2875X_4$$

$$t_2 = -4.0707 - 1.2328X_1 + 1.1891X_2 + 0.9979X_3 + 0.7538X_4$$

$$t_3 = -1.3150 + 0.8424X_1 + 0.1107X_2 - 0.1926X_3 - 0.4724X_4$$

and,

where the model equation for modality j is:

$$t_j = \log(P(\text{category} = j)/P(\text{category} = 0)).$$

The symmetric matrix in Table 6 reflects the correlation between the explaining variables used in our model:

Table 6. Matrix of correlation of the independent variables. Source: own elaboration.

	X_1	X_2	X_3	X_4
X_1	1.0000	0.5116	−0.0364	0.0087
X_2	0.5116	1.0000	0.0847	0.0868
X_3	−0.0364	0.0847	1.0000	0.2249
X_4	0.0087	0.0868	0.2249	1.0000

In the estimated parameters, the following independent variables X_1, X_3 and X_4 are not significant as predictors for Y. On the other hand, it appears that only y X_2 is consistently statistically significant at 5% significance level. Thus, a growing demand from other companies (B2B operations) can be identified with the existence of sustainability departments. This conclusion can be graphically represented in Figure 8.

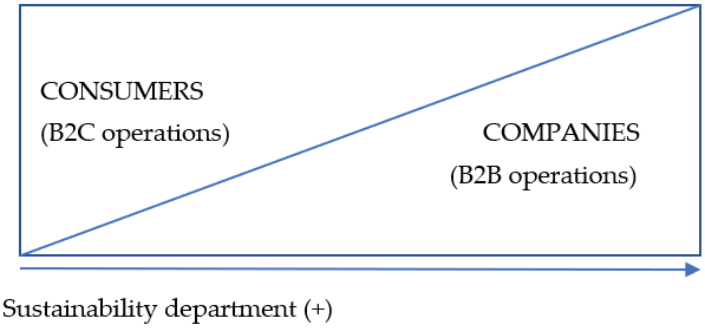

Figure 8. Relationship between the business model (B2B or B2C) of FinTechs and the existence of sustainability departments (+ and − mean more and less departments, respectively) in such companies. Source: own elaboration.

In our study, a negative coefficient indicates that the corresponding variable is associated with a probability of not having a department of sustainability, greater than the probability of having such a department. On the other hand, a positive coefficient indicates that the involved variable is associated with a probability of having a department of sustainability, lower than the probability of not having such a department. The results show that a one-unit increase in X_2 implies a greater probability of having a department of sustainability. As indicated, only one variable is significant in both categories at a 5% significance level: X_2.

As the interpretation of odds and log odds is not intuitive, it is more interesting to determine the effects of each covariate on the selection probabilities. In effect, by calculating the inverse logit, one has:

$$p_1 = \frac{1}{1 + e^{t_2} + \cdots + e^{t_k}}$$

$$p_2 = \frac{e^{t_2}}{1 + e^{t_2} + \cdots + e^{t_k}}$$

and

$$p_k = \frac{e^{t_k}}{1 + e^{t_2} + \cdots + e^{t_k}}$$

The intercept has an easy interpretation in terms of probability (instead of odds) since each intercept b_0 in the logit regression can be interpreted as the result of a value 0 for all predictors in the model (see Table 7). In our case:

Table 7. Interpreting intercepts in terms of probability. Source: own elaboration.

Regression	b_0	p-Value	e^{b_0}	p_h
0 related to 0	0.0000 (*)	0.0000	1.0000	0.7236
1 related to 0	−1.3150	0.3780	0.2685	0.1943
2 related to 0	−4.0707 (*)	0.03547	0.01707	0.0124
3 related to 0	−2.3398	0.08420	0.09635	0.0697

* Significant at 5% level.

Considering the fact that only two intercepts are significant, we can state that, in case of there being no awareness regarding sustainability in a FinTech company, the probability of not changing its offer from B2C is 72.36%, and the probability of changing its offer from B2C to "Products related to environmental, social and good governance criteria" or "Other products and services" is very small (namely, 1.24%).

5. Discussion

Sustainability is a multi-faceted concept, with socioeconomic and environmental dimensions. The economic aspect is the one closest to the aim and research question of this study and is the basic pillar of the other sustainability concerns (no money, no party). FinTech's sustainability is also closely linked to ESG drivers and sustainable development goals, as illustrated in Figure 9.

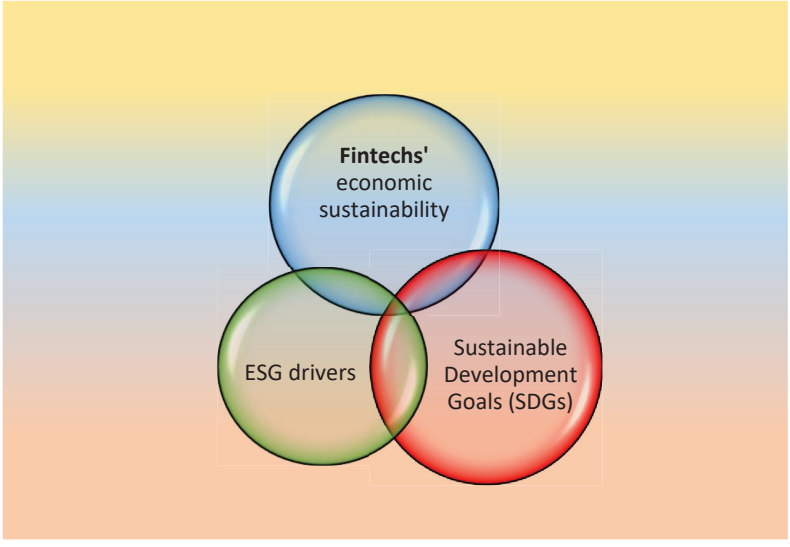

Figure 9. Relationship between FinTech's economic sustainability and ESG/SDGs. Source: own elaboration.

FinTech can help companies to evaluate and reduce their environmental impact through technologies such as advanced data analytics, blockchain, and artificial intelligence. Thus, the European Commission and financial regulators have conveyed the importance of the role that FinTech, PropTech, and InsurTech must play [47].

Meeting ESG criteria is an increasingly important goal for companies which both investors and consumers support [48]. According to Refinitiv data [49], investor interest in sustainable assets increased by 34% in 2020, and 61% when it came to millennial investors.

Some studies point out that "66% of global consumers" (and 73% of millennials) "are willing to pay more for environmentally friendly products" [50]. There has also been a substantial movement within demographic profiles. Millennials are the ones who have changed the most as they have become greener: 58% of those traditionally considered a millennial—27 to 32-year-olds. Millennials want to know not just how much return an investment will make, but how it will make that return and at what cost to people, the planet, or communities. For instance, this could be understood as an opportunity for a process of change that promotes more sustainable habits from Spanish consumers' demand so far [51].

As discussed, our results support the idea that green startups are characterized by more efficient, responsible, and less expensive production processes. For example, this type of company is not only limited to the FinTech sector, although this is the most popular. They can also be found in the construction industry, ecotourism, renewable energies, and the technology sector, among others [52].

Some securities market supervisory bodies have dealt with the need and convenience of a sustainability commission in listed companies [53]. In the current environment, compliance sustainability plans are crucial and the existence of a sustainability department will also be a must in the short term to improve, grow and increase our present consumer demand, both in FinTech, InsurTech, and PropTech companies [54,55].

The results of our survey are illustrative examples of the clear opportunity for companies in the FinTech/InsurTech/PropTech sector to pay attention to the interests, opinions, and wishes of investors to implement regulations regarding data protection, accessibility, discrimination, and financial exclusion [50].

Finally, for many consumers, there are certain legal factors, such as a sandbox (a regulatory test space in which FinTechs and InsurTechs are in the initial stages of innovative projects) which can help sustainable departments in terms of efficiency.

Many empirical studies on the economic aspects of FinTechs have pointed out a change in the business strategy of these companies, going from B2C to B2B providers [39]. Very recently, the literature and the market analysis indicate that green FinTech has an impact, in effect, along the whole value chain of financial services covering customer-to-customer (C2C), business-to-customer (B2C), and business-to-business (B2B) services [56]. These studies related to B2B and B2C suggest that, in Switzerland, most of the startups provide B2B services, which primarily provide investment solutions to the clients. Additionally, in the B2C market, startups also supply investment solutions, and the C2C area is only represented by advisory and investment solution provider.

From an empirical point of view, Campanella et al. [57] observed the importance that Fintech providers have a green reputation since it enhances the consumers' trust and satisfaction with the offered internet banking services. These scholars encourage the financial institutions to promote sustainable development and green strategies in their planning as concern for the environment and sustainability affects consumers, who increasingly consider non-financial attributes in their investments, such as environmental, social, and governance criteria.

Most studied FinTechs target other companies, a process characterized as B2B [58]. However, other B2C FinTechs address individuals. There is also a small group of FinTechs which serves both targets, which were classified as B2B2C. They also can be identified as actors from the service-dominant (S-D) logic perspective (an alternative theoretical framework in behavioral economics for explaining value creation, through the exchange, among configurations of actors).

The trends that are likely to develop in the future, and how it will become ever more important for incumbent financial services providers to partner with FinTechs to offer tailored solutions, are described in [59]. Consequently, the authors discuss how

consolidation within the B2B FinTech space is expected to continue, while the emergence of tech giants in the financial services space represents the potential for a FinTech future. Additionally, the FinTech companies that are more likely to succeed are those that target existing markets with growth potential, such as credit markets [60].

On the other hand, [61] point out that, among the factors that limit the benefits of sustainability programs, some barriers can be considered, such as the disconnection of the sustainability department from the rest of the organization and the too-little influence of the sustainability department inside the organization.

However, in this study, we wonder if this change of strategy is due to the sustainability strategies implemented in the FinTechs, InsurTechs, and PropTechs. To do this, we have proposed a multiple regression between the business orientation of these companies and all sustainability-related variables analyzed in a sample administered to all members of the AEFI. After several iterations, the regression model only considers significant (at a 5% significance level) the existence of a department of sustainability in the company in such a way that having this kind of department increases the odds of the company being B2B-oriented.

The above consideration that the FinTechs should promote the creation of sustainability departments (as a reverse of the business models of FinTechs can be identified with the existence of such departments) is related to the world trend of moving towards sustainable economic models which by 2030 could create economic opportunities worth 12 trillion USD a year [62].

6. Conclusions

In their beginnings, FinTech companies were more devoted to offer new products and services to final consumers (B2C operations). However, some research in this field has pointed out the reversal of this tendency towards new products and services to other companies (B2B operations). In this paper, we have considered whether this statement holds for Spanish FinTechs and, in the affirmative case, whether this change is associated with the existence of certain sustainability plans in the FinTech industry. The empirical study shows that this change is related to the existence of sustainability departments in the companies included in the sample. In effect, this dichotomous variable is significant at the 5% level whilst the other variables involved in the study are irrelevant. In effect, after reviewing the main features of the Spanish FinTech, PropTech and InsurTech industry, this study has shown that growing demand for FinTech services from other companies (B2B operations) can be identified with the existence of sustainability departments in FinTech companies. To do this, we have administered a questionnaire to the 186 companies belonging to the Spanish Association of FinTech, InsurTech and PropTech, by obtaining 55 valid answers. The methodology employed in this paper has been the multinomial logit regression since the explained and all exploratory variables are categorical.

ESG-compliant FinTechs find it easier to attract new customers and fresh capital from green investors. Current concerns about environmental issues have led to many new trends in technology and financial management [63]. The market value of FinTechs is positively assessed [64].

Generalization of these conclusions beyond the Spanish market [65,66] fosters geographical scalability of sustainability strategies, with an impact on cross-border initiatives, especially within a homogeneous financial market (such as the EU).

FinTechs may strongly contribute, with their innovative features, to aligning financial intermediaries (a conservative Moloch) to ESG-compliant SDGs, pursuing digitally sustainable patterns.

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Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

CEO	Chief Executive Officer
CFO	Chief Financial Officer
CTO	Chief Technical Officer
CCO	Chief Customer Officer
B2B	Electronic commerce among companies through the internet
B2C	Electronic commerce with the final consumer through the internet
AEFI	Electronic commerce with the final consumer through the internet
AEFI	Asociación Española de FinTech, InsurTech y PropTech

Appendix A

A study of the FinTech, InsurTech, and PropTech sectors and the evolution of their projects in the Spanish market. The challenges and opportunities for the FinTech sector in a constantly changing socio-economic environment.

Purpose:

The purpose of this study is to analyze the FinTech, InsurTech, and PropTech sectors in Spain based on the opinions of its main actors to try to detect the foreseeable challenges and opportunities. It will also propose improvements to increase sustainable innovative activity and beneficial knowledge transfer to both producers and consumers in the FinTech, InsurTech, and PropTech sectors in Spain.

(1) Current position in the company

- ○ Founder
- ○ CEO
- ○ CFO
- ○ CTO
- ○ CCO
- ○ Other

(2) Year of creation of your company Your answer_____

(3) Location of the company Your answer_____

(4) Workforce—Number of Employees

- ○ <10 employees
- ○ 10–20
- ○ 20–50
- ○ 50–100
- ○ >100
- ○ Other:

(5) Percentage of female and male employees Your answer_____

(6) Your business area

- ○ Private Wealth Management
- ○ Payments
- ○ Alternative Financing

- ○ Regtech
- ○ Marketplaces and Aggregators
- ○ Neobanks and Challenger Banks
- ○ Insurtech
- ○ Cryptocurrencies and Blockchain
- ○ Online identification of clients
- ○ Personal Finance
- ○ Transactional services/Currencies
- ○ Crowdfunding/Lending on tangibles or assets
- ○ Financial Infrastructure

(7) Has your company made sustainability plans or adopted sustainability measures?

- ○ Yes
- ○ No

(8) If you have answered "Yes", go to question (9). If you answered "No", answer the following question. Why not?

- ○ Because you plan to take measures in the future
- ○ Because your company lacks the resources or experience
- ○ Because you believe they are not profitable for your company
- ○ Because they do not have the support of the headquarters

(9) Has your company adopted actions or measures in the following business areas?

(a) Corporate strategy:

- ○ Yes
- ○ No
- ○ Don't know/no answer

(b) Product development:

- ○ Yes
- ○ No
- ○ Don't know/no answer

(c) Technology:

- ○ Yes
- ○ No
- ○ Don't know/no answer

(d) Organizational (Do you have a sustainability department?):

- ○ Yes
- ○ No
- ○ Don't know/No answer

(10) If you have answered "No" in any of the previous sections, please answer the following question. If you have answered "Yes" in all the previous sections, go to question (11). Are actions or measures planned in the following areas?

(a) Corporate strategy:

- ○ Yes
- ○ No
- ○ Don't know/no answer

(b) Product development:

- ○ Yes
- ○ No
- ○ Don't know/no answer

(c) Technology:

- ○ Yes
- ○ No

- ○ Don't know/no answer

(d) Organizational (Do you have a sustainability department?):

- ○ Yes
- ○ No
- ○ Don't know/No answer

(11) List three of the Sustainable Development Goals (SDGs) that are easy for your company to achieve Your answer_____

(12) What advantages do you hope to achieve by being "sustainable"?

- ○ More benefits
- ○ More customers
- ○ More CSR
- ○ Greater commitment
- ○ Other_____

(13) The most important reasons for the development of sustainable finance are:

- ○ Increasing demand from customers for sustainable products or services
- ○ Contribution to the sustainable development of Spain
- ○ New European Union regulation in the area of sustainable finance
- ○ Increase additional income
- ○ Competitive differentiation
- ○ Risk management
- ○ Image/marketing
- ○ Reputational improvement
- ○ Defensive strategic moves against competitors
- ○ Other reasons_____

(14) Sustainable finance is relevant for:

- ○ Portfolio management based on environmental, social, and good governance criteria
- ○ Development of new products or services for the consumer
- ○ Improve reputation
- ○ The development of new products or services
- ○ Others

(15) A growing demand from customers has been identified with:

- ○ Sustainable products and/or services for the consumer
- ○ Environmental, social, and good governance reports
- ○ Products related to environmental, social, and good governance criteria
- ○ Sustainable products and/or services for the company
- ○ Other

(16) What economic measures would help protect the current financial eco-system Fintech /Insurtech/Proptech and Legaltech ecosystem?

- ○ Your answer_____

(17) What is the probability that Spain will become the center of sustainable finance in Europe?

- ○ A very low probability
- ○ A low probability
- ○ A good probability
- ○ A high probability

(18) Future European regulation should have the following criteria: Relevance:

- ○ No level of relevance
- ○ A low level of relevance
- ○ A good level of relevance
- ○ A high level of relevance

Implementation:

- ○ Short term: less than 1 year
- ○ Medium/low term: between 1 and 3 years
- ○ Medium/high term: between 3 and 5 years
- ○ Long term: more than 5 years

(19) What is your perception about the regulation European Union on Sustainable Finance:

- ○ It is an opportunity
- ○ It is an expense/cost
- ○ Don't know/No answer

(20) Which of these aspects do you consider the most important in the implementation of the Sandbox?

- ○ Development of innovative solutions
- ○ Promotion of a competitive environment
- ○ Constant legislative updates
- ○ Minimization of risks
- ○ Other:

(21) Have FinTech/InsurTech and PropTech companies gained more prominence during the COVID-19 health crisis? Your answer_____

The information collected in this questionnaire will be confidential and the data will be used in an aggregate way so as not to harm the rights of the participants. The use of this information will be neutral and be only used for academic and investigative purposes. It will also be used in compliance with the EU REGULATION 2016/679 (RGPD) which indicates that the processing of your data is done with the legal and technical guarantees indicated in these regulations.

Your answer_____

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Impacts of Digital Technostress and Digital Technology Self-Efficacy on Fintech Usage Intention of Chinese Gen Z Consumers

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Abstract: The role of digital technostress and self-efficacy in digital marketing research is seldom discussed and even more rarely examined among Gen Z consumers. This study investigates the relationships between four sub-dimensions of technostress (complexity, overload, invasion, and uncertainty), digital technology self-efficacy, and fintech usage intention. Data from a total of 266 Chinese Gen Z consumers were used in multiple regression analysis. The results of the study generally support that all sub-dimensions of technostress were negatively related to fintech usage intention. Related to the moderating effects of digital technology self-efficacy on the relationship between the four sub-dimensions of technostress and fintech usage intention, significant interaction effects with complexity and overload were found. Finally, the study discusses the theoretical and managerial implications of the research findings.

Keywords: digital technostress; digital techno self-efficacy; fintech usage intention; Chinese Gen Z consumers

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1. Introduction

"Fintech" is a portmanteau formed from the terms finance and technology [1]. It is currently utilized in nearly every consumer financial service—from mobile payment to online investment management service, consumer insurance, and peer-to-peer lending [2]. Fintech is rapidly revolutionizing the financial landscape with the progress of the fourth industrial revolution [3,4]. In particular, the Chinese fintech industry has evolved at a remarkable pace at which the rest of the world struggles to emulate [5–7]. Leading Chinese fintech businesses, such as mobile payment services and big data-based online lending, are at the frontier of the global fintech industry [8]. The Chinese fintech industry has evolved differently from those in developed countries in many ways. While Western countries have mainly developed fintech that focuses on cryptocurrencies or cross-border payment services, Chinese fintech businesses have focused more on consumer mobile financial services, such as mobile payment and online lending [9,10]. Therefore, for Chinese consumers, fintech is becoming a most widely used digital technology that encompasses most online-to-offline (O2O) commerce from mobile payment to entertainment, education, cultural services, transportation, medical care, and other miscellaneous consumption areas [11]. Therefore, many digital marketing researchers have tried to find determinants of consumers fintech behavior in China as fintech has most vastly reached Chinese consumers. Zhou identified that trust, flow, and satisfaction determine the continuance intention of mobile payment [12]. Chuang et al. found that brand and service trust, perceived usefulness, and perceived ease of use positively related to the adoption of fintech service [13]. Wang et al. found that trust in fintech service and structural assurance can encourage the continuance usage intention of fintech service [14]. While many researchers identified the promoting factors of fintech behavior in digital marketing literature, few studies have focused on the constraints of fintech behavior.

Digital innovations, such as fintech, offer greater convenience and efficiency to consumers, but some consumers experience digital technostress due to the rapid development of digital technology. In this digital revolution era, consumers feel the pressure to quickly adapt to a new digital technology as soon as they have adapted to the previous one. In addition, as the fintech industry evolves, risk of personal privacy infringement, financial accidents, and fraud increase, and these risks are likely to increase consumers' technostress. Technostress has early been defined as a modern disease of adaptation caused by an inability to cope with new computer technologies in a healthy manner [15]. Moreover, it has recently been defined as a physical, behavioral, and psychological strain resulting from information and communication technology (ICT)-driven changes in work environment. Many researchers have examined the impacts of technostress on organizational and personal performances at work because technostress construct was developed in the human resource management research field. However, the impact of technostress on digital technology adoption behavior from the consumers' perspective has hardly been examined. Moreover, research focusing on the technostress of Gen Z consumers—the so-called digital natives [16]—is even more scarce. Therefore, the study tries to empirically examine the relationship between digital technostress and fintech usage behavior among Chinese Gen Z consumers, who most commonly use fintech services in their daily life [16]. In addition, the study tries to verify the moderating effect of digital technology self-efficacy on the relationship between digital technostress and fintech usage behavior among Gen Z consumers. Gen Z consumers are called "digital natives" who have grown up in the digital age and so are likely to have high digital technology self-efficacy; however, they also experience technostress caused by rapidly changing digital technologies. Therefore, the study aims to find a sustainable fintech marketing strategy in the Chinese Gen Z consumer market, which is the most rapidly emerging in the world, through finding new empirical evidence of an interaction effect between technostress and digital technology self-efficacy on fintech usage intention of Gen Z consumers.

The study is expected to expand the scope of digital marketing research by examining the impact of technostress on fintech usage behavior of Gen Z consumers which, unlike technostress, has been mainly researched in terms of work and mental health. For the digital marketing research field, discovering constraint factors of consumer's usage behavior of new digital technology, such as fintech, is as important as finding promoting factors as new digital technologies are expected to be continuously developed and be more widely adopted to a variety of products and services. Digital marketers should find and manage the impediments of fintech usage behavior of Gen Z consumers, which form the most important market segment for digital company. Therefore, the study results are expected to provide practical and academic implications for the digital marketing field.

2. Literature Review and Hypotheses

2.1. Fintech Growth in China

Fintech is being used in various consumer financial services, from mobile payment to lending, stocks, insurance, remittances, and asset management. Mobile payment is the most widely used fintech service in China. It was first used in earnest for internet and mobile payment services to support e-commerce consumers in the early 2000s [17]. As of 2019, 87% of Chinese consumers were using fintech services, far ahead of Hong Kong, Singapore, South Korea (67%), and Australia (58%) [17]. Alipay and WeChat Pay, which are non-bank mobile payment business, experienced 75% annual growth between 2015 and 2019. The Chinese mobile payment business has grown in such a way that non-bank companies' mobile payment services dominate banks' mobile banking payment services [18,19]. Tencent, Alibaba, and other major tech firms have been changing the financial services landscape. The mobile payment platform is creating a variety of innovative business models both online and offline, beyond the provision of payment services [20]. The rapid growth of mobile payments by non-bank payment companies in early 2000 resulted in online shopping being quickly replaced by mobile shopping as the Chinese communication

system rapidly jumped from wired communication to wireless communication. The online payment system of Chinese banks was insufficient at that time; thus, the payment system of non-bank internet e-commerce companies, such as Alibaba, could develop significantly. Alipay currently provides total consumer financial services that support various financial activities beyond mobile payment services, including personal asset management, online insurance, loans, and stock trading [19]. In addition, fintech is becoming the digital technology most used in China in various daily consumption activities, such as cultural content, education, medical care, beauty, and housekeeping as well as financial services.

However, fintech has also created serious financial risks and social problems in China. The fintech sector is still in its early stage of development, and many fintech business models are not holistically developed. Chinese authorities are currently trying to formulate new financial regulations for balancing between innovation and stability. However, despite these efforts by the Chinese authorities, the development of fintech exposes consumers to the risk of hacking, ransomware, and financial fraud caused by personal information leakage [10]. Recently, peer-to-peer (P2P) financial transaction accidents have frequently occurred in China, recording millions of victims due to the insolvency of P2P financial companies [8]. Chinese authorities are strengthening the supervision and regulation of the fintech industry as the number of accidents of online payment and P2P lending as well as consumer concerns about financial risks have recently increased [21]. In 2019, CNNIC conducted a survey regarding the problems of most concern when using online services in which 30,000 internet users in 31 regions of China participated. As a result, respondents expressed concern in the order of personal information leakage (20.4%), online transaction fraud (17.0%), hacking or virus infection (10.7%), and account or password theft (9.9%) [11].

2.2. Digital Technostress

Stress refers to a state in which negative emotions appear in the process of responding to external threats, a physiological imbalance is felt, and involving reacting to survive [22]. In the medical field, researchers have mainly paid attention to the patients' psychological and physiological reactions and the negative effects of stress on the body [23]. Further, the academic fields of sociology, psychology, and business have also begun to pay attention to the effects of stress as the complexity of modern society and the psychological burden of people increased. In particular, many researchers in the human resource management field have paid much attention to the impact of employee job stress on organizational activities and performance [24–29]. In addition, job stress research began to focus on technical stress related to computer or internet use with the rapid development of ICT [15]. Technical stress is addressed in various terms, such as *Technostress*, *Computer Anxiety*, *Negative Computer Attitudes*, *Computer Stress*, *Technophobia*, *Computerphobia*, and *Cyberphobia*. Technostress is a compound word first used in 1982 by the American clinical psychologist Craig Brod, who defined it as a modern disease of adaptation caused by the inability to cope with the new computer technologies in a healthy manner [15]. Hudiburg also defined technostress as an adaptation-related modern disease resulting from the inability to cope with new technologies used in digital devices, such as computers [30]. Shu and Wang found that technostress is positively related to computer literacy and the acceptance of digital technologies [31]. Moreover, Arnetz and Wiholm found that employees who were heavily dependent on computers for their work were usually observed to be in a state of technostress arousal [32].

The existing technostress literature presents technostress as being multi-dimensional, including work overload, invasion of individual life, high complexity of technology, and occupational crisis [15,33]. Salanova et al. and Tarafdar et al. also insisted that technostress consists in the sub-dimensions of technology overload, invasion, complexity, insecurity, and uncertainty [34,35]. Tarafdar et al. developed the technostress measurement scale and validated the construct in the US [35]. The scale consists of five sub-dimensions of technostress that computer technology users can potentially experience at work. First, techno-overload is the stress that emerges when ICTs push employees to work faster.

Second, techno-invasion is the stress that emerges when pervasive ICTs invade personal life. Third, techno-complexity is the stress that emerges when the complexity of new ICTs makes employees feel incompetent. Fourth, techno-insecurity is the stress that emerged when fast-changing ICTs threaten the job security of employees. Finally, techno-uncertainty is the stress that is imposed on employees due to the constant changes, upgrades, and bug fixes in ICT hardware and software. Brillhart insisted that technostress consists of four sub-dimensions of data smog, multitasking madness, computer hassles, and burn-out [36]. Ayyagari et al. argued that technostress consists of five sub-dimensions, namely work–home conflict, work overload, invasion of privacy, role ambiguity, and job insecurity, and that they are related to users' perception of ICT's usefulness, complexity, trust, connectivity, anonymity, and development speed [37]. The sub-dimensions of technostress presented in previous research on technostress are shown in Table 1.

Table 1. Sub-dimensions of technostress.

Researcher	Sub-Dimensions	Number
Brod [15]	work overload, invasion of individual life, high complexity of technology, occupational crisis	4
Brillhart [36]	data smog, multitasking madness, computer hassles, burn-out	4
Tarafdar et al. [35]	overload, invasion, complexity, insecurity, uncertainty	5
Ragu-Nathan et al. [38]	techno-overload, techno-complexity, techno-anxiety, techno-uncertainty	4
Ayyagari et al. [37]	work-home conflict, work overload, invasion of privacy, role ambiguity, job insecurity	5

Technostress has been examined by digital marketing researchers since ICT began to widely invade general consumers' daily life [36]. Lee and Lee argued that some digital device users tend to stop using digital devices, such as digital breaks or digital detox, to avoid stress, which appears as a side effect of using smart devices [39]. Çoklar and Şahin examined the technostress levels of Turkish social networking services (SNS) users to find that they have a "medium technostress level" [40]. They found that technostress results from the pressure of using technology, remembering large quantities of passwords and usernames, and anxiety regarding data loss [41]. Chen et al. conceptualized technostress as a phenomenon of end users experiencing overload and intrusiveness due to too much information and communication in a short period of time when they use mobile shopping applications [41]. Perceived information overload is referred to as a kind of mental stress when people perceive the environment as a condition exceeding their ability to deal with [42]. According to the stressor–strain–outcome framework, perceived overload induces fatigue and dissatisfaction in the SNS environment, which further increase the discontinuance intentions of SNS users [43]. In addition, perceived intrusiveness lowers the chances of accepting and allowing permission marketing [44]. It was also determined that the social, hedonic, and cognitive uses of social media induce technostress and SNS exhaustion which, in turn, influence a discontinuous use intention based on the stimulus–organism–response framework [45].

New digital technology, such as fintech, provides consumers with convenience and new customer experiences, but it also induces technostress, such as pressure to adapt to new technologies and risks from technological imperfections. Consumers experience technostress while utilizing fintech services, but few studies have verified the impact of technostress from the perspective of fintech users. It is harder to find research on technostress among Gen Z consumers who are always involved in various services and products adopting fintech. Even young and educated consumers are likely to feel difficulty in constantly acquiring new digital technology as this rapidly changes from day to day. In

addition to the pressure of acquiring new digital technology that is constantly updated, there are many other types of technostress, such as privacy invasion problems, digital security instability, difficulties in using complex digital devices, and pressure to replace new digital devices due to the continual updates to digital technology. Therefore, the study assumes that consumers' digital technostress negatively affects the usage intention of fintech services based on previous related research. In detail, the study assumes that four sub-dimensions of technostress—complexity, overload, invasion, and uncertainty—are negatively related to usage intention of fintech services [35,38]. Meanwhile, the study excluded insecurity (or job insecurity) as a sub-dimension of technostress which might affect fintech usage intention. Tarafdar et al. and Ayyagari et al. explained that insecurity is a stress that emerged when fast-changing ICTs threaten the job security of employees [35,37]. Therefore, insecurity is not likely to be related with the stress that Gen Z consumers feel when using fintech service. Therefore, hypotheses 1 to 4 are presented as follows:

Hypothesis 1. *Digital techno-complexity is negatively related to the usage intention of fintech services.*

Hypothesis 2. *Digital techno-overload is negatively related to the usage intention of fintech services.*

Hypothesis 3. *Digital techno-invasion is negatively related to the usage intention of fintech services.*

Hypothesis 4. *Digital techno-uncertainty is negatively related to the usage intention of fintech services.*

2.3. Digital Technology Self-Efficacy

Bandura defined self-efficacy as people's judgment of their capabilities to organize and execute courses of action required to attain designated types of performances [46]. Self-efficacy is a strong sense of personal efficacy related to better health, higher achievement, and more social integration, and it represents the key construct in social cognitive theory [46–48]. Bagozzi defined self-efficacy as an individual's confidence in their own work ability. Self-efficacy has received much attention in the business literature [49]. Gist and Mitchell found that people who think they can perform their task well show better work performance than those who think that they will fail [50]. In the organizational behavior research field, researchers found that self-efficacy is positively related to job proficiency and performance, and self-efficacy lowers the negative impact of job stress on job performance [51–53].

Meanwhile, as ICT invades every corner of people's life, such as work, school, and daily lives, technology self-efficacy is attracting much attention in many research disciplines, such as psychology, education, and business. Cassidy and Eachus presented computer user self-efficacy as a factor that contributes to success in tasks in the domain of computer technology [54]. They further adapted to cover digital self-efficacy to measure individual self-efficacy in the digital domain. Self-efficacy-related ICT is often used in terms of computer efficacy or internet efficacy [55]. Venkatesh and Davis defined computer self-efficacy as a self-assessment of one's ability to use information technology or one's belief that people can use computer or internet-related technologies well [56]. Compeau and Higgins defined computer self-efficacy as a self-judgment of one's ability to use information technology [57]. Rogers found that technology self-efficacy is a trait that is variable at an individual level and positively influences the acceptance of new technologies, and that technology self-efficacy has a positive relationship with the innovation and acceptance of new technologies of organizational leaders [58]. Table 2 summarizes the antecedents and outcome variables of technological self-efficacy used in previous studies related to technological self-efficacy. Meanwhile, many researchers pay much attention to the impact of consumers' technology self-efficacy on the acceptance behavior of ICT products or services since ICT began to be widely used for general consumers. According to Bandura's theory, people with high self-efficacy tend to believe they can perform well even if they are in difficult situations, and tend to view difficult tasks as something to be mastered rather than something to be avoided [48]. Therefore, people with high self-efficacy are

likely to put more effort into learning technological skills, while those with low technology self-efficacy are likely to put in relatively little effort or give up halfway. In addition, people with high technology self-efficacy find using new technology relatively to be less difficult and show a positive attitude toward using technology [58]. The study therefore assumes that digital technology self-efficacy positively affects the usage intention of fintech services and presents the following hypothesis 5:

Hypothesis 5. *Digital technology self-efficacy is positively related to the usage intention of fintech services.*

Perceived self-efficacy to control thought processes is a key factor in regulating stress and depression [46]. People with high self-efficacy tend to approach threatening situations with the assurance that they can have control over situations, and their efficacious thought reduces stress and lowers vulnerability to depression [46]. A significant amount of research has shown that self-efficacy acts to decrease people's potential for negative stress by increasing their belief of being in control of the threatening situations they encounter. The perception of being in control represents an important buffer of negative stress [59]. Lu et al. found that managerial self-efficacy had significant moderating effects on the stressor–strain relationship in the Chinese workplace [60]. Self-efficacy was also found to be a stress moderator in some of the stressor–work well-being relationships among employees in Hong Kong and Beijing. Some researchers have found that mobile users with high self-efficacy prefer to take more proactive behavior to deal with stressors of mobile shopping apps [41]. Although little research has tried to examine the relationship between digital technology self-efficacy, technostress, and new digital technologies' usage intention from the consumer perspective, many researchers in clinical, educational, social, business management, health, and personality psychology disciplines have found that self-efficacy lowers the negative effects of stress. People with high self-efficacy can accurately perceive their situation and self-manage themselves in stressful situations; thus, self-efficacy is positively related with an active lifestyle. Therefore, technology self-efficacy is likely to lower the negative effects resulting from people's psychological anxiety or stress caused by new digital technology. Based on previous research arguments, the study presents the following hypotheses 6 to 9:

Hypothesis 6. *Digital technology self-efficacy lowers the negative impact of digital techno-complexity on the usage intention of fintech services.*

Hypothesis 7. *Digital technology self-efficacy lowers the negative impact of digital techno-overload on the usage intention of fintech services.*

Hypothesis 8. *Digital technology self-efficacy lowers the negative impact of digital techno-invasion on the usage intention of fintech services.*

Hypothesis 9. *Digital technology self-efficacy lowers the negative impact of digital techno-uncertainty on the usage intention of fintech services.*

3. Research Model and Methodology

3.1. Research Model

The research model is developed based on the assumption that the four dimensions of technostress (complexity, overload, invasion, and uncertainty) resulting from rapidly changing digital technology are negatively related to fintech usage intention. Constructs rooted in the secondary evaluation procedure (digital technology self-efficacy) are also considered as determinants to fintech usage intention. In addition, it is also argued that digital technology self-efficacy moderates the relationship between technostress and fintech usage intention. For the convenience of notation, the study will use abbreviations of the constructs in the latter part of this paper. Figure 1 illustrates the research model.

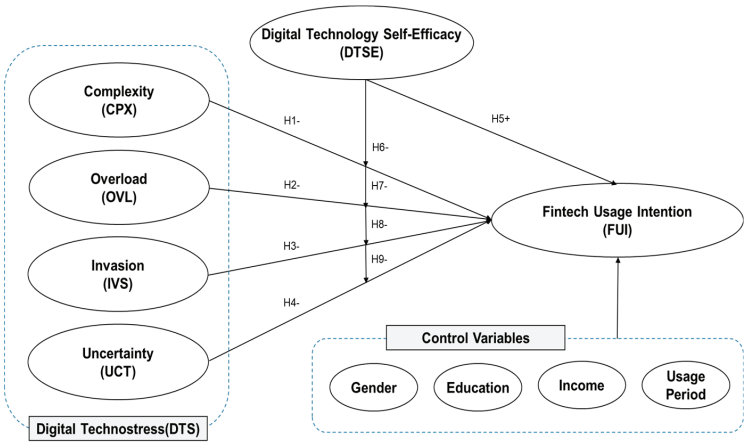

Figure 1. Conceptual research model.

3.2. Data Collection and Sampling

The study collected data by means of an online survey administered by Wenjuan Xing (www.wjx.cn, accessed on 18 September 2020), which is a professional online survey website in China. A pilot test was conducted in July 2020 for 30 Chinese undergraduate students at D university in Korea that did not form part of the sampling frame of the main study, so as to assert the reliability of the scales used the questionnaire [61,62]. The feedback resulted from a pilot test was used to refine a final questionnaire. Data collection used a snowball sampling method in August to September 2020 in which the online survey URL was transmitted to the respondents who had previously agreed to receive it. The study collected a total of 314 responses from the participants. It excluded samples with a less than 20% response rate of all measurement items or missing responses to the outcome variable to ensure the external validity of the data, in addition to considering the subject scope. The study used 266 samples for the final analysis.

Table 2 provides demographic information on the sample. The number of male respondents, at 53.4%, was slightly higher than that of females at 46.6%. Of the respondents, 94.7% of participants were single, and 5.3% were married. More than 80% had bachelor's degrees and higher, and around 70% respondents had an average monthly personal income under CNY 2000. Furthermore, 70.7% of the respondents answered that they had used a smartphone for over five years.

3.3. Construct Measurement

The construct measurement scale employed in the study was taken from existing literature, and all constructs dealing with perceptions were measured using five-point Likert scales (1 = *strongly disagree* and 5 = *strongly agree*). The operational definition and measurement scale for constructs are as follows. The study first defined digital technostress (DTS) as a psychological pressure consumers feel from using digital technology and digital devices. The study modified the technostress measurement scale of Tarafdar et al. based on the scope and purpose of the study and used the modified measurement scale to measure the sub-dimensions of technostress: CPX, OVL, IVS, and UCT [35]. The study measured CPX as four items, OVL as four items, IVS as three items, and UCT as two items, as shown in Table 3. Next, the study defined digital technology self-efficacy (DTSE) as a psychological self-belief that people can utilize digital technology well, and developed three measurement items based on the measurement scale of Cassidy and Eachus [54]. Finally, the study defined FUI as a consumer's intention to choose and use fintech services as much as possible and developed a measurement scale for FUI based on the technology acceptance model (TAM) [63]. The full survey instrument is presented in Table 3.

Table 2. Demographic information of respondents.

Attribute Structure of Sample		Frequency	Percentage (%)
Gender	Male	142	53.4
	Female	124	46.6
Marriage status	Single	252	94.7
	Married	14	5.3
Educational background	Middle school	13	4.9
	High school	27	10.2
	Undergraduate school	186	69.9
	Graduate school or above	40	15.1
Monthly personal income	Under 500 yuan	65	24.4
	501–1000 yuan	80	30.1
	1001–2000 yuan	43	16.2
	2001–3000 yuan	22	8.3
	3001–5000 yuan	17	6.4
	Above 5000 yuan	39	14.7
Usage period of smart phone	Less than 1 year	7	2.6
	1–3 years	27	10.2
	3–5 years	44	16.5
	5–7 years	67	25.2
	7–9 years	57	21.4
	Longer than 9 years	64	24.1

Table 3. Constructs and measurement items.

Constructs	Measurement Items	Sources
CPX	I do not know enough about digital technology to handle my job satisfactorily.	[35,64]
	I need a long time to understand and use new digital technologies.	
	I do not find enough time to study and upgrade my digital technology skills.	
	I often find it too complex for me to understand and use new digital technologies.	
OVL	I am forced by digital technology to do more work than I can handle.	
	I am forced by digital technology to know even unnecessary information.	
	I am forced by digital technology to work much faster.	
	I am forced by digital technology to work with very tight time schedules.	
IVS	I feel my personal life is being invaded by digital technology.	
	I spend less time with my family due to this technology.	
	I sacrifice my personal time to keep up with new technologies.	
UCT	I think there are always new developments in digital technologies.	
	I think there are constant changes in computer and mobile software.	
DTSE	I believe I can handle most digital technology well.	[54]
	Most digital technologies I have had experience with have been easy to use.	
	Digital technology helps me to save a lot of time.	
FUI	I love to choose financial services that adapt fintech.	[63]
	I want to use the fintech services as much as possible.	
	I prefer fintech payment methods over other payment methods, such as credit card, cash payment, or bank transfer, etc.	
	I would recommend fintech services to my friends if I had the chance.	

3.4. Research Methodology

The data analysis methods used in the study are as follows. First, frequency analysis was conducted to investigate the demographic characteristics of respondents. Second, the feasibility and reliability tests of the measurement scale were conducted to examine the predictability and accuracy of constructs. Third, correlation analysis was conducted to examine the correlations among constructs. Fourth, moderated regression analysis (MRA) was conducted to examine the relationships between constructs using IBM SPSS 20.0. MRA is an analytic approach that maintains the integrity of a sample yet provides a basis for controlling the effects of a moderator variable; therefore, MRA can avoid the loss of information resulting from an artificial transformation of a continuous variable into a qualitative one [65]. The study adopts the MRA to build three regression Equations as follows, and it examines the equality of the regression coefficients for the following three regression equations:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 \quad (1)$$

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5Z \quad (2)$$

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5Z + b_6X_1Z + b_7X_2Z + b_8X_3Z + b_9X_4Z \quad (3)$$

In the above equations, if (2) and (3) are not significantly different, then Z is not a moderating variable but a simple independent variable. If Equations (1) and (2) are not different from each other but different from Equation (3), then Z is a pure moderating variable. Lastly, if Equations (1)–(3) are not different from each other, then Z is a quasi-moderating variable. The study adopts the above moderated regression analysis approach to identify the research model.

4. Empirical Analysis and Results

4.1. Validity and Reliability of Measurement Instruments

The study first assessed the validity and reliability of the measurement model. An exploratory factor analysis was conducted on the 19 items relating to variables. Six principal component factors were extracted, as they had a cut-off factor loading of 0.6 and an eigenvalue greater than 1 [66]. Of the total variances, CPX accounted for 19.44%, OVL accounted for 12.97%, IVS accounted for 12.41%, UCT accounted for 8.29%, DTSE accounted for 23.89%, and FUI accounted for 19.44%. The six factors accounted for 84.79% of the total variability. The rotated component matrix of the factor analysis is shown in Table 4. Regarding the construct reliability of the six factors, all values for Cronbach's α exceeded the threshold value of 0.7. This provides sufficient evidence for the high reliability of constructs listed above [67]. The detailed results of the validity and reliability analysis are shown in Table 4.

4.2. Correlation Test

Table 5 shows the correlation matrix between the constructs. This study used partial correlation to measure nonlinear as well as linear relationships between variables. Most variables show a relatively low correlation of less than 0.6, which demonstrates that there is little chance for multicollinearity to exist between the constructs. The relationships between variables in the correlation matrix are consistent with the direction of the hypotheses. In addition, although the constructs show low Pearson correlation coefficients, nonlinear relationships between them may still exist [68].

Table 4. Measurement item's loading (λ) and construct's convergent validity.

Measurement Items	CPX	OVL	IVS	UCT	DTSE	FUI
CPX1	**0.904**	0.146	0.199	0.058	−0.018	0.014
CPX 2	**0.907**	0.089	0.219	−0.006	0.013	−0.033
CPX 3	**0.891**	0.081	0.216	0.061	−0.033	−0.023
CPX 4	**0.895**	0.065	0.210	0.064	−0.078	−0.046
OVL1	0.084	**0.744**	0.176	0.336	0.165	0.229
OVL 2	0.241	**0.814**	0.237	0.057	0.204	−0.029
OVL 3	0.087	**0.797**	0.187	0.307	0.144	0.188
IVS 1	0.296	0.216	**0.811**	0.199	0.013	0.012
IVS 2	0.330	0.228	**0.822**	0.025	0.094	−0.022
IVS 3	0.282	0.127	**0.871**	0.078	0.021	−0.017
UCT1	0.217	0.365	0.209	**0.757**	0.176	0.076
UCT 2	−0.018	0.293	0.084	**0.765**	0.303	0.247
DTSE1	−0.060	0.186	0.007	0.128	**0.840**	0.306
DTSE2	−0.011	0.079	0.007	0.074	**0.856**	0.323
DTSE3	−0.057	0.250	0.127	0.294	**0.707**	0.206
FUI1	−0.038	0.076	0.020	0.150	0.197	**0.902**
FUI2	−0.075	0.112	0.014	0.114	0.166	**0.927**
FUI3	0.004	0.085	−0.001	0.077	0.210	**0.906**
FUI4	0.018	0.063	−0.054	0.000	0.218	**0.894**
Cronbach's α	**0.946**	**0.861**	**0.904**	**0.780**	**0.863**	**0.947**
Eigenvalue	3.646	2.464	2.459	1.576	2.327	3.693
Variance Explained (%)	19.44	12.97	12.41	8.29	12.25	19.43

CPX: complexity; OVL: overload; IVS: invasion; UCT: uncertainty; DTSE: digital technology self-efficacy; FUI: fintech usage intention.

Table 5. Correlations between constructs (n = 266).

Variables	gen.	edu.	inc.	sup.	CPX	OVL	IVS	UCT	DTSE	FUI
gen.	1									
edu.	0.185 **	1								
inc.	−0.140 *	0.091	1							
sup.	−0.075	0.224 **	0.306 **	1						
CPX	−0.087	−0.063	−0.069	−0.078	1					
OVL	−0.025	0.162 **	0.017	0.185 **	0.295 **	1				
IVS	−0.074	0.098	0.057	0.027	0.551 **	0.480 **	1			
UCT	0.047	0.176 **	−0.060	0.140 *	0.201 **	0.573 **	0.363 **	1		
DTSE	0.007	0.123 *	0.014	0.131 *	−0.049	0.450 **	0.143 **	0.513 **	1	
FUI	−0.036	0.140 *	0.039	0.053	−0.042	0.284 **	0.016	0.338 **	0.531 **	1

Note: * $p < 0.05$, ** $p < 0.01$. gen.: gender; edu.: education; inc.: income; sup.: smartphone usage period; CPX: complexity; OVL: overload; IVS: invasion; UCT: uncertainty; DTSE: digital technology self-efficacy; FUI: fintech usage intention.

4.3. Hypotheses Test

This study conducted a hierarchical regression analysis to find more detailed causal relationships among variables. First, the study set gender, education, income, and smartphone usage period as control variables; it then verified the influences of the control variables on FUI in Model 1. The results found that the F value was 1.594, and R^2 was 0.024; therefore, Model 1 was not statistically significant. Next, in Model 2, regression analysis was conducted on the impacts of the control variables and four sub-dimensions of technostress (CPX, OVL, IVS, and UCT) on FUI. The results found that the F value was 6.225, and R^2 was 0.163; therefore, Model 2 was statistically significant. In detail, Model 2 demonstrated that OVL, IVS, and UCT negatively affect FUI ($\beta = -0.177$, $p < 0.05$; $\beta = -0.151$, $p < 0.05$; $\beta = -0.228$, $p < 0.01$). In Model 3, regression analysis was conducted to analyze the impacts of control variables, four sub-dimensions of technostress (CPX, OVL, IVS, and UCT), and DTSE on FUI. The results found that the F value was 12.996, and R^2 was 0.314; therefore, Model 3 was statistically significant. Model 3 demonstrated that IVS has a significant negative impact of on FUI ($\beta = -0.133$, $p < 0.05$), and DTSE has a significant

positive impact on FUI ($\beta = 0.470$, $p < 0.01$). Finally, in Model 4, regression analysis was conducted to examine the impacts of control variables, four sub-dimensions of technostress (CPX, OVL, IVS, and UCT), DTSE, and the four interaction variables (CPX×DTSE, OVL×DTSE, IVS×DTSE, and UCT×DTSE) on FUI. The results found that the *F* value was 12.110, and R^2 was 0.385; therefore, Model 4 was statistically significant. Model 4 demonstrated that the four control variables have no significant impacts on FUI. The four sub-dimensions of technostress (CPX, OVL, IVS, and UCT) are all negatively related to FUI ($\beta = -0.615$, $p < 0.05$; $\beta = -0.800$, $p < 0.01$; $\beta = -0.544$, $p < 0.01$; $\beta = -0.420$, $p < 0.05$), while DTSE has a significant positive impact on FUI ($\beta = 0.661$, $p < 0.01$). Of the interaction variables, the results showed that CPX×DTSE and OVL×DTSE interactions have significant negative impacts on FUI ($\beta = -0.357$, $p < 0.05$; $\beta = -0.498$, $p < 0.05$). In addition, impacts of CPX×DTSE and OVL×DTSE interactions on FUI ($\beta = -0.357$, $p < 0.05$; $\beta = -0.498$, $p < 0.05$) were lower than the direct impacts of CPX and OVL on FUI ($\beta = -0.615$, $p < 0.05$; $\beta = -0.800$, $p < 0.01$) in Model 4. In result, DTSE lower the negative impacts of CPX and OVL on FUI.

Meanwhile, the study verified the statistical significance of direct and moderating effects of variables by comparing the regression coefficients of each model [65]. As a result of estimating the analysis model of the study with the regression Equations of Model 2 and 3, the explanatory power of Model 3 increased at a statistically significant level in comparison with Model 2 (△F = 20.81 **). In addition, the explanatory power of Model 4 increased at a statistically significant level (△F = 3.73 **) in the comparison of the explanatory power of Model 3 and Model 4 [65,69,70]. Therefore, the study finally interpreted the research results based on Model 4. In Model 4, the four sub-dimensions of technostress (CPX, OVL, IVS, and UCT) all negatively affect FUI; thus, H1 to H4 are supported. In addition, DTSE has a positive impact on FUI; hence, H5 is supported. Finally, of the interaction variables, the results of Model 4 showed that CPX×DTSE and OVL×DTSE interactions have significant negative impacts on FUI; therefore, H6 and H7 are supported. The detailed analysis results are shown in Table 6 below.

Table 6. Results of multiple regression analysis (MRA).

Variables		(Dependent variable) Fintech Usage Intention			
		N = 266			
		Model 1	**Model 2**	**Model 3**	**Model 4**
Control variables	Gender.	−0.060	−0.077	−0.079	−0.088
	Education	0.147 **	0.094	0.099	0.096
	Income	0.014	0.058	0.061	0.078
	Usage Per.	0.012	−0.066	−0.069	−0.094
Independent variables	CPX		−0.071	0.011	−0.615 **
	OVL		−0.177 **	0.056	−0.800 ***
	IVS		−0.151 **	−0.133 **	−0.544 ***
	UCT		−0.228 ***	−0.105	−0.420 **
Moderating variable	DTSE			0.470 ***	0.661 ***
Interactions	CPX *DTSE				−0.357 **
	OVL *DTSE				−0.498 **
	IVS *DTSE				−0.201
	UCT *DTSE				−0.167
R^2		0.024	0.163	0.314	0.385
F		1.594	6.255	12.996	12.110
ΔF			-	20.81	3.73

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$.

5. Discussion and Conclusions

5.1. Summary and Discussion

The study aims to verify the impact of digital technostress and digital technology self-efficacy on the usage intention of fintech services among Chinese Gen Z consumers, who are the most exposed to advanced digital technologies, such as fintech [16]. In particular, as consumers are currently experiencing technostress due to the rapid development of digital technologies, including fintech, the study focused on the negative effects of technostress on the usage intention of fintech services. In addition, the study assumed that digital technology self-efficacy not only has a direct positive effect on fintech usage intention but also a moderating effect on the relationship between digital technostress and fintech usage intention. The summary of the empirical analysis results is as follows.

First, it was found that all four sub-dimensions of DTS (CPX, OVL, IVS, and UCT) had a statistically significant negative effect on FUI. The abovementioned empirical analysis results are consistent with the results of previous research [37–41]. It was found that Chinese Gen Z consumers with high perception of CPX, OVL, IVS, and UCT show a lower intention to use fintech services. Therefore, Hypothesis 1 to 4 were supported. Next, the DTSE of Chinese Gen Z consumers was found to increase their intention to use Fintech service, which is consistent with previous research results [54,55,57]. Therefore, hypotheses 5 was supported. Lastly, DTSE was found to significantly lower the negative impact of CPX and OVL on FUI, while DTSE has not shown statistically significant interaction effects with IVS and UCT on FUI. Therefore, hypotheses 6 and 7 were supported, while hypotheses 8 and 9 were rejected.

The study showed that Gen Z consumers experience digital technostress due to rapidly changing digital technology, and the digital technostress negatively affect fintech usage intention of Gen Z consumers. Therefore, the empirical results of the study are contradicted to the previous study's argument that Gen Z consumers generally show a very positive psychological response to digital technology [16,71]. According to the above study findings, digital marketers and researchers should consider novel approaches to predict fintech usage behavior of Gen Z consumers. Meanwhile, the study also found that DTSE has moderating effects on the negative impacts of CPX and OVL on FUI. The interaction effect between DTSE and technostress among Gen Z consumers is a very new finding for digital marketing research field. This seems because Gen Z consumers with high DTSE have self-belief to respond the negative effects of techno-complexity and techno-overload on fintech usage intention in the consumer's individual level. However, the study found that DTSE has no moderating effect on the negative impacts of IVS and UCT on FUI. It seems because techno-invasion and techno-uncertainty are structural problem that is difficult to respond in the consumer's individual level. Therefore, the study results can offer digital marketers with practical implications that they should actively utilize digital technology self-efficacy to manage technostress which can be handled in the individual-level, such as techno-complexity and techno-overload. In addition, digital marketers must also prepare special measures to reduce the negative impact of structural technostress, such as techno-invasion and techno-uncertainty, on Gen Z consumers fintech usage intention.

5.2. Conclusions

The study results not only offer practical implications to fintech marketers but also contribute academic implications to the digital marketing research field. First, according to results of the study, fintech marketers should develop media-based materials, such as pictures, animations, or videos, through which consumers can more easily and quickly understand the features of new digital technologies and how to use them, by considering the behavioral traits of Gen Z consumers. Second, fintech marketers should present higher level of norms and regulations for personal privacy and security issues. Third, it is important to be careful not to directly expose consumers to excessively frequent updates or digital technology changes and to establish a more meticulous marketing strategy to reduce the increased cognitive and emotional burden on consumers due to digital technology

changes. Such marketing efforts can lower the digital technology technostress of consumers, contributing to forming consumers' positive attitude and behavior to a wider variety of fintech services. Finally, fintech marketers should focus on a marketing strategy that can increase Gen Z consumers' DTSE as the study found a significant positive direct effect of DTSE on FUI and moderating effects of DTSE on the relationship between DTS and FUI. Therefore, fintech marketers should provide various ways for Gen Z consumers to understand and learn new digital technologies with ease and enjoyment through various media means to increase a level of Gen Z consumers' DTSE. In addition, digital marketing researchers need to have a broader perspective to find more various impediments, such as technostress, which negatively influence consumers' adoption and usage behavior of new digital technologies like fintech. In particular, examining the impacts of new negative factors, such as technostress, in a new consumer segment like Gen Z can contribute to broadening the academic scope of digital marketing.

Despite the academic and practical contributions of this study presented above, this study has the following limitations. First, the number of samples used in this study is small compared to China's population; therefore, future research will have to collect a larger amount of data for empirical analysis. In addition, the study results should be carefully interpreted as the sample size is not large enough. Second, in the case of the technostress variable, there will be large differences according to consumers' age groups; it is thus necessary to compare different impacts of DTSE on fintech behavior between age groups in future research. Third, the study has limitations in reflecting demographic and regional diversity in China; therefore, future research should consider collecting data in various consumer segments in China to compare the distinctions of fintech usage behavior. Finally, this study used consumers' comprehensive and general usage intention of various fintech services as outcome variables. However, a wide variety of new fintech services have recently been launched in the Chinese market which are being widely accepted by consumers. Therefore, future research should consider the differences in various types of fintech services and fintech consumption behavior for a more comprehensive understanding of Chinese fintech behavior.

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sustainability

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Article

Toward a Chatbot for Financial Sustainability

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Abstract: This study examines technology effectiveness for industry demand in which artificial intelligence (AI) is applied in the financial sector. It summarizes prior studies on chatbot and customer service and investigates theories on acceptance attitudes for innovative technologies. By setting variables, the study examines bank revenue methodologically and assesses the impact of customer service and chatbot on bank revenues through customer age classification. The results indicate that new product-oriented funds or housing subscription savings are more suitable for purchase through customer service than through chatbot. However, services for existing products through chatbot positively affect banks' net income. When classified by age, purchases by the majority age group in the channel positively affect bank profits. Finally, there is a tendency to process small banking transactions through the chatbot system, which saves transaction and management costs, positively affecting profits. Through empirical analysis, we first examine the effect of an AI-based chatbot system implemented to strengthen financial soundness and suggest policy alternatives. Second, we use banking data to increase the study's real-life applicability and prove that problems in customer service can be solved through a chatbot system. Finally, we investigate how resistance to technology can be reduced and efficiently accommodated.

Keywords: chatbot; artificial intelligence; financial sustainability; telemarketing; cube model; voice recognition and conversion model

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1. Introduction

Professor Yoshua Bengio, the winner of the 2019 Turing Award, gave a lecture on core technologies in deep learning, such as meta-learning and reinforcement learning, at the Samsung AI Forum 2020 in November 2020. He refuted what Professor Carl Benedict Frey had argued, citing success stories in the application of information technology (IT) in the financial sector. Professor Frey had argued that less than half of financial jobs were set to disappear with the increasing use of artificial intelligence (AI). However, Professor Bengio predicted, Professor Frey's arguments would lose their convincing power [1], as it had happened for Professor Zoonky Lee who had published articles in a Korean newspaper to combat prejudice against artificial intelligence (Special Series of *JoongAng Daily*, "Lee Zoonky, Ask about the Future") [2]. The common points between Lee and Frey are as follows. Considering the history of technology adoption, technological innovation should be considered as a digital transformation that changes roles rather than kills jobs. Hence, as AI grows, digital transformation occurs and people seek new roles. A chatbot, which provides advice on financial products to customers, applies AI to the financial industry. Both Lee and Frey conclude that a chatbot does not eliminate jobs; rather, humans use the chatbot system to venture into new areas. The lack of insight, imagination, and responsiveness to new variables of the chatbot algorithms require humans to resolve them. Thus, AI creates a new ecosystem within the industry, and the role of humans changes for a new era in which machines and humans coexist in a complementary way [3].

Natural language processing technology and speech recognition technology are currently providing personal assistant services that communicate directly through personal mobile devices [4]. Chatbot, an interactive AI, has been widely deployed in finance, retail, public, and manufacturing industries. Apple's Siri, Amazon's Alexa, Google's OKgoogle, and Samsung Electronics' Bixby are good examples of voice conversion personal assistant services. In addition, Naver and Nugu of SK Telecom provide high-quality voice recognition services through the Korean search platform and communication market. As such, major IT companies, portal sites, and telecommunication companies worldwide are developing commercial voice recognition services and investing significant financial resources to provide AI services with higher accuracy [5].

This study investigates the role of AI in the financial industry from several aspects. First, the social demand for and expectations from artificial intelligence in the financial sector are high. The amount of investment in this field is larger compared to other industries such as the distribution, manufacturing, and public sectors [6]. Second, despite this interest, there are many misconceptions around using AI, and whether AI has been properly applied to the financial industry has been questioned [7]. Finally, the systematic criticism of AI technology applied to financial products is lacking in extant research. Recent media comments about AI describe the positive and negative effects of AI in a stimulating tone [8]. However, it is difficult to find an in-depth comparative study. Many recent studies examine the combination of AI and the financial sector because anyone who engages in economic activities is a financial consumer. Furthermore, even software used exclusively by traditional asset managers can be downloaded easily and used by ordinary people [9]. Hence, AI in the financial industry is simply a tool that individuals can access and use; it is not the exclusive property of experts. This study compares and analyzes the impact of customer service through the existing automatic response service (ARS) with the chatbot system currently being used by banks. In addition, we empirically analyze data to determine how each of these two channels (customer service and chatbot) affects bank profits and then derive practical implications based on the results [10].

The article structure is as follows. Section 2 reviews prior extant research, divided into four areas. First, through the latest research on financial chatbot systems, we investigate AI technologies and their effects in financial environments. Second, we summarize the research on problems faced by customer service counseling staff and on coping strategies and techniques to solve them. Third, we study theories of effective ways to introduce technology. Finally, we examine prior research on indicators representing bank contribution from a methodological perspective. In Section 3, we set the hypothesis for this study and perform statistical analysis based on bank data for new products and existing services by channel. We conduct quantitative analysis using statistical techniques to establish and verify the hypotheses while considering prior studies and descriptive statistics. Section 4 evaluates the theoretical underpinnings verified by data and summarizes the study. Finally, we conclude this study by revealing implications, limitations, and future research plans.

2. Background

2.1. Financial Chatbot Service

The term "chatbot" is a combination of "chatting" and "robot," which is commonly used for text messages or messengers. A chatbot is a communication software that can store appropriate answers to questions on a server, create models that continuously develop correct answers through conversations with customers, control exceptions, and provide accurate answers [11]. Chatbots create a self-learning model through computer programs and mathematical calculations and provide customers with answers and other relevant information as close as possible to user questions in real time. For companies, a chatbot is an interface that provides information required by customers and marketing through communication with financial consumers [12]. The first chatbot service in the financial sector was Bank of America's Erica introduced in May 2017. Erica's early look was similar to Apple's Siri. Erica provided simple text and voice-based responses, including trans-

action details, limit amount, and account balance. Additionally, it provided advanced services such as credit rating upgrade application, fund product introduction, bank loan application, interest rate guidance, utility bill payment, and fund management consulting services [13,14]. The chatbot learned customers' personal profile information, past financial product purchase history, location information, and personal routine data by applying machine learning and deep learning technologies to provide accurate and customized services. Customers could enjoy convenience by securing personalized financial services quickly and easily through a chatbot [15]. In Korea, most commercial banks and other types of financial institutions have introduced chatbot services for customers (Table 1).

Table 1. Financial chatbot services in Korea.

Type	Financial Institution	Chatbot Name	Service Platform	Starting from
Banking Corps.	Shinhan	Aurora	Shinhan Sol	2018. 02
	Kookmin	Smartly (TalkTalk)	Liiv TalkTalk	2017. 07
	NH	Consultation Talk	NH banking	2018. 11
	Hana	HAI	Hana Members	2017. 09
	Woori	Wibee-bot	WibeeTalk	2018. 09
Credit Card Company	Shinhan	FANi	Shinhan Paypal	2017. 06
	Samsung	Sam	Chatbot Sam	2019. 03
	Hyundai	Henry & Fiona	Buddy	2017. 08
	Lotte	LOCA	The Loca Lab	2018. 04
Others (Securities, Insurance, and Third Bank Sector)	Daishin (Sec.)	Benjamin	Kakao Talk	2017. 09
	Samsung (Ins.)	Tabot	TABOT	2017. 06
	Welcome (3rd S.)	Welcomebot	Kakao Talk	2017. 09
	OK (3rd S.)	Oktok	Kakao Talk	2017. 08
	JT (3rd S.)	JT Mobile Chatbot	Kakao Talk	2018. 05

Chatbots can be classified into a retrieval model and a generative model according to the implementation method in web or mobile applications. First, a chatbot based on the retrieval model is a rule-based method that provides prepared answers according to conditions of a specific topic or question. Most early chatbot versions in financial institutions were developed based on rules [16]. However, with the commercialization of chatbot, sophisticated machine learning has become possible as industry data continue to accumulate. Second, the generative model chatbot is a deep learning method that improves the accuracy of new responses through self-evolution as customer and communication data accumulate [17]. With the latest developments in deep learning technology, the system understands the customer's question and the intent of the sentence and presents the appropriate answer to the customer [18,19]. Therefore, it is possible to recommend personalized products for customers. Studies for commercialization are being actively conducted to capture current emotions of users through individual routines and basic profiles. Despite its many advantages, cost is an issue with the generative model because it requires the accumulation of vast amounts of data for continuous self-evolution [20].

Chatbots are important in terms of technology and user interface (UI). The chatbot is a technology service that implements communication between users and AI-based on text and voice and is a representative non-face-to-face service. Most chatbot services are implemented through conversational interactions based on customer questions and chatbot responses [21]. Through the interaction process with machines, customers perceive chatbots as objects of communication rather than simple machines [22]. Therefore, the chatbot service should be designed to reflect user needs and planned as an efficient and

proven system with clear interactions. Chatbot services are mostly text-based messengers in online or mobile applications [23]. Therefore, a UI that enables customers to input and check information on a small screen effectively is essential. As shown in Table 2, design elements, such as product composition, button position, and background color, may vary depending on the screen. Therefore, the chatbot's design needs to project user experience on the screen elaborately. In addition, the screen of the chatbot is a publicity vehicle that presents the image of the company [24].

Table 2. Interface design elements of the financial chatbot.

Process	Design Element	Interface Example
Access Screen	Functional Design	Chatbot location
	Value Design	Chatbot icon and name by function
Start Screen	Visual Design	Background color and overall layout
	Functional Design	Help on key features
Answer Screen	Functional Design	Speech bubble space utilization and option selection function
	Value Design	Character and profile image
Information Screen	Visual Design	Graphic information

2.2. Telemarketing and Technical Elements of Alternative Systems

Customer services centers provide online consultation with and for customers. They operate under various names such as customer support centers, call centers, contact centers, and customer relationship management (CRM) centers, depending on the company [25]. Initial customer service began as an organization that performed simple response services by receiving calls from customers [26]. In recent years, it has transformed into an organization that creates added value by enhancing the corporate image, providing information on products, conducting marketing and promoting activities, providing customer service, and communicating with customers. Customer service is an organization that provides non-face-to-face interactions with customers, but these interactions require emotional labor beyond face-to-face channels [27]. Customer service's emotional labor is an essential element of a company, as it can retain existing customers, attract new customers, and maintain a company's competitive advantage. However, this causes considerable stress on workers due to the incongruity of internal emotions and external expressions. These difficulties have led many companies to build systems that replace customer service [28,29].

Many technical elements are required to build an alternative customer service system. The customer service helper system must respond appropriately by inferring the meaning of the customer's question in real time [30]. For this reason, a semantic reasoning technique that can infer the meaning of a customer's query and provide an appropriate answer is essential. Semantic reasoning techniques can be classified into two broad categories according to their development process. First, knowledge-based question-and-answer (Q&A) structures are used by humans in the system using an ontological method. This method finds the result by inferring the large-scale knowledge database built in a logical form. Second, information retrieval-based Q&A orders a list of answers through probabilistic calculations by searching for answers to questions based on indexes in a large document set [31,32].

For the alternative customer service system to provide intelligent services, a Q&A method through ontology-based reasoning should be used, rather than a simple rule-based search. Recently, owing to the development of deep learning technology, ontology-based Q&A technology has been used in industries and chatbots in the financial sector (Table 3) [33]. Recently, the application of AI and advanced statistical analysis has enabled users to control local information, weather guidance, Internet searches, route searches,

and product searches. These systems can provide advanced services based on user experiences [34].

Table 3. Components of intelligent virtual assistant technology.

Division	Component	
Interactive interface	Speech recognition, multimodal, context recognition	
Semantic reasoning	Intelligence level	Assistant chatbot, intelligent assistant, cognitive assistant
	Conversation process	Goal-oriented conversation processing, question and answer skills
	Knowledge	Semantic Web, ontology-based technical data
Other services	Modeling, big data analysis, web service	

Another essential element for alternative customer service systems is voice recognition technology. In 1952, the AT&T Bell Laboratory in the United States developed the first technology to convert recordings into text. Since then, various laboratories have attempted to develop speech recognition, but the accuracy has not exceeded 80%. The low accuracy of voice recognition is due to different accents, volume, degree of dialect, and background noise [35].

Figure 1 illustrates a recently developed two-step voice recognition and conversion model that leverages deep learning techniques to recover ambiguous speech and further clarifies speech semantic transmission by considering speech characteristics and the surrounding environment. Voice recognition techniques are evolving into deep learning-based systems that can recognize speech, including long sentences or dialogues [36].

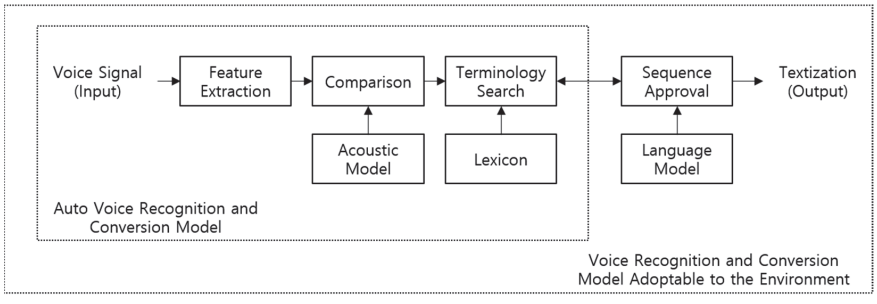

Figure 1. Two-step voice recognition and conversion model.

2.3. Intention to Accept New Technology and Its Spread

Due to internal conflicts and external situations of the system, it is difficult to accommodate and apply innovative technologies to existing systems to create a completely different paradigm [37]. In the financial sector, especially in organizations that perform customer services using mainly call centers, considerable conflicts, along with trial and error, will occur when applying chatbot services initially [10].

This study examines five theories on technology acceptance and diffusion. First, the theory of reasoned action (TRA) is the basis for acceptance and proliferation of new technologies, which argues that consumer attitudes influence behavior and that behavior can be predicted if attitudes are accurately measured. In particular, this theory presupposes that people are highly rational and systematically use the information they have. TRA has three components—attitude, subjective norm, and intention [38].

Second, the newly defined technology acceptance model (TAM) is based on TRA and focuses on user evaluation of the technology as a model to emphasize individual

characteristics or beliefs in the process of accepting technology [39]. TAM argues that the greater the perceived ease and perceived helpfulness of users, the greater the behavior and intention of using technology. Used by several researchers, TAM is recognized as an excellent model that demonstrates simple and high explanatory power in explaining users' IT acceptance and utilization behaviors [40].

Third, diffusion of innovation theory comprehensively describes the process by which a new paradigm of innovation is accepted and adopted by a particular organization or individual [41]. The theory considers the psychological rejection of accepting new techniques. Innovation resistance is the tendency of individuals to maintain their status quo. Created perceived risk is an important concept in accepting technologies. Perceived risk is the user's subjective perception of uncertainty about the future and possible negative consequences [42].

Fourth, the theory of planned behavior (TPB) is different from all of the above because it includes intentional action and strategic intention, and planned behavior control. This theory argues that control of intended and planned actions should be added to the performance of actions. TPB emphasizes that the main determinants of behavior are not the individual's attitude toward it but the intention to perform it and that it is under human control. From this perspective, we add a new concept, a critical variable called perceived behavior control, which sufficiently compensates for the weaknesses in rational behavior theory (Figure 2) [43].

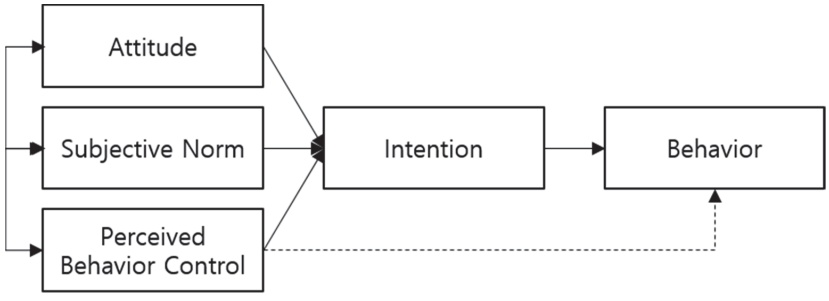

Figure 2. Schematic of the theory of planned behavior (TPB) model.

Fifth, the unified theory of acceptance and use of technology (UTAUT) is a highly descriptive model, because it has been selected as a significant proven factor through numerous trials and verification procedures [44]. In particular, studies analyzing acceptance of fintech payment services, by applying additional variables called reliability to UTAUT, show that individual effort, social impact, and reliability have a positive impact on the acceptance of fintech services. Furthermore, studies using UTAUT in consumer use of internet banking have shown that variables, such as information security risks, uncertainty risks, and transaction efficiency, have a negative impact on the dispersion of internet banking. Prior research results demonstrate that UTAUT is suitable for measuring the intent to use chatbot services introduced by many financial institutions. Studies have found that variables, such as consumer performance expectations, social impact, and promotion conditions, have a significant effect on bank performance [45].

Through the various technology acceptance models described above, we deduce a positive effect of lowering internal resistance and encouraging pro-sustainability behavior, even though there is the disadvantage of being slightly expensive strategically as several variables are added. In addition, we expect to be able to develop models for advancing theory improvement and environmental policy formulation [46].

2.4. Profitability Indicators

Research using detailed profitability indicator data from companies is limited. However, many studies in finance and accounting have used stock market data through the Open API (Application Programming Interface) as a dependent variable. Research has been conducted on the quality of services that are difficult to determine quantitatively [47]. In addition, there are many studies on how political factors cause instability in the financial industry. An empirical analysis of the Bank of Korea's profitability determinants and policy measures that conducted a regression analysis using independent variables such as equity ratio, per capita expenses, assets per capita, total receivable growth rate, and corporate bond yields [48]. A study of profitability determinants for commercial banks in Japan empirically analyzed how the classification of ownership structures affects profitability. The study used gross asset net profit margins, return on equity (ROE), and net interest margin (NIM) as indicators of profitability [49]. Furthermore, a Korean study conducted a multi-regression analysis using major financial indicators and macroeconomic data of general banks from 2000 to 2009 to identify the profitability determinants of banks. The study found that the non-profit loan ratio (NPL) had a statistically significant effect on the profitability of commercial and local banks, and that poor loan management in banks had a significant impact on asset size [50].

Research in the financial sector, which specializes in financial profitability, examined bank profitability determinants in Europe, North America, and Australia, using gross asset net return, return on capital (ROC), and value-added return on total assets as indicators of profitability [51]. Another study identified the impact of each independent variable on the subsidiary variable using gross capital operating profit, gross capital net income, gross capital net return, and net sales net income, of which gross asset net income was the most effective indicator [52]. Other studies compared the profitability and efficiency of commercial and local banks to examine the impact on the bank's management performance and suggested ways to stabilize the profitability of local banks. This was an empirical analysis of the factors affecting profitability with time-series cross-section regression, using portfolio mix as a methodology, and using changes in stock prices and gross capital return as an indicator [53]. In addition, long-term time-series data from 22 general banks were used to ascertain the determinants of the bank's management performance using the net return on assets and the ratio of non-profitable loans as an indicator of the general bank's profitability. These results demonstrate that macroeconomic variables affect bank asset portfolio and productivity variables. Another study used approximately 10 years of accounting data from Spain, Portugal, Germany, and France to analyze the relationship between net return on assets and net return on equity and profitability on commercial banks [54,55].

3. Methods

3.1. Samples and Data Collection

This study analyzed product data from a large Korean banking company to determine the impact of customer product and service purchases on bank profits (return rate increase) based on two channels using ARS. We analyzed the statistical significance of how much each channel contributed to bank profits based on customer information using financial products and services through customer service calls or chatbot systems. We anticipate that our analysis will help banks derive measures to secure financial stability. Furthermore, we expect to empirically derive the extent to which AI-based chatbot can replace the existing customer service business for all financial affiliates, including banks. From Bank A, we collected 34,089 personal data of four major products and services sold through the chatbot channel for 36 months (on a daily basis) from January 2018 to December 2020, when the chatbot was first introduced at this bank. In addition, we collected 317,438 unstructured voice data acquired through customer service based on similar products at the same time. We standardized the unstructured data through a text conversion system and used a two-step voice recognition and conversion model. Except that each of the four products was

handled through customer service or chatbot, all conditions were completely the same; therefore, it is safe to assume that the statistical effect is controllable in advance. Bank A is a nationwide commercial bank, with its target customers individuals residing in Korea; it handled all products during the time of the study. Therefore, the conditions for recognition of region, seasonality, environment, and age are the same. In addition, statistical sampling bias is assumed to be controlled, because the data handled were not part of the extracted data but the parameter data for the entire product. However, unlike chatbots, in the case of responses through counseling staff, there may be a promotional event depending on the period. Therefore, the purchase of a product different from the original purpose may occur due to a specific promotion. However, this cannot be measured quantitatively, and it can be assumed that the effect of counselor promotion is negligible in a situation in which the response to customer purchases is the primary purpose of inbound calls. We deleted sensitive information from Bank A's customer data through blur-masking. In addition, we made the response to the information protection request by performing mixed-combination conversion of the primary key and set it as data that can be analyzed through data cleansing. Financial product information as final analysis data is shown in Table 4.

Table 4. Classification of sample data.

Financial Goods	Customer Service	Chatbot	Total	%
Fund subscription	28,435	2531	30,996	8.8
Housing-subscription savings	49,937	4365	54,302	15.4
Loan interest payment	54,833	6350	61,183	17.4
Utility bill	187,233	18,843	206,076	58.5
Total	320,438	32,089	352,527	100.0

Bank A's main products are new sales of funds and home subscription savings products, loan interest payment and repayment services, and local taxes and utility expenses payment services, with a total of 351,527 cases. Since we used the analysis data based on the number of cases, we counted all duplicate product purchases. The data collected included contract channel (contract manager, chatbot unique allocation code), contract date and contract product, contractor's identification information, and contract number for the individual number of all products. Based on the data, we performed basic statistical information, data preprocessing, hypothesis setting, and testing. We used SAS University Edition, an open-source software, for statistical analysis and the Oracle virtual machine to prepare the software operating environment.

3.2. Operational Definition and Preprocessing

Information on the four financial products selected for this study and product information for each channel through offline counters and online ARS is summarized as follows. First, in the case of funds, the total assets of listed funds (ETFs) handled by six major Korean banking companies amounted to USD 50 billion at the end of 2019. Adding unlisted funds, the amount is over USD 100 billion, which is an increase of 26.1% year-on-year—this is classified into 335 domestic products and 115 overseas products. By investor entity, individual investors account for 38.6% and institutional and foreign investors, 61.4%.

The second product group is housing subscription savings. As of August 2019, the number of Korean subscribers exceeded 25 million, accounting for 50% of the population, and the total amount exceeded USD 80 billion, with savings per person averaging at USD 3000.

The third product group is service products related to loan interest payment and repayment. At the end of 2019, the total amount of personal loans exceeded USD 1.3 trillion, including the amount on credit cards. The average loan per capita is USD 60,000, and interest expenses were, on average, over USD 300 per month.

The final product group, the amount paid in utility bills including local taxes and administrative fees is not large; however, recently commercial banks are promoting a

policy to increase the number or amount through promotions. These policies have positive benefits for high interest rates and currency exchange; hence, consumers are also actively using this system. Table 5 shows the data preprocessing status.

Table 5. Data preprocessing according to variable classification.

Variable	Preprocessing	Remarks
Customer Number	Assign a unique number after masking	Excluding the first 2 digits
Age	Age of subscribers	
Age Group *	Age category of subscribers	0 = under and equal 45, 1 = over 45
Purchase Date *	Date of first contact	
Approval Date	Subscription savings, loan payment, and utility bills are processed in real time (same with Purchase Date)	Fund needs to adjust date according to conditions
Amount1	Subscription amount of Funds	
Amount2	Amount of housing-subscription savings	
Amount3	Amount of loan interest payment	
Amount4	Amount of utility bills payment	Includes national tax, local tax, and other utility expenses
Purchase Channel	- Customer service: employee #- Chatbot: HQ unique code (CB0-#)	
Channel Classification *	Customer service and chatbot channel classification	0 = customer service, 1 = chatbot
Net profit1 *	Revenue from Funds—Expenses	-Exp1: Counselor salary -Exp2: Chatbot cost (develop and maintenance)/average IT infra depreciation period (daily-base)
Net profit2 *	Revenue from housing-subscription savings—Expenses	
Net profit3 *	Revenue from loan interest—Expenses	
Net profit4 *	Revenue from utility bills—Expenses	

* marked variable is newly created data for preprocessing.

As shown in Table 5, the * marked variable is newly created data for preprocessing. However, in the case of the fund's approval date, it may differ from the sale date depending on the product's contract terms and the buyer's credit terms. For this study, age groups were classified as "Junior" for individuals less than 45 years old, and "Senior" for individuals of 45 years and older. Purchasing channels were classified by the employee number—58 employees of the ARS team at the bank's head office—and the unique codes of employees of five other inbound marketing service companies. In the case of the chatbot, the purchasing channels were classified with Bank A's own chatbot allocation code starting with "CB00". All amount-related variables were calculated based on the total amount received by the bank for each product in the period. To estimate the effect of product-specific returns on bank contribution, we created a new variable of net increase or net income excluding costs from profits by using the gross return on assets (ROA), which was used as a dependent variable in previous studies. We set the customer service cost formula by dividing the number of customers by the sum of labor cost and organizational operation

cost. We used the average annual depreciation cost ratio of general system infrastructure of 11.3% and general management cost for server operation to calculate the formula of development and operation cost for the chatbot. We divided this amount by the number of chatbot users and calculated the average cost per chatbot use. As a result, the final cost was set at USD 1.03 per case for customer service and USD 0.39 for the chatbot.

3.3. Descriptive Analysis

As shown in Table 6, in the specific classification of each channel-product group, among all consumers who purchased all financial products using ARS, the number of customers who purchased products through customer service was about 9.3 times more than those who purchased the same products through the chatbot. Therefore, 90.3% of the parameter data purchased products through customer service, whereas purchases through chatbot only remained at 9.7%. In terms of age groups, the purchase of products and services through customer service is higher in the Senior group (54.7%) than in the Junior group (45.3%). This trend is the same for all four products sold through customer service. In particular, in the case of housing subscription savings, the gap widens by 14.6%, which is approximately 5% more compared to the average of 9.5%. In terms of the product purchase rate, 55.8% of customers use customer service to pay utility bills.

Table 6. Descriptive statistics.

Channel	Goods	Age Groups				Total (%)	
		Junior (%)		Senior (%)			
Customer Service	Fund	15,665	(46.9)	17,770	(53.1)	33,435	(10.5)
	H.S.S.	23,469	(42.7)	31,468	(57.3)	54,937	(17.3)
	L.I.	22,845	(44.1)	28,988	(55.9)	51,833	(16.3)
	Bills	81,729	(46.1)	95,504	(53.9)	177,233	(55.8)
	Total	143,708	(45.3)	173,730	(54.7)	317,438	
Chatbot	Fund	2,023	(79.9)	508	(20.1)	2,531	(7.4)
	H.S.S.	2,798	(64.1)	1,567	(35.9)	4,365	(12.8)
	L.I.	3,787	(59.6)	2,563	(40.4)	6,350	(18.6)
	Bills	13,105	(62.7)	7,738	(37.1)	20,843	(61.1)
	Total	21,713	(63.7)	12,376	(36.3)	34,089	
Total	Fund	17,688	(49.2)	18,278	(50.8)	35,966	(10.2)
	H.S.S.	26,267	(44.3)	33,035	(55.7)	59,302	(16.9)
	L.I.	26,632	(45.8)	31,551	(54.2)	58,183	(16.6)
	Bills	94,834	(47.9)	103,242	(52.1)	198,076	(56.3)
	Total	165,421	(47.1)	186,106	(52.9)	351,527	

Regarding consumers using the chatbot, the distribution of purchases is completely different from that of customer service. First, in terms of frequency of use, the Junior group (63.7%) clearly used the chatbot more than the Senior group (36.3%). However, in terms of the product purchase rate, 61.1% of users, which is higher than customer service, used the chatbot for utility bill payment services. In addition, the frequency of purchases of funds and housing subscription savings, which are subscriptions for new products, is completely different from payment of loan interest or utility bills, which are services for existing products. The most striking statistic related to the difference between the chatbot and customer service channels is that customer service occupies a higher proportion of handling new products at 10.5% and 17.3%, compared to 7.4% and 12.8% of the chatbot.

3.4. Hypotheses

Considering the statistics in the case of new product sales, the ratio of total purchases per channel was lower in chatbot than in customer service. Conversely, in terms of loan interest payment and utility bill management, the chatbot has a higher relative ratio than customer service. Based on these data, we posit the following hypothesis to fit the

assumption of the null hypothesis that there is no basis for expecting that new product purchases through customer service will have a greater positive effect on bank profits than purchases through the chatbot:

Hypotheses 1 (H1). *Comparing customer service and chatbot users, there is no difference in their impact on bank contribution according to product classification.*

Considering age groups, the data demonstrated that the relative proportion of seniors is considerably large for products handled through customer service than for those handled through the chatbot. Conversely, in the case of product handling through chatbot, the proportion of Junior users was higher than that of Seniors. Therefore, we expect that specific age groups will have a greater positive effect on bank profits in the division by channel, and we propose the following hypothesis to fit into the null hypothesis assumption similar to H1:

Hypotheses 2 (H2). *Comparing customer service and chatbot users, there is no difference in their impact on bank contribution according to customer classification.*

Finally, we examined the concrete effects of the two hypotheses. We created a cube model with a combination of four cases in the form of 2 × 2 by mixing product groups and customer age groups. We analyzed the effect of each combination on the increase or decrease in the bank's net income. We categorized the sale of funds and housing-subscription savings products as "new product sales," and categorized loan interest and payment of utility bills as "existing service provisions." Utilizing these categories and the two age groups, we developed the four areas as follows: (1) New product sales–Junior group, (2) Existing service provision–Junior group, (3) New product sales–Senior group, and (4) Existing service provision–Senior group. Table 7 presents the data of the cube combination.

Table 7. The relative ratio of rows and columns by cube combination.

Combination		Channel			Col. Ratio	Row Ratio
		Customer Service	Chatbot	Total		
Junior	New Products Sales	39,134	4821	43,955	8.1	26.6
	Provision of Existing Services	104,574	16,892	121,466	6.2	73.4
	Total	143,708	21,713	165,421	6.6	
Senior	New Products Sales	49,238	2075	51,313	23.7	27.6
	Provision of Existing Services	124,492	10,301	134,793	12.1	72.4
	Total	173,730	12,376	186,106	14.0	
Total		317,438	34,089	351,527	9.3	

We present the following hypotheses for each of the four combinations to investigate their bank contribution:

Hypotheses 3a (H3a). *In the case of the Junior group who purchased new products, there was no difference in the degree of contribution to the bank according to the classification by channel;*

Hypotheses 3b (H3b). *In the case of the Junior group that received the existing services, there was no difference in the degree of contribution to the bank according to the classification by channel;*

Hypotheses 3c (H3c). *In the case of the Senior group who purchased new products, there was no difference in the degree of contribution to the bank according to the classification by channel;*

Hypotheses 3d (H3d). *In the case of the Senior group that received the existing services, there was no difference in the degree of contribution to the bank according to the classification by channel.*

4. Results

4.1. Statistical Hypothesis Testing

To test Hypothesis 1, which assumes that there is no difference in the impact on bank contribution of customer service and chatbot users according to product classification, we performed an analysis of covariance (ANCOVA), as shown in Table 8.

Table 8. Covariance analysis test for Hypothesis 1 (H1).

	DF	**SS**	**MS**	**F-Value**	***p*-Value**
Model	2	145.3548	72.6774	18.8893	<0.0001
Error	357,435	1,375,248.4582	3.8475		
Total	357,437	1,375,393.8130			
Parameter	DF	Estimate	S.E.	T for H_0	*p*-value
Intercept	1	−1.4275	0.05251	−2.719	0.0014
T	1	0.0215	0.1457	0.148	<0.0001
NT	1	0.0378	0.2437	0.155	<0.0001

The results show that both purchases of new products and existing services have a significant effect on the increase or decrease in bank profits according to customer service and chatbot channels. This means that new product-oriented funds and housing subscription savings are more suitable for customer service than the chatbot. Conversely, services for existing products, such as loan interest or payment of utility bills, are more suitable for processing through chatbot, which has a positive effect on bank net income.

Hypothesis 2 assumes that there is no difference in the impact on bank contribution of customer service and chatbot users according to customer classification. We performed ANCOVA, as shown in Table 9, to test two or more elements, as in Hypothesis 1.

Table 9. Covariance analysis test for Hypothesis 2 (H2).

	DF	**SS**	**MS**	**F-Value**	***p*-Value**
Model	2	645.3548	322.6774	70.1013	<0.0001
Error	357,435	1,645,278.4582	4.6030		
Total	357,437	1,645,923.8130			
Parameter	DF	Estimate	S.E.	T for H_0	*p*-value
Intercept	1	3.4572	0.4251	8.133	0.073
T	1	0.0035	0.0024	1.458	<0.0001
NT	1	0.0081	0.0075	1.080	<0.0001

Hypothesis 2 secured model suitability according to the F-test result (F = 70.1013). From the results (Table 9), we conclude that both Junior and Senior customers have a significant effect on the increase or decrease of bank revenues according to the two customer channels—customer services and chatbot. In the case of product purchase through customer service, the proportion of Seniors was higher, while the proportion of Juniors was larger for the chatbot. In conclusion, the age group that occupies a relatively large proportion has a positive effect on bank profits.

The total number of samples in Hypothesis 3a is 43,955, which are Junior group customers purchasing new products. The dependent variable is the net increase in bank revenue. We tested the statistical significance of the difference according to the classification by channel.

In the case of Hypothesis 3a (Table 10), the assumption of equal variance is satisfied by the F test (F = 8.12). Therefore, we refer to the pooled t-test, and the test result accepts the hypothesis (t = 1.4352). Hence, when comparing customers who purchase products through customer service and customers who purchase products through chatbot, that there is no difference in the bank net profit (New products–Junior group).

Table 10. Two-sample *t*-test for Hypothesis 3a (H3a).

	Variance	DF	t-Value	*p*-Value
Pooled	Equal	43,953	1.4352	0.312
Satterthwaite	Unequal	43,864.245	1.4345	0.416
Equality of Variance	Num DF	Den DF	F-value	*p*-value
Folded F	39,134	4821	8.12	0.357

Hypothesis 3b is classified by product–customer, and the total number of samples is 121,466 users: Junior customers receiving existing services. The dependent variable is the net increase in revenue for the bank. We tested the statistical significance of differences in channel classification.

In the case of Hypothesis 3b (Table 11), the assumption of equal variance is satisfied by the F test (F = 6.19). Therefore, we referred to the pooled t-test, and the test result rejected the hypothesis (t = 18.2142). That is, when comparing customers who purchase through customer service and those who purchase through chatbot, bank net profits from the customer groups (Existing service–Junior group) are statistically different. In the case of the Junior group receiving only existing service, the bank profit was higher from the chatbot group than from the customer service group. The junior group's handling of small amounts of multiple utility bills through the chatbot has a positive effect on bank finances due to the regular transaction costs of customer service. Therefore, inducing the use of chatbots with low operating costs is a positive contribution to the bank, due to the nature of existing services involving a small amount of money but a larger number of transactions.

Table 11. Two-sample *t*-test for Hypothesis 3b (H3b).

	Variance	DF	t-Value	*p*-Value
Pooled	Equal	121,464	18.2142	0.012
Satterthwaite	Unequal	121,435.328	14.2146	0.011
Equality of Variance	Num DF	Den DF	F-value	*p*-value
Folded F	104,574	16,892	6.19	0.452

In Hypothesis 3c, the total number of samples classified by product and customer is 51,313 because they are customers who purchase new products and belong to the Senior group. The dependent variable is the net increase in bank revenue. We tested the statistical significance of differences in channel classification.

For Hypothesis 3c (Table 12), the assumption of equal variance was not satisfied by the F test (F = 23.73). Therefore, we refer to the *t*-test of the Satterthwaite method, and the test result rejects the hypothesis (t = 34.1223). When comparing customers who purchase through customer service and those who purchase through chatbot, bank net profits of these group customers (New product purchase–Senior group) are not statistically equal. This result is due to the large number of Senior group customers who purchase new products such as funds and savings through customer service. Additionally, the amount of fund products is large. This increases the average bank receipts. In addition, since the housing subscription savings product has regularity, it is expected to have a positive role in terms of bank contribution.

Table 12. Two-sample *t*-test for Hypothesis 3c (H3c).

	Variance	DF	t-Value	*p*-Value
Pooled	Equal	51,311	21.0113	<0.0001
Satterthwaite	Unequal	51,304.525	34.1223	<0.0001
Equality of Variance	Num DF	Den DF	F-value	*p*-value
Folded F	49,238	2075	23.73	<0.0001

In Hypothesis 3d, when categorized by product and customer, the total number of samples is 134,793; they are users receiving existing services and customers belonging to the Senior group by age. The dependent variable is the net increase in revenue for the bank. We tested the statistical significance of differences in channel classification.

In the case of Hypothesis 3d (Table 13), the assumption of equal variance is not satisfied by the F test (F = 12.09). Therefore, we refer to the Satterthwaite method t-test, and the test result rejects the hypothesis (t = −12.1025). Contrary to Hypothesis 3b, in the case of the Senior group, handling existing services with high transaction frequency and small monetary amounts through customer services has high transaction costs and a negative effect on bank revenue.

Table 13. Two-sample *t*-test for Hypothesis 3d (H3d).

	Variance	**DF**	**t-Value**	***p*-Value**
Pooled	Equal	134,791	−13.1452	0.026
Satterthwaite	Unequal	134,731.583	−12.1025	0.025
Equality of Variance	Num DF	Den DF	F-value	*p*-value
Folded F	124,492	10,301	12.09	<0.034

4.2. Cube Model Interpretation

To plot the results of Hypothesis 3, the combination of two conditions by product and by age was made into a 2 × 2 cube model. The X-axis is divided into the age group of customers, and the Y-axis is divided into product characteristics. In addition, we divided the channels into customer service and chatbot. We plotted the four combinations and analyzed the effect of each combination on bank revenue. The analysis results for each combination are shown in Table 14.

Table 14. Interpretation of the hypotheses from the cube model.

New Products (Y_1)	X_1–Y_1 (H3a) Not significant	X_2–Y_1 (H3c) Positive in net profit from Customer Service
Existing Service (Y_2)	X_1–Y_2 (H3b) Negative in net profit from Chatbot	X_2–Y_2 (H3d) Negative in net profit from Customer Service
	Junior Group (X_1)	Senior Group (X_2)

As for X1–Y1, the hypothesis of the study was adopted, so there is no difference in the effect on the net profit of banking operations between the two channels. In the case of X1–Y2, the analysis result was significant, because multiple small transactions were able to save labor and management costs through automated processing. Additionally, X2–Y1 positively affected contribution based on the behavior of the Senior group purchasing new products with large amounts of money. Finally, in the case of X2–Y2, multiple micro-transactions using a chatbot rather than using customer service positively affect bank finances.

5. Conclusions

This study conducted an empirical analysis to pursue the expansion of the use of AI-enabled chatbot in banking financial products and bank policy changes, based on the ARS data of leading banks. For empirical analysis, we summarized the practical implications through the results of hypotheses setting and testing. First, we empirically analyzed the effect of the AI-based chatbot system and suggested policy alternatives to strengthen the financial soundness of large banks. We evaluated the performance of the chatbot system, newly introduced to the existing ARS system in January 2018. In addition, we presented alternatives on how this system contributed financially to banks

and what aspects should be supplemented to optimize customized profits in the future. The findings indicate that reinforcing customer service expertise according to product and age classification increases bank profits. In some chatbot cases, the increase is greater. Second, companies, especially in the financial sector, are furiously building AI platforms. However, applying new technologies to the field, including acceptance and adaptations, requires considerable time and public relations, and may result in internal friction. This can affect short-term profits and may lead to economic opportunity losses. If companies fail to make the right investment at the right time, they may forfeit future opportunities. Therefore, this study categorized whether banks are investing with an eye to profits and analyzed the effectiveness of these investments. This study can be applicable to financial institutions other than banks in the future.

We examined previous studies in four dimensions and in that backdrop, summarize the academic contributions of this study. First, considering the financial chatbot system, we examined AI technologies and effects introduced in various financial environments through prior research. Second, in relation to the ARS system, we summarized the practical problems of customer service counseling staff and the countermeasures and techniques to solve them. Third, we studied the properties of resistance to the introduction of technologies and theories related to alternatives that help reduce the resistance and increase acceptance. Fourth, we investigated prior research on actual indicators representing bank contribution from a methodological perspective. Thus, this study provides a real-world situation through data and meaningful statistical inference.

Despite the various academic significances and practical contributions described above, there are problems and limitations of this study. First, data handled at offline counters that account for most product management were excluded. Banks sell bank-specific savings and loan products, and they offer specialized products such as insurance and bonds. The percentage of products sold through ARS is less than 5% of the bank's total sales. Of these, sales through chatbot are insignificant, less than 10%; hence, it may be unreasonable to closely associate them with bank profits. However, building a new infrastructure for a chatbot is an important factor, considering the unknown impact for the new era. Therefore, continuous research on the introduction of the AI financial system is necessary. Second, the four products and services presented in this study are all parameters of the data accumulated for two years after the chatbot was introduced. These data were developed through trial and error at the time of initial settlement, and the stability of the sample is poor. In addition, there are many macro-environment variables that should be considered along with the impacts presented in this study. This is expected to be a problem that can be resolved naturally as data are continuously accumulated and the system is stabilized in the future. Nonetheless, it remains practically and academically necessary to continuously correct these problems for research. Third, we also need to design an experiment by separating the cases of failure from the success cases in the chatbot service and additionally analyze the service failure factors [56]. In other words, we need meticulous research to control situations that are unfamiliar to customers through further investigation of chatbot service failures. Fourth, we overlooked dealing with digital governance issues. The main challenge in digital governance is not technical but the people involved in the decision-making process [57]. In other words, it is important to create a governance structure so that people participate in decision making and at the same time do not fall into the trap of knowledge issues. Therefore, we need to provide multiple processes at different levels for a sustainable transition to digital governance. Finally, we omitted the study of distorted trust between social cognition and the cognitive ability of chatbots [58]. In other words, we need to list the significant negative impacts of a number of faulty interfaces that could be considered in the conceptual model of a chatbot and provide reasonable evidence of its impact on users. We expect that through the process of closing this set of limitations, we will be able to more accurately relocate the contributions of our research to the digitization of society through chatbots.

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An Acceptance Approach for Novel Technologies in Car Insurance

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Abstract: Background: Unlike other financial services, technology-driven changes in the insurance industry have not been a vastly explored topic in scholarly literature. Incumbent insurance companies have hitherto been holding their positions using the complexity of the product, heavy regulation, and gigantic balance sheets as paramount factors for a relatively slow digitalization and technological transformation. However, new technologies such as car telematic devices have been creating a new insurance ecosystem. The aim of this study is to assess the telematics technology acceptance for insurance purposes. Methods: The study is based on the Unified Theory of Acceptance and Use of Technology (UTAUT). By interviewing 502 new car buyers, we tested the factors that affect the potential usage of telematic devices for insurance purposes. Results: The results indicate that facilitating conditions are the main predictor of telematics use. Moreover, privacy concerns related to the potential abuse of driving behavior data play an important role in technology acceptance. Conclusions: Although novel insurance technologies are mainly presented as user-driven, users (drivers and insurance buyers) are often neglected as an active party in the development of such technologies.

Keywords: car insurance; insurance technologies; Internet of Vehicles; telematics; technology acceptance; sustainable insurance

1. Introduction

Unlike their banking counterpart [1], technology-driven changes in the insurance industry have not been a vastly explored topic in scholarly literature. Incumbent insurance companies have hitherto been holding their positions using the complexity of the product, heavy regulation, and gigantic balance sheets as paramount factors for a relatively slow digitalization and technological transformation. This, however, does not imply that the digital tones have not been playing a part in the realm of insurance business. As a matter of fact, the whole insurance value chain has been affected with the digitalization paradigm shift. For supporting activities such as general management, IT, human resources, controlling, legal department, or public relations in an insurance company, these changes are more or less the same as in other service or financial companies. However, Ref. [2] imply that even the core activities in insurance, such as contract administration, claims management, asset management, and risk management, are witnessing the change based on technologies such as the Internet of Things, cloud computing, chatbots and artificial intelligence, blockchain, robot-advisors, and big data.

One of the Internet of Things' (IoT) technologies that might propel the digitalization of the insurance industry is vehicle telematics. In general, vehicle telematics encompass the collection, transmission, and analysis of data collected from a device installed in a motor vehicle [3]. For more than a decade now, telematic devices in automobiles have been propounded as a technology that will reshape the future of car insurance [4]. By 2030, the industry of the car telematics value pool

is expected to be as large as $750 billion [5]. Although the technology can be used for a myriad of different purposes, it is best suited to the decision-making process of car insurance companies [4]. The main idea behind the introduction of telematic devices is that they can affect driving behavior and decrease the moral hazard of drivers. This will consequently decrease accidents and improve safety. Ultimately, risk premiums will decrease. As stated by [6] (p. 19), "[b]y recording data on drivers' behavior, the information asymmetry between the policyholder and the insurer is reduced, enabling a granular risk differentiation based on the true risk levels of drivers."

The main problem with this approach is the axiomatic presumption that all drivers are the same. Some scholars have already made the argument that telematic devices are not "one size fits all" [7]. Neither the devices nor the approach to potential users has been personalized. The aim of our study is to fill the gap in the present body of knowledge by examining the main factors that affect customers' intention to use vehicle telematics. Specifically, we question how drivers respond to new technology, and whether or not they are willing to accept it. For the purpose of this study, we adopted the Unified Theory of Acceptance and Use of Technology (UTAUT), developed by [8] as one of the most prominent theories on user acceptance of technology. The present body of knowledge recognizes the importance of novel insurance technologies, and especially vehicle telematics. However, most of them shed light on technology push or pool strategies, thus putting the spotlight on high-tech or insurance companies.

Only a paucity of studies even tangentially mentions users (drivers and potential users of telematics) as an active player in the telematic-based insurance ecosystem. Technology-driven advances in the insurance industry allow for the creation of new business models and emphasize the digital transformation of the industry. Accordingly, our study is motivated by a recent call to research the opportunities, challenges, and global trends of this sector and how they might contribute directly and indirectly to the achievement of a sustainable development of the insurance industry. Telematics-based insurance products have already been promoted in the literature as a perspective solution for sustainable insurance, as they directly affect environmental, safety, energy, and resources saving [9].

The remainder of this study is organized in as follows. Section 2 explains how telematics affect the insurance ecosystem and puts the emphasis on the role of end users (drivers). Section 3 thoroughly elaborates on the methodology used in the study-variables, measures, sampling procedure, and data processing. Section 4 presents the results of the study. Section 5 contextualizes the results by explaining the main findings, contributions, implications, limitations, and further recommendations. The final section is reserved for concluding remarks.

2. Theoretical Framework

2.1. The Telematic-Based Car Insurance Ecosystem

In this subsection, we explain how the car insurance ecosystem has changed due to the emergence of a novel Internet of Things device-telematics. Insurance is a complex financial service business based on pooling funds from a large number of policyholders and paying to the ones experiencing losses. Car insurance, specifically, involves writing insurance for both commercial or private vehicle owners. The mandatory third-party vehicle liability insurance policy, for instance, is linked exclusively to the vehicle, not to the driver. This means that any damage will be covered, regardless of who is driving the vehicle. The essence of the insurance business is related to the selection and quantification of numerous policy risks and setting the right price. This assignment is conducted by actuaries. Once the decision on the premium is set, the insurance policy can be sold either directly by the insurance company or via the broker or insurance agent.

Some studies simplify the revenue model of insurance companies by dissecting two main streams [10]. The first revenue stream is by investing the premiums collected into a portfolio of investments, which is usually highly regulated and specified by a supervising national body. This stream will be completely neglected in this study.

The second stream comes from underwriting activities. The profit from such activities is basically the difference between the premiums sold and the payment made to, or on behalf of, the losses, together with the service-related expenses. This stream is particularly important for our study, as one of the main differentiators in the "core" business is the efficiency of the underwriting process. This holds for both life and non-life insurance, including car insurance. The conventional and highly saturated car insurance industry has been facing major challenges recently. The World Bank Group reports that, especially in less developed insurance markets, vehicle insurance can be the largest class of non-life business [11]. The nature of the risk has changed dramatically since February, as vehicle use has fallen sharply in many countries as a result of public health measures. The first evidence of reduced risk implies that this type of business makes a positive contribution to the business of insurers in the short term. In the long run, however, insurance renewal is likely to decline, and reduced economic activity will lead to a reduction in portfolio size, with a proportionate reduction in claims. In addition, changes in the way you go to work may mean that some clients change vehicle use and location in a way not provided for in the policies.

In a concurrent business environment, technology is the paramount driver of efficiency for insurance companies [12]. One technology that fundamentally disrupts the car insurance industry is telematics. Given its prolificacy, vehicle telematics is a subclass of the Internet of Things (IoT), usually referred to as the Internet of Vehicles (IoV) [13]. These devices enable data sharing through vehicle-to-vehicle (V2V), vehicle-to-person (V2P), and vehicle-to-road (V2R) interconnectivity [14]. Ever since their introduction into the car industry, telematic devices have spread rapidly, from commercial to non-commercial uses [15].

Telematic devices are not a novelty in the car industry, but their use in industries such as insurance certainly is. Innovative insurance companies that favor the use of telematics will experience initial profit increases, but the profits are eroded by entry [16]. Thus, only first-movers will benefit from the new telematics-based car insurance ecosystem. This novel ecosystem is displayed in Figure 1.

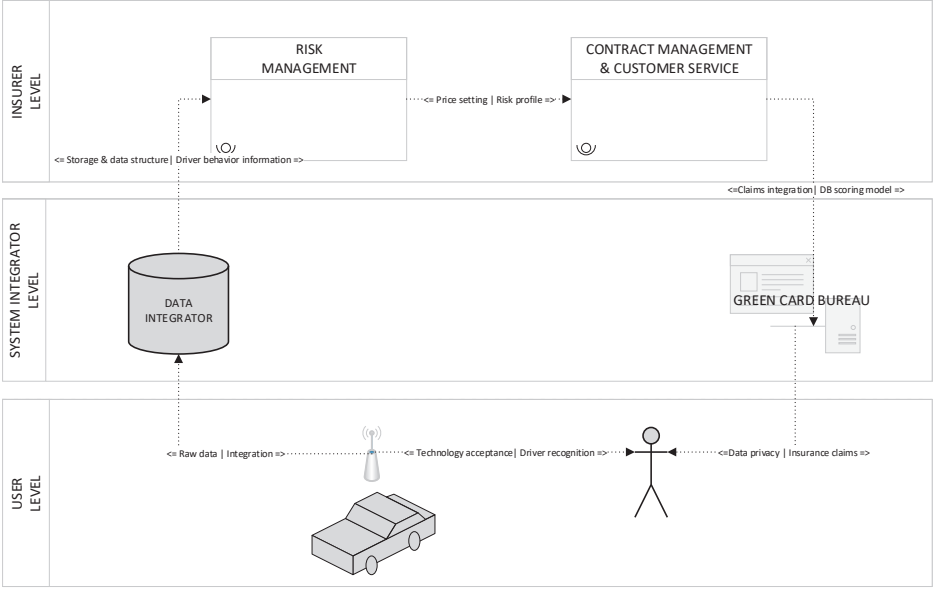

Figure 1. Simplified telematics-based car insurance ecosystem.

As shown in Figure 1, three main levels of stakeholders in this simplified ecosystem are users, data and system integrators, and insurers. As for the users, they are represented by drivers,

vehicles, and telematic devices, either integrated or added later to the vehicle. As for the integrators, they encompass data processors and insurance system integrators, such as the Green Card Bureaus. The third level dissects the core functions of insurance companies. The relationship among the main stakeholders is described in the section below.

2.2. The Dissection of Relationships among Main Stakeholders

Following the aforementioned car insurance paradigm shift, in the following subsection, we thoroughly examine and discuss the main nods (stakeholders) and the relationships among them. We also set the stage for the role of drivers and their willingness to accept the novel Internet of Vehicles technology for insurance premium purposes.

To start with, the four main types of vehicle telematic devices that can serve for data collection from customers are (1) black boxes, (2) dongle, (3) embedded, and (4) smartphone-based [17]. The extant body of knowledge has centered on telematic device usage in all main categories of vehicles. For instance, ref. [18] examined the use of telematic devices in semi-autonomous vehicles and discussed how this technology will require great collaboration between the car manufacturers and insurance companies in order to get a full understanding of the risks. Some authors raise another question for telematic devices and their use in the insurance context [19]. Namely, these authors emphasize the difference for telematics of two-wheelers and provide a novel crash detection algorithm proved against the experimental data for this type of vehicles. This is of particular interest, as motorcycle drivers cause the highest number of accidents [20]. Other vehicles, such as heavy-duty trucks [21], have also been investigated, but this is out of the scope of our study.

The telematic device connects the driver, the vehicle, and the data integrator. As for the connectivity with the driver, an issue with telematic device use is the fact that the driver is not necessarily driving one vehicle. A number of biometric matching techniques are used for this purpose [22]. For instance, ref. [23] propose a mechanism for driver identification based on driving dynamics signals currently available in production cars. The system collects and filters sensing data in a sliding window iteration, computes statistical and spectral features, and, finally, provides driver identification for each window frame through a classification process.

As for connectivity with the data integrator, this integration is made through Internet services usually by the LTE (Long-Term Evolution) standard for wireless communication [24]. Different classes of information, such as GPS data, vehicle temperature, engine information, vehicle information, break-system usage, and other data, are then sent to the data integrator. Important concerns have been raised for this information flow. First, the information can be subject to DDoS (hacking). Second, [25] shed light on data privacy, compare the privacy policies given on the companies' websites and model privacy requirements, and focus on privacy requirements engineering in V2X (vehicle-to-everything, which encapsulates vehicle-to-vehicle, vehicle-to-person, and vehicle-to-road interconnectivity) telematic insurance applications.

This information is further processed to generate risk profiles within the insurers. The raw data is first combined and contextualized, at least for environmental factors, when an accident occurs. Some scholars [26] specify that these environmental factors include the location where certain events occurred, conditions on the road, weather conditions, and their overall contribution to risk.

Risk assessment and price setting are the core activity of insurers. A myriad of different data mining and machine learning approaches have been proposed to predict car accidents and accident claims [27,28]. For instance, [29] explained how new information (the event of a serious road accident being detected, based on airbag deployment and impact sensor information, transmitting GPS co-ordinates to local authorities in an effort to reduce response times and get assistance to the crash scene more quickly) would impact the price setting for European insurers. Obviously, insurance companies still lack the capacity to develop various algorithms using artificial intelligence. Accordingly, ref. [3] described the partnership of a system integrator and auto insurers based on the use of telematic devices, which in turn created a profitable business venture. This has opened an avenue for a number of data

mining [30] and risk modeling approaches [31] based on the close ties between system integrators and the risk and contract management departments of insurers.

Individual assessment of risk is the core value of a telematic-based insurance ecosystem. Insurance companies in general can differentiate the policies and prices of their products by a precise formulation and calculation of the expected risk. Traditional models, however, only rely on general vehicle- or driver-specific variables [32]. With the richness of data provided by novel technology, insurance companies and their risk departments can count on the full modeling of drivers' behavior. Namely, insurance companies can create driver behavior scoring models. These models could be applied to individual levels and driving styles as proposed by [33]. This particular scoring model would allow for a direct extension of common tariff functions, either by using ex post discounts or by entering an ex ante risk factor into the tariff model. Walcott-Bryant et al. [34] extend current usage-based insurance models and present context-based driving scores and driving behavior that include weather, time-of-day, and road quality. Most of the studies only pinpoint how insurers can appraise the behavior and attitudes of drivers. Nonetheless, this information is typically withheld from drivers. To fully close this feedback loop, [35] modeled a behavior change support system based on a telematic device that generates textual feedback for automobile drivers. This feedback is delivered as a weekly report via the smartphone application. Using the simulation-based approach, [36] experimented with sending safety messages to drivers and proved that in-vehicle telematics can play a pivotal role for novice drivers in relation to their driving behaviors.

To actually tailor the premium against a specific customer, an insurance company needs to create a driving behavior scoring system. The simple collection of a large amount of driving behavior data is not sufficient. The processing of such data and the creation of useful information and scoring models is another challenge for insurers. From an actuarial point of view, [37] made an attempt to scale sensitive telematic observables and generate efficient and effective scoring models that would be used in individual actuarial pricing. Additionally, [38] used multivariate credibility modeling for different strata of drivers, ranging from new drivers without a telematics record to contracts with different seniority, as well as drivers using their vehicle in a different capacity, to examine the nature and frequency of claims.

2.3. Predictors of Customer Acceptance of Telematic Devices and Research Hypotheses

The insurance ecosystem based on novel technology is a multifaceted phenomenon and includes a number of stakeholders. This study investigates the perspective of a single stakeholder—the user (driver insurance customer). Currently, insurance companies are changing the paradigm of their business, and some of them have been actively advocating for usage-based insurance (UBI) policies. As inferred by [26] (p. 817), "UBI is based on a myriad of data such as mileage, speed, location, time, total duration of trip, G-force, etc. extrapolated from telematics devices." These policies include different services, such as pay-as-you-drive (PAYD), pay-how-you-drive (PHYD), and manage-how-you-drive (MHYD). Most of the concurrent telematics are based simply on OBD-II programs, but by 2022, black-box devices will be dominant [39]. Recently, most of the practical and scholarly attempts to analyze telematic-based insurance and UBI models have evolved around the "technology push". Contrary to that, we wanted to examine the "pull" side-technology acceptance by users.

A number of models of technology acceptance have been proposed in the literature. The theoretical research frameworks used in this context are TPB (Theory of Planned Behavior), TRA (Theory of Reasoned Action), TAM (Technology Acceptance Model), and UTAUT (Unified Theory of Acceptance and Use of Technology). As explained by [40], TAM and UTAUT were most commonly employed in investigating driver technology acceptance.

Venkatesh et al. [8] reviewed eight prominent information technology user acceptance models and integrated their elements into the UTAUT model. This empirically validated model introduced four determinants of behavioral intention and usage behavior, along with four moderator variables: gender, age, experience, and voluntariness of use. Given that UTAUT effectively explains technology acceptance for novel information technology products [41], this model was specifically selected

and adapted to examine telematics acceptance in the following terms: performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioral intentions. UTAUT has been vastly used when examining user acceptance of a myriad of different technologies, which range from mobile devices and smart grids IoT to blockchain technology and beyond [42–44]. For behavioral intention, in particular, the scenario is thoroughly explained in Appendix A. Simply put, the use of telematic devices would improve the users' bonus-malus scheme.

Besides the constructs drawn from UTAUT, our proposed research model was extended by adding a privacy concerns variable. The original UTAUT model has already been enriched with additional variables, which also stand for privacy concerns [42]. The main theoretical assumption behind introducing privacy concerns is that sharing any personal data raises questions on the acceptance of the technology. Furthermore, the geographical context of the study implies a high sensitivity of respondents to the privacy setting for any innovation [45].

Following these conclusions, we set two main hypotheses:

Hypothesis 1 (H1): *Performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) positively affect behavioral intention (BI) to use telematics for insurance purposes.*

Hypothesis 2 (H2): *Privacy concerns (PC) moderate the relationship between technology acceptance predictors and behavioral intention to use telematics for insurance purposes.*

Following a literature review and the aforementioned hypotheses, our proposed research model is given in Figure 2.

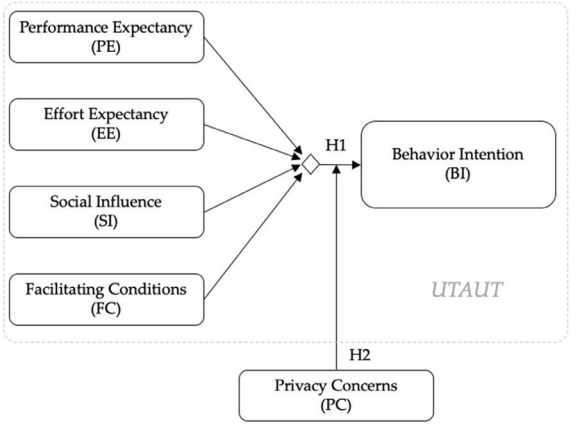

Figure 2. The proposed research framework for telematics-for-insurance users' acceptance.

3. Methodology

Our study was based on primary data collected in the premises of several insurance companies and car dealerships in Belgrade (Serbia) in August and September 2020. We used a Pen-and-Paper Personal Interview (PAPI) questionnaire form to collect the data. The main rationale behind the use of a hard copy, rather than an electronic version of the questionnaire, was the novelty of telematics technology. Prior to responding to the questionnaire, trained assistants explained the use of the technology to potential respondents.

3.1. Variables and Measures

The aim of our study was to assess drivers' openness to embracing and using new technology for insurance purposes motivated by discounts and improved bonus-malus schemes. Technology readiness

is a vividly discussed topic in the literature, and a number of scholars have already made an effort to examine the readiness of customers to participate in IoT-based business models [43,46].

Following these approaches, we first set a scenario for the use of telematics for insurance purposes. For the scenario explanations, we adapted the prerequisites of [47], who implies that "customers who consent to the installation of a black-box on their vehicles and allow the insurance company to collect and record data concerning their driving patterns, are normally rewarded with cheaper car insurance rates." To some extent, this is a specific trade-off between the intrusion on customers' privacy and the lower price they would pay for this intrusion. The detailed description of the scenario is given in Appendix A.

Afterwards, we operationalized measures based on UTAUT and the theoretical model set in Section 2. For the independent variables, we developed the following measures:

1. FC: Facilitating condition (inspired by [8] and [48])
2. SI: Social influence (based on [8] and [49])
3. EE: Effort expectancy (adapted from [8] and [48])
4. PE: Performance expectancy (inspired by [48], [40], and three inquires modestly contributed by the authors)
5. PC: Privacy concerns (inspired by [50]).

Due to the lack of instantaneous readiness to implement an insurance operated telematic device, the dependent variable was determined as a possibility, rather than a firm readiness to purchase the device, following [40].

Even though the majority of the items and constructs were based on previous scales, we pilot-tested the questionnaire. The reason for this was that the items were translated into our native language (Serbian). The pilot testing was conducted by eight undergraduate students at the University of Belgrade. After collecting feedback, the inquiries were refined. The final list of individual items and a full questionnaire are given in Appendix B. Aside from the demographic part, all the items were measured on a Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree).

3.2. Sampling Procedure, Data Collection, and Processing

The particular aim of our study was to assess users' readiness to embrace and use new telematic technology, which could be installed in new vehicles. Using a convenience sampling method, the survey involved 502 respondents. As we tried to include respondents from various demographic groups, and as the questionnaire was simultaneously delivered by several trained assistants, the questionnaires were coded in order to decrease any possible invasive sub-clustering [51,52].

The data were entered into SPSS (Statistical Package for Social Science) version 20.0. The pre-analysis was done with descriptive statistics (means, standard deviations) and internal reliability tests (Cronbach's Alpha). The interdependence of variables was tested with correlations (Pearson moment two-tailed correlation coefficient analysis). The main analysis and hypotheses testing were conducted by a series of multiple regressions.

4. Results

In this section, we first describe the main sample characteristics, then conduct a pre-analysis, and afterwards test the study hypotheses.

4.1. Sample Characteristics

The total number of respondents in our study was 502. The sample was gender balanced (Female = 48.4%; Male = 50.8%; refuse to say or other = 8%). The age structure was also balanced (Mean = 37.97 years, SD = 11.11); 48.4% of respondents was between 17 and 35 years old (two respondents being only 17, and three being older than 65). Most of the respondents were experienced drivers (see Table 1).

Table 1. Driving experience of respondents.

Item	Frequency	Percent	Cumulative Percent
Less than 2 years	28	5.6	5.6
Between 2 and 5 years	113	22.5	28.1
Between 5 and 15 years	120	23.9	52.0
Between 15 and 25 years	95	18.9	70.9
More than 25 years	118	23.5	94.4
N/A	28	5.6	100.0
Total	502	100.0	

When asked about their usual driving frequency, most of the respondents were commuters, using their vehicle between two and five days a week (54.4%), followed by those using their vehicle only occasionally (23.9%). Of the total, 12.4% of respondents used their vehicle for professional purposes.

As for automated driving assistance in their cars, the majority of respondents claimed not to have any device at all, or having low assistance, such as parking sensors (47.6% and 34.1%, respectively).

When asked about how tech-savvy they considered themselves to be, contrary to our expectations, approximately 70% of respondents claimed to be very interested in new technologies. Only 2.19% of respondents considered themselves not to be interested in new technologies.

4.2. Pre-Analysis

Since all the constructs of the independent variables and the dependent variables were multi-itemed, we first analyzed the descriptive statistics (means and standard deviations) of particular items. The results are displayed in Table 2.

Table 2. Descriptive statistics for particular items.

Item	Mean	STD	Item	Mean	STD
Facilitating Conditions (FC)			**Performance Expectancy (PE)**		
Resources (FC1)	5.35	1.60	Useful (PE1)	4.36	1.51
Knowledge (FC2)	5.61	1.46	Prompt (PE2)	4.34	1.77
Expert support (FC3)	5.08	1.66	Improves driving (PE3)	2.42	1.40
Technology compatibility (FC4)	5.24	1.63	Improves bonus-malus (PE4)	3.72	1.84
Social Influence (SI)			Increases safety (PE5)	4.06	1.78
Important persons support (SI1)	4.66	1.88	Enhances effectiveness (PE6)	3.99	1.79
Influencing person support (SI2)	3.57	1.78	**Behavioral Intention (BI)**		
Insurance company support (SI3)	4.68	1.78	Affordable price (BI1)	3.56	1.60
Effort Expectancy (EE)			Appropriate technology (BI2)	4.47	1.61
Utilizing technology (EE1)	3.76	1.85	Intention to use (BI3)	4.26	1.91
Becoming skillful (EE2)	3.59	1.95	**Privacy Concerns**		
Easy to use (EE3)	4.22	1.57	Insurance company (PC1)	5.86	1.47
Easy to learn (EE4)	4.67	1.85	Tech-manufacturer (PC2)	3.57	1.64

After examining singular items, we created composite measures for each construct. Namely, we calculated arithmetic means for each multi-itemed construct (FC, SI, EE, PE, and BI). Prior to doing this, we examined the internal reliability by calculating Cronbach's Alpha (α) for each construct. Using a standard threshold of $\alpha > 0.70$, we ascertained constructs for FC ($\alpha = 0.86$), EE ($\alpha = 0.70$), PE ($\alpha = 0.81$), and BI ($\alpha = 0.72$). We also accepted the internal reliability for SI (where $\alpha = 0.64$), as the value was approaching the traditional threshold for statistical significance. As indicated by respondents, Facilitating Conditions (FC) were rarely marked as an obstacle (Mean = 5.32, SD = 1.33).

Performance Expectancy (PE), on the other hand, was marked relatively low compared to other constructs (Mean = 3.82, SD = 1.21). All other results are shown in Table 3.

Table 3. Descriptive statistics, reliability analysis, and correlation matrix for constructs.

Construct	Mean	STD	α	2	3	4	5	6	7
FC	5.32	1.33	0.86	0.49	0.38	0.56	0.43	0.14	0.23
SI	4.31	1.39	0.64		0.42	0.52	0.25	0.31	0.21
EE	4.06	1.31	0.70			0.58	0.28	0.13	0.11
PE	3.82	1.21	0.81				0.44	0.25	0.23
PC1	5.86	1.47	n/a					0.14	0.14
PC2	3.57	1.64	n/a						0.58
BI	4.10	1.37	0.72						

Note: Highlighted in gray: significance at $p < 0.05$; else: significant at $p < 0.00$.

Table 3 also displays the correlation matrix for independent, dependent, and control variables. Bearing in mind that the scale used in the study has already been actively used for technology acceptance, it was not odd to see that a number of positive correlations were captured. At the same time, these results have opened an avenue for further hypotheses testing, but also drawn our attention to the possible multi-collinearity issue.

4.3. Hypotheses Testing

After conducting the pre-analysis, the hypotheses were tested. For this purpose, three standard multiple regression analyses were conducted. Table 4 shows the results of the regression analyses of behavioral intention to use telematic devices for insurance purposes based on independent variables (Model 1: FC, SI, EE, and PE; Model 2: FC, SI, EE, PE, and PC1; and Model 3: FC, SI, EE, PE, and PC2).

Table 4. Regression models for behavioral intention to use telematics.

	Model_1	VIF	Model_2	VIF	Model_3	VIF
[Constant]						
FC	0.142 *	1.597	0.143 *	1.713	0.154 *	1.598
SI	0.102	1.582	0.098	1.596	−0.046	1.665
EE	−0.049	1.535	−0.042	1.537	−0.025	1.537
PE	0.112	2.147	0.100	2.269	0.047	2.163
PC1	/	/	0.027	1.322	/	/
PC2	/	/	/	/	0.541	1.616
R	0.275		0.278		0.581	
R^2	0.075		0.077		0.338	
Adjusted R^2	0.067		0.067		0.331	
Durbin–Watson (d)	2.059		2.076		2.044	
F test	9.521		7.792		47.528	
Significance	0.000		0.000		0.000	

Notes: Dependent variable for Models 1–3: Behavioral intention (BI). Only standardized coefficients (betas) are displayed. Significance: * $p < 0.05$; ** $p < 0.01$.

Prior to acknowledging the theoretical model, we tested the variables for auto-collinearity and multi-collinearity issues. As for auto-collinearity, we examined Durbin–Watson statistics. None of the models showed autocorrelation for the given threshold, $1.5 < d < 2.5$ (the results were $d_1 = 2.059$, $d_2 = 2.076$, and $d_3 = 2.044$, respectively). For the purpose of multi-collinearity check, we calculated the Variance inflation factor (VIF) as a quantification of the severity of multi-collinearity in an ordinary least square regression analysis. The traditional thresholds are $1.5 < VIF < 2.5$. As shown in Table 4, none of the variables had VIF below or above the standard thresholds.

After testing for auto- and multi-collinearity, we tested the hypotheses of the study. In general, H1 was confirmed. However, the overall effect was modest, as only about 7% of variability was found

(Adj. $R^2 = 0.067$; $p < 0.00$). In particular, only Facilitating Condition (FC) was found to be a significant predictor of Behavioral Intention and was able to explain as much as 14.2% of the variability of the independent variable.

For H2, we split the overall moderating effect of Privacy Concerns into those related to the insurance company (H2a) and the ones related to the telematics manufacturer (H2b). When added to the regression model, Privacy Concerns related to insurance companies do not affect the overall effect. Accordingly, H2a is not confirmed.

However, the technology manufacturer plays a pivotal role in the decision to use a telematic device for car insurance purposes. When added to the regression model, PC2 significantly changes the overall effect. Privacy concern accounts for more than half of the variability of the model (B = 0.459, SE = 0.034; β = 0.541; $p < 0.00$). Accordingly, H2b is confirmed.

5. Discussion

In this section, we contextualize the study results by elaborating on key findings and contributions, twofold implications (for scholars and practitioners), as well as limitations and further recommendations.

5.1. Key Findings, Contributions, and Implications

The aim of our study was to question how drivers respond to new technology, and whether or not they are willing to accept it for car insurance purposes. For the purpose of this study, we adopted the Unified Theory of Acceptance and Use of Technology (UTAUT), one of the most prominent theories on user acceptance of technology, and interviewed 502 drivers/insurance premium buyers.

As the results indicate, Facilitating Conditions (FC) are a statistically significant predictor of the behavioral intention to use car telematic devices for insurance purposes. This is in line with some studies that recognize physical potential and capacity as the foremost driver of novel technology usage [53]. Nonetheless, other studies, such as [40], find all the other factors to be significant predictors, isolating only Facilitating Conditions as insignificant. One explanation for this phenomenon might be the fact that users would generally need pre-experience in order to fully understand Effort Expectancy and Performance Expectancy, as inferred in [54].

We developed a rich understanding of the main drivers behind technology adoption and how insurers can benefit from it. However, an even more profound insight and general contribution can be drawn from the testing of the second hypothesis. Namely, we found that users generally do not see insurance companies as privacy invaders. Although it might be a judicious judgment, the underlying rationale for this is probably the heavy regulation of the insurance industry and layers of information flow control. On the other hand, respondents generally see high-tech manufacturers as information abusers.

The study results indicate that insurance companies should go on introducing new technologies into the changing insurance ecosystem, following the users' readiness to accept novelties. However, the innovative side of our findings comes from a lateral conclusion, which emphasizes the direction of their cooperation with technology producers. Users find insurance companies to be reliable partners in using their personal driving behavior data. Telematic device producers, however, are not seen as a trustworthy partner at the moment. Seemingly, digital technologies in general are poised to create privacy vulnerabilities.

This study has twofold implications. For researchers, it provides an opportunity to further question the development of the technology-driven ecosystem. As insurance technologies advance, the business, revenue models, dynamics, and growth of the insurance industry change. This study puts the spotlight on a single stakeholder—the user. Although some progress has been made for other stakeholders in the insurance ecosystem, this remains a "blue ocean". As for practitioners, this study emphasizes the importance of facilitating conditions on one side and privacy concerns on the other. As for the facilitating conditions, new vehicles are inevitably going to be equipped with

more sophisticated technologies. Their uses will go beyond the current ones—electronic diagnostics, navigation system, automated driving assistance, internet data, etc. Insurance companies should become a stronghold in the usage of this technology for car insurance purposes. Even though this study finds a positive relationship between facilitating conditions and behavioral intentions to use telematics, we might speculate that this factor will not be the uppermost determinant in the near future. As for privacy concerns, new vehicle technologies should convince drivers and insurance users that their data would be safely stored and that any information on driving behavior would not be abused. As the results indicate, the main driver of car telematic use might be the partnership between the device manufacturers, data integrators and insurance companies. This network might alleviate concerns related to the possible misuse of driving behavior data.

5.2. Limitations and Further Recommendations

As all other quantitative studies, ours has a number of flaws and limitations. The first limitations that might raise the question of the generalizability of the findings is the narrow geographical context of the study. The study was conducted in Serbia. At best, the findings could be replicated in those countries with a similar level of economic development, tech-savvy attitude, and insurance sector features. It should be noted that both risky driving behavior [55] and preference toward insurance [56] are highly contextual and culture-driven phenomena. A further body of knowledge should be built around new evidence from authors' markets, as well as from comparative studies.

Another limitation of the study is the paucity of factors taken into consideration for the use telematics for insurance. An avenue for further research is the inclusion of new potential drivers of technology use. Moreover, additional studies might inspect new mediating variables. For instance, an interesting mediating variable might be the experience of drivers with insurance claims, as [57] generally find that the trust in insurance falls with previous bad experiences.

It should be noted that this study is cross-sectional by nature. Technology acceptance in general, and telematics for insurance purposes acceptance in particular, are dynamic phenomena. Thus, we only captured a singular moment. Follow-up studies should examine and explore evolutionary time-based characteristics of telematics acceptance.

6. Conclusions

The market for telematic devices and the Internet of Vehicles (IoV) is evolving and becoming more saturated and consolidated. Concurrent approaches to the development of these promising technologies have mostly been based on technology push models, putting the spotlight on those stakeholders aimed either at manufacturing the devices or capturing, processing, and analyzing the data generated from them. As the devices become more sophisticated and the data become more manageable, standardized, and actionable, the focal point will transfer from supply to demand. This study is a modest contribution to the alleviation of this paradigm shift. We report on early user acceptance of this novel technology, considering insurance as the main purpose of telematics.

As reported in the study findings, users have a statistically significant influence on the acceptance and intentional use of car telematic devices for car insurance purposes. However, this influence is relatively low, as we captured only a small portion of the variability. When moderated for privacy concerns, however, the variability significantly increases. Accordingly, we conclude that novel technologies are highly affected by the consciousness of technology users of the accustomed collection of data on their everyday actions and behaviors.

This study adds to the concurrent body of knowledge in several ways. First, we delineate the possible model of telematic-based insurance market. Second, we draw attention to the pull rather than push effects of the introduction of novel telematic technology. Third, we empirically validate the main factors of the possible usage of novel technologies by the end users. With regards to the practical use, this study sheds the light on the need of insurers (both companies and regulatory bodies) to manage regulatory requirements and demonstrate high-quality data security management for a

digital paradigm shift. The use of telematics will help insurers in accurately estimating policies and reducing frauds, but every technology comes with apprehensions.

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Appendix A. Scenario Description

The telematics system is a system for collecting, processing, and transmitting data on the driving style and operation of vehicles. An example of a telematics system for the purposes of this research is a combination of so-called "Dongle" devices and mobile phone applications. The "Dongle" device simply plugs into an OBD2 diagnostic connector that all new cars have. The device collects data on speed, mileage, driving time, movement maps, sudden accelerations and braking, airbag deployment, etc. The driver can monitor the collected data in real time or after driving via a mobile phone application.

If you accept usage of the telematic device, and allow an insurance company to retrieve the data on your driving behavior, you will be granted a premium discount and/or advanced bonus-malus scheme.

Appendix B. Final Questionnaire (Constructs Only)

Table A1. Individual items and constructs used as a part of the questionnaire.

Construct	Items
Facilitating Conditions (FC)	FC1 I have the necessary resources to use telematics in my vehicle.
	FC2 I have the necessary knowledge to use telematics in my vehicle.
	FC3 If I have difficulty using telematics, there will be experts to help me.
	FC4 Telematics is compatible with other technology I use in my vehicle.
Social Influence (SI)	SI1 People who are important to me think that I should use telematics in my vehicle.
	SI2 People who influence my behavior think that I should use telematics in my vehicle.
	SI3 In general, the insurance company I am associated with would support the use of telematics.
Effort Expectancy (EE)	EE1 I could quickly and easily utilize a new telematics device.
	EE2 It would be easy for me to become skillful at using telematics.
	EE3 I find telematics easy to use
	EE4 Learning to operate telematics is easy for me.
Performance Expectancy (PE)	PE1 I would find telematics useful in collecting all information about my driving behavior.
	PE2 Using telematics would quickly provide my company with all the information that it needs.
	PE3 Using telematics would improve my driving performance.
	PE4 If I use the system, I will increase my chances to improve my bonus-malus scheme.
	PE5 Using telematics in driving would increase my safety.
	PE6 Using telematics would enhance the effectiveness of my driving.
Privacy Concerns (PC)	PC1 I am concerned that my vehicle telematic data could be misused or abused by the insurance company I am associated with.
	PC2 I am concerned that my vehicle telematic data could be misused or abused by the manufacturers of the vehicle or telematic device.
Behavioral Intention (BI)	BI1 If a telematics system is available on the market free of charge or at an affordable price, I intend to purchase the system.
	BI2 If my vehicle was equipped with a telematics system, I predict that I would use the system regularly when driving.
	BI3 Assuming that the system is available, I intend to use the system regularly when driving.

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sustainability

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Sustainability in FinTechs: An Explanation through Business Model Scalability and Market Valuation

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Abstract: *Framework*: Financial Technology (FinTech) is an industry composed of diversified firms that combine financial services with innovative technologies. The research question and main goal are attempting to answer whether they are more similar to traditional banks or trendy technological firms deploying their innovativeness to favor financial inclusion and sustainability. *Justification*: Evaluators may wonder if FinTechs follow the typical evaluation patterns of bank/financial intermediaries or those of technological firms. Preliminary empirical evidence shows that the latter interpretation is the one consistent with the stock-market mood. *Objective*: This study goes beyond the extant literature, analyzing the differences between FinTechs and traditional banks in market valuation, and showing the potential for digital interaction and cross-pollination of complementary business models. *Methodology*: The differences will be empirically analyzed with the stock market valuation and the multipliers associated with these firms. *Results*: The main contribution of this paper is that the appraisal approaches of FinTechs follow those of technological startups, having a revenue model much more scalable than that of a typical bank. FinTechs may so provide a solution for sustainable finance with microfinance and crowdfunding among others. FinTechs and traditional banks may eventually converge towards a common market exploiting co-opetition strategies.

Keywords: financial innovation; value chains; scalability; digital platforms; financial ecosystem; discounted cash flows; market value; Sustainable Development Goals

1. Introduction

The term "FinTech" denotes the firms that combine financial services with innovative technologies offered to financial service providers. As a rule, new participants in the market offer Internet-based and application-oriented products. FinTechs generally attract customers with products and services that are more user-friendly, efficient, transparent, and automated than those currently available. Traditional banks have not yet exhausted the possibilities for improvements along these lines [1–3].

In addition to offering products and services in the banking sector, some FinTechs distribute insurance and other financial instruments or provide third party services.

FinTech is recognized as one of the most critical innovations in the financial industry and is evolving at a rapid speed, driven by the sharing and circular economy, favorable regulation, and information technology. FinTech promises to disrupt and reshape the financial industry by cutting costs, improving the quality of financial services, and creating a more diverse and stabler financial landscape. FinTechs foster technological innovation in financial services that could result in new business models, applications, processes, or products with a material effect on financial markets and institutions, and the provision of financial services [4].

The relevance of the link between sustainability, finance, and technology has been evidenced by the COVID-19 pandemic crisis, which has urged all countries to re-think the models traditionally deployed and rely more on technology and sustainability [5].

FinTechs have already started to fill the financial inclusion gap by providing services to the Bottom of the Pyramid unbanked people, enabled by information and communications technologies (ICT) and new business models. The triple-bottom-line impact analysis that considers economic, social, and environmental sustainability is a new, emerging research area [6]. Nevertheless, as FinTech is innovative but inherently unpredictable, customers are still hesitant to adopt and use it, so affecting its growth. Uncertainty is more critical in FinTech than in traditional e-banking because FinTech transactions are more complicated and less predictable [7].

FinTechs are gaining importance and presence in the financial and banking sector, becoming a game-changing, disruptive innovation capable of shaking up traditional financial markets [8].

The playing field of this study is FinTech business models and their variegated sustainability, providing complementary activities to banks that favors the removal of traditional barriers of the financial sector, favoring financial inclusion. This research strand has been recently well-developed [9] by considering FinTech as the key driver for financial inclusion, and sustainable balanced development, as embodied in the UN Sustainable Development Goals that are a set of 17 targets to create a sustainable world by 2030 (https://sdgs.un.org/goals). Their full potential to support these Goals may be realized progressively supporting digital financial transformation. In this context, the valuation of FinTech companies that make projects viable is an essential part of the sustainability process.

The business model of FinTechs is intangible-driven, combining e-finance, internet technologies, social networking, artificial intelligence, blockchains, and big data analytics, and is more scalable than that of traditional banks. These features impact growth opportunities and trendy patterns consistent with Sustainable Development Goals. This phenomenon will be analyzed in Section 2. The main dimensions aforementioned in the definition of FinTechs are displayed in Figure 1.

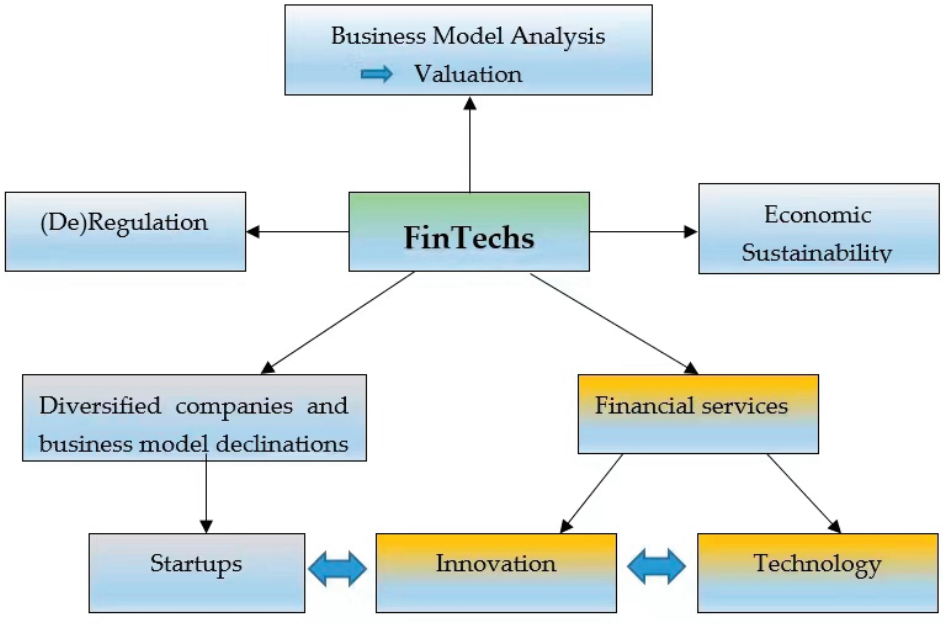

Figure 1. Main dimensions of the FinTech definition. Source: Own elaboration.

Technological *startups* include companies operating in the FinTech segment, providing services and financial products with information and communications technologies (ICT). FinTechs reformulate business models, with innovative software and algorithms, value chains based on interactive computer platforms, artificial intelligence, and big data.

Financial services that focus on the transmission of information on digital platforms rely on *innovative activities* concerning data processing and interpretation in real-time with automated descriptive, prescriptive, and predictive *technologies*. The design of digital financial markets and systems provided by [9] supports broader access to finance and investment. This means a tremendous potential to transform not only finance but economies and societies, through FinTech, financial inclusion, and sustainable balanced development.

FinTech has become a hot term due to many driven forces, which include technical development, business, and market innovation, cost-saving requirements, and customer demand [10,11]. FinTech refers to a vast and diverse industry that disrupts the financial industry, solving friction points for consumers and businesses to make the overall business more resilient and *sustainable*.

The banking industry is facing radical transformation and restructuring, as well as a move toward a customer-centric platform that can foster financial inclusion. The competition will increase as new players enter the industry, but the long-term impact is more open. The *regulation* will decisively influence to what extent FinTechs will enter the industry and who the dominant players will be. The challenge for regulators will be to keep a level playing field that strikes the right balance between fostering innovation and preserving financial stability, and consumer protection [12].

The *valuation* issues of FinTechs must be adapted to often young companies, given the novelty of the sector, which have all the prerogatives of startups (in terms of expected growth, survival rate, volatility, etc.). The valuation methodologies must consider first the underlying business model. The main internal driver of sustainability is represented by their economic and financial viability that can be detected by examining their business model and current accounts (with reference to economic and financial margins, like EBITDA, net result, operating, and net cash flows). If they are self-sustainable, then they can improve their ecosystem's overall sustainability [13].

According to [14], there are two types of FinTech companies: competitive and collaborative. Competitive FinTechs are larger and mature firms, not necessarily hyper-specialized, aiming to squeeze out new competitors with lower prices. Collaborative FinTechs offer ancillary services to enhance the position of competitors, cooperating with banks [1]. Cooperation is primarily geared to the integration of a FinTech application (product-related cooperation) along the financial intermediation supply chain [15]. A further pattern is be represented by co-opetition, according to which FinTechs and banks both compete and cooperate.

In recent years, considerable progress has been made in the areas of both FinTech and sustainability. However, up to now, these two areas have rarely come together, even if they are the two major drivers of change in the financial sector. There is not a financial institution that is not involved in it. "FinTech is a new financial industry that applies technology to improve financial activities" [16]. In theory, it would be possible to include banks, but this would make it harder to draw a line between traditional market participants and FinTechs.

Moreover, sustainability has grown from a niche preoccupation for business to a mainstream concern. Established FinTech can act as a sustainability catalyst to trigger collaborative innovation between traditional financial and banking institutions [17]. The Sustainable Development Goals offer businesses and stakeholders a common playground on sustainable development [17].

FinTech could help accelerate the development of green and inclusive financial markets and help realign finance to support sustainable development. It offers the prospect of quickening the integration of the financial system with the real economy, which will in turn enhance opportunities for greater decentralization and increased participation.

Based on these premises, the research question of the paper is concerned with the hybrid "Fin + Tech" nature of these innovative firms, wondering if they are more similar to traditional banks

or trendy technological firms. The business model comparison will be complemented by stock market empirical evidence, limited to a subset of successful listed FinTechs that represent a mighty target for mushrooming startups. Economic sustainability will be investigated as a prerequisite of other sustainability declinations, ranging from the social impact of financial inclusion to the related environmental concerns, consistent with the Sustainable Development Goals.

This paper is organized as follows. Section 2 includes a literature survey, showing the originality of this research question. Section 3 describes the methodology and the research question in further detail, reporting the empirical evidence, with the stock market valuation, and the multipliers of a sample of FinTechs, banks, and technological firms. The implications follow in the subsequent paragraphs. Section 4 synthetizes some interactions between FinTechs and banks, showing differences, and converging patterns. Section 5 contains a discussion, concentrated on asymmetric risk patterns, and Section 6 summarizes and concludes.

2. Literature Revision

In this section, we undergo a literature review on the FinTech topic to provide a wide range of approaches from some general concepts [9,18–21], to business model declinations, going from InsurTech [22] to PropTech [23], SupTech [24], RegTech, or services offered (e.g., PayTech - payment systems and processing, P2P loans, open banking, Banking-as-a-Service, etc.) [25], innovative intangibles, like blockchains [26,27], big data [28], or artificial intelligence [29]. FinTech's regulation and supervisory constraints represent a further debated issue [30]. Regulation is softer than that of hyper-vigilated deposit-collecting banks.

A literature revision is propaedeutic to a better-focused framework of the issues analyzed in this study. A comparative analysis of FinTechs versus traditional banks will be considered in particular, consistently with the research question and its multifaceted declinations that also embrace economic sustainability issues.

The long-term viability of FinTechs and their economic sustainability, consistent with their business models, represents an ancillary target of this study. Economic sustainability is a core pillar of a wider interpretation that also embraces social and environmental aspects. Sustainable FinTechs may contribute to the overall stability of the financial system, a well-investigated topic that will be synthetically recalled in the conclusions.

The comparison of the regulatory constraints on fintech versus "traditional" financial firms has been investigated in [31,32], according to which, recent tendencies require the banks to increase investment in FinTech, rethink service distribution channels, especially the business-to-consumers models, increase further standardization of back-office functions, etc. Other authors show that FinTechs ease access to financial services, fostering competition by new players [33]. To survive, incumbent banks must react, face rising competitive pressure, and adopt new strategies.

The FinTech business can also mitigate financial inclusion concerns [21,34] that first of all depends on the economic sustainability issues analyzed in this study, with their social and environmental consequences. Accordingly, FinTech "is the key driver for financial inclusion, which in turn underlies *sustainable* balanced development, as embodied in the UN Sustainable Development Goals. The full potential of this technological phenomenon to support the Sustainable Development Goals may be realized with a progressive approach to the development of underlying infrastructure to support digital financial transformation" [35]. Additionally, the report "FinTech and Sustainable Development—Assessing the Implications" [35] assesses how the innovations in financial technology could help to align financing with sustainable development. To do this, this report considers the following items:

1. "Unlock greater financial inclusion by reducing the costs for payments and providing better access to capital domestically and internationally;
2. Mobilize domestic savings at a scale that will enable long-term investment directed at the long-term sustainability of the real economy;

3. Disrupt the provision of financial protection, risk management, risk transfer, and risk diversification for vulnerable and exposed communities, real economy assets and infrastructures, and nature's ecosystems;
4. Collect, analyze and distribute information on the financial system and the real economy for better economic decision-making, regulation, and risk management;
5. Provide financial markets with the level playing field and market integrity needed for long-term real economy investments aligned with the sustainable development agenda".

The "Sustainable Finance and FinTech in Europe" report [36] supports "policymakers in the European Union around the synergies between Sustainable Finance and FinTech, to serve as a starting point for Financial Centers for Sustainability Network global work in the field".

Finally, Figge et al. [37] point out the cost of sustainability capital and the creation of sustainable value by companies, and [38] uses an investment valuation model for sustainable infrastructure systems: Mezzanine debt for water projects.

Focusing on sustainable financial products in the Latin America Banking Industry, a very recent paper on sustainability itself should be highlighted [39]. The purpose of this study is to analyze the extant literature on sustainable financial products (SFP) with a comprehensive understanding of the status quo and research trends.

Hammadi et al. [40] investigate the sustainable performance of FinTechs. A comparative analysis of the business models of FinTechs versus traditional banks is, however, missing (the marketing aspects are investigated in [41]). This study, therefore, fills a gap in the literature, linking the business model analysis with stock market returns.

Other authors interpret FinTech as a platform for the development of sustainable economic growth and as a prompter of the fourth industrial revolution [42]. Traditionally, FinTech has been considered as an expansion of the ordinary or traditional financial industry. The same authors [42] view the industry as having a wider and more inclusive role in transforming all industries toward value creation due to the following arguments. First, FinTech supports all other industries, especially manufacturing, as it induces more production and supply. Contrarily, the effect of the conventional financial industry is limited to the financial subsector and its associated service sectors. Second, the FinTech industry permits a positive linkage between all industries nationwide. Consequently, the industry could be an effective prompter for the sustainable development of the national economy. In effect, under FinTech, financial/monetary-related activities can be executed with higher security through data-validating technologies such as blockchain.

To summarize, FinTech organizations, mainly startups, are reshaping the financial services industry, offering customer-oriented services that combine "speed and flexibility, backed by forward-looking strategies, and cutting-edge business models" [43]. A clear example of these statements can be found in agriculture sustainability [44]. Agriculture is fundamental for food security and primary sustainability issues. However, lack of funding and limited distribution channels are frequent problems. In this context, agriculture's sustainability can be strengthened with innovative services such as FinTech and the digital marketplace. FinTech-enabled digital marketplaces could foster the sustainability of agriculture's business process improving the funding (e.g., crowdfunding) and distribution (e.g., digital payment system) channels. All involved actors (farmers, landowners, investors, and consumers) can then be connected to a digital platform that promotes transparency, empowerment, resourcefulness, and public engagement. Additionally, the University of Cambridge Institute for Sustainability Leadership [45] enumerates significant opportunities for multinationals, financial institutions, and start-ups where FinTech can solve sustainability challenges in the real economy. A case study in Taiwan [46] shows a replicable pattern with geographical scalability elsewhere.

We hypothesize that modularity or scalability is the key factor for developing the banks' future and then creating value [47]. In effect, new banking opportunities must be exploited through higher levels of openness towards third parties and a growing number of modular services bundled together. Another methodology to value FinTech investments is using real options in six business models mainly

implemented by startups: payment, wealth management, crowdfunding, lending, capital market, and insurance services.

From another point of view, the UK Green Building Council [48] identified 11 value drivers for built environment businesses. A value driver is defined as "Any variable or factor (i.e., a resource, activity or condition) that can be influenced, measured, managed and controlled and, in turn, affects the value of the business by one or more of the following means: reduces risk, increases profitability, leads to future growth in profitability". In this context, sustainable business activities positively interact with many value drivers. Specifically, the main four value drivers proposed by the UKGBC members are highlighted in red in Figure 2. The other complementary drivers impact the business model, shaping the identity and business purpose, and contributing to the overall economic sustainability. FinTechs can be considered here as a complementary catalyzer for scalability, bankability, digital innovation, etc.

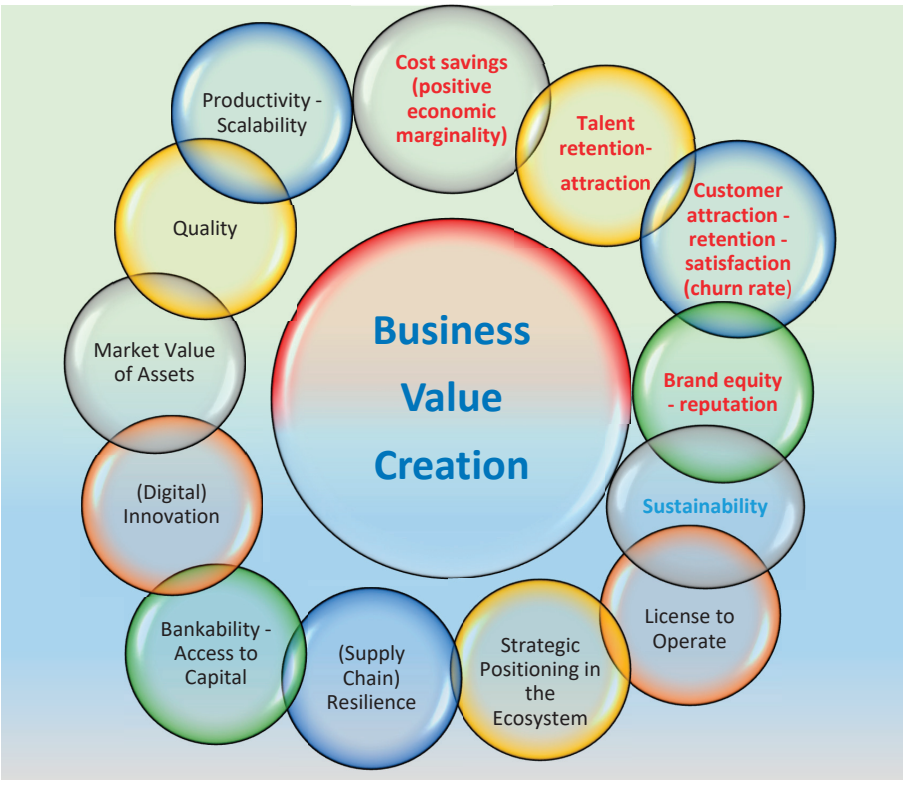

Figure 2. Sustainable Business Activities. Source: own elaboration, adapted from [48].

Given that trillions of dollars will be needed to finance sustainable development, policymakers must assess and consider leveraging opportunities presented by FinTech to contribute to the greening of the global financial system and achieving a sustainable future for humanity [35], consistent with the aforementioned Sustainable Development Goals.

FinTech has the potential to unbundle the banking sector's core functions: clearing and settling payments, performing maturity transformation, sharing risk, validating trust, and allocating capital. FinTech also brings about a new paradigm in which information technology is the driving innovation in the financial industry. FinTech is touted as a game-changing, disruptive innovation capable of shaking up traditional financial markets, being viable to discuss various FinTech business models and investment types [8].

The economic sustainability of FinTechs backed by stock market investments has never been comprehensively analyzed. Even the business model comparison between the FinTechs, and either banks or IT companies, has hardly been investigated and represents a further research gap.

This study goes beyond the current literature, analyzing how the differences between FinTechs and traditional banks are reflected in stock market valuation, and showing the potential for digital interaction and cross-pollination of complementary business models. It will be shown that listed FinTechs, like those analyzed in the panel (see Table 3), represent a template and a target for mighty startups that show a strong technological component, and act as digital disruptors in a conservative financial market presided over by established incumbents. The literature concerning the economic sustainability of the FinTechs and its ongoing integration with the banks can, therefore, be expanded, incorporating the main findings of this study.

3. Methodology and Empirical Evidence

The appraisal methodology may conveniently start from a synthetic recap of the main evaluation approaches traditionally used for startups, banks, and technological firms that may be adapted to FinTechs.

A comparison of the primary evaluation criteria in traditional (non-financial) firms [49], high-tech firms (startups), and banks/financial intermediaries is reported in Table 1. The correlation with high tech firms and banks seems a useful tool to assess the overall sustainability of FinTechs and their contribution to making the overall financial ecosystem more resilient and inclusive. Internal sustainability (i.e., self-economic-financial viability) is crucial in the confrontation with adjacent firms that populate the same ecosystem. FinTechs are sustainable if they replicate "survival patterns" that resemble those of other technological startups. They also need to interact with banks, sharing their clients.

In an equity valuation theory and practice, there are generally two valuation approaches-discounted cash flows (DCF) and comparables [50].

Table 1. Comparison of the main evaluation approaches of traditional firms, technological startups, and banks. Source: Own elaboration.

Traditional Firm [51]	**Technological Startup/Internet Company [52]**	**Bank (Financial Intermediary) [53]**
Balance-sheet based	Venture capital method [54,55]	Expected dividends per share/Dividend discount models
Income	Binomial trees/Real option model [56,57]	Adjusted book value of equity (to proxy market value)
Mixed capital-income	Net asset value	Excess return models
Financial (Discounted Cash Flows-DCF)		
Market multiples (comparable firms)		

Banking and financial activities [58] follow peculiar valuation patterns which often concentrate on parameters like adjusted equity or dividends. These parameters are, however, not particularly meaningful with FinTechs, especially if they are in the startup phase [59].

If the FinTech activity is developed within a banking group by a captive company, it acts as a catalyzer of (traditional) banking activity. In this case, what mostly matters is not the value of the FinTech as a stand-alone reality, but rather its contribution to the incremental marginality of the (traditional) banking group.

FinTechs naturally tend to cooperate with banks, as in most cases they share the same customers, presiding over contiguous segments of the financial supply and value chain. Product-related FinTech-bank cooperation is primarily originated by the integration of original FinTech applications in a wider business model.

Demyanova [60] considers several methodologies that, in most cases, are rarely applicable to FinTechs. For example, the liquidation value or book value method is not consistent with the innovative nature of startups that become valueless if wound up and derive most of their potential value from intangible assets with little if any collateral value. The Berkus method (five factors of success: idea, technology, employees, market-entry, and the start of sales) appears too undetermined, and real options may be embedded in the estimate of future cash flows with multiple scenarios.

As anticipated, among the main evaluation methodologies, the following are the most relevant:

1. Financial approach (discounted cash flows or DCF).
2. Market comparables.

The financial approach is based on the principle that the market value of the company is equal to the discounted value of the cash flows that the company can generate ("cash is king"). The determination of the cash flows is essential in the application of the approach, as is the consistency of the discount rates adopted in the denominator of the Discounted Cash Flows (DCF) metrics, represented by the cost of capital. The doctrine (especially the Anglo-Saxon one) believes that the financial approach is the "ideal" solution for estimating the market value for limited periods. It is not possible to make reliable estimates of cash flows for longer periods. The conceptually correct methods are those based on cash flow discounting. However, other methods—even though they are conceptually incorrect—continue to be used frequently [51].

The Venture Capital Method is described in the IPEV valuation guidelines [54] that refer to the Option Pricing Method in a scenario analysis (par. 5.11.): for certain early-stage investments, option pricing models are deemed by some to provide a reliable indication of Fair Value where a limited number of discrete outcomes can be expected. This framework is consistent with FinTech startups.

Real options incorporate flexibility and scalable growth opportunities in the business model estimation, so reflecting sustainability concerns. They are consistent with binomial trees probabilistic forecasting and are routinely used in the appraisal of technological firms. Real options can be used in FinTech investment decisions [56,57]. This can be justified because financial institutions may opt to take an immediate investment or wait for the aforementioned investment options based on the volatility and duration of the involved FinTechs. Real options, specifically the option to wait or to quickly expand a scalable product, make sense when investing in venture capital and startups, particularly in internet-related companies such as FinTechs. The appropriate starting time of a novel business is affected by volatility concerns that could undermine its strategic assumptions. Lee et al. [8] state that "real option valuation can be used to develop traditional financial institutions' FinTech projects". Many projects are experimental and are developed in highly dynamic technical, economic, and regulatory environments that require timely flexibility and adaptation. They are so consistent with a real option representation that incorporates resilience and captures uncertainty potential.

Moreover, the classic Net Present Value (NPV) methodology ignores the flexibility of the project which, therefore, is undervalued. On the other hand, the lack of reliable market data makes the use of options difficult. However, real options incorporate flexibility and growth opportunities in the business model forecasting. Consequently, the options to wait, expand, abandon, and contract out make full sense in the context of FinTechs. Finally, they are consistent with binomial trees probabilistic (stochastic) forecasting and are routinely used in the appraisal of technological firms, providing a more intuitive decision tool to decision-makers.

Apart from [56], further literature supports these well-known statements. See, for instance, the Venture Capital Method, described in [54], where the IPEV guidelines refer to option pricing method in a scenario analysis (par. 5.11): for certain early-stage investments, option pricing could provide a reliable indication of fair value where a limited number of discrete outcomes can be expected.

Lee et al. [8] provide an example of a bank looking to invest in a P2P lending FinTech project, by using a binomial tree to calculate the NPV and the option price. The binomial tree valuation methodology, as stated above, mostly applies to startups that still lack a consolidated track-record.

Whenever FinTechs that survive Darwinian selection evolve and go public (consistently with the panel selected in Table 3), they tend to incorporate their real options in stabler cash flow forecasting, expressed by DCF metrics or market multipliers. Listed FinTechs like Visa or MasterCard are established firms that represent a template and a mighty target for promising startups.

The market (empirical) approach identifies how much investors are paying for similar investments. In practice, an examination of the prices used in negotiations with companies in the same sector leads to average parameters like those represented in Table 3.

The empirical evidence is based on the stock market trend of a sample of FinTechs, compared to an industry benchmark of banks or technological firms. Further insights are given by the metrics of market multipliers of a sample of firms belonging to these three industries.

3.1. The Stock Market Value of a Sample of FinTechs and Banks

FinTechs have a hybrid business model, as they operate in the financial (banking) sector deploying their technological attitudes. Evaluators may, therefore, wonder if they follow the typical evaluation patterns of bank/financial intermediaries or those of technological firms. Preliminary empirical evidence−reported below−shows that the latter interpretation is the one consistent with the stock-market mood.

These empirical findings are important for the assessment of the best evaluation criteria. Figure 3 (with data sourced from Bloomberg) contains the comparative stock market price (from 1 August 2015 to 30 June 2020) of:

(a) IFINXNT—Indxx Global FinTech Thematic Index (source: Bloomberg elaboration from public data).
(b) MXW00BK—MSCI World Banks Weighted Equity Index (large and mid-cap stocks across 23 Developed Markets (DM) countries and 26 Emerging Markets (EM) countries) (source: Morgan Stanley elaboration from public data).
(c) MXW00IT—MSCI World (ex-Australia) Information Technology (IT) Index—(source: Morgan Stanley elaboration from public data).

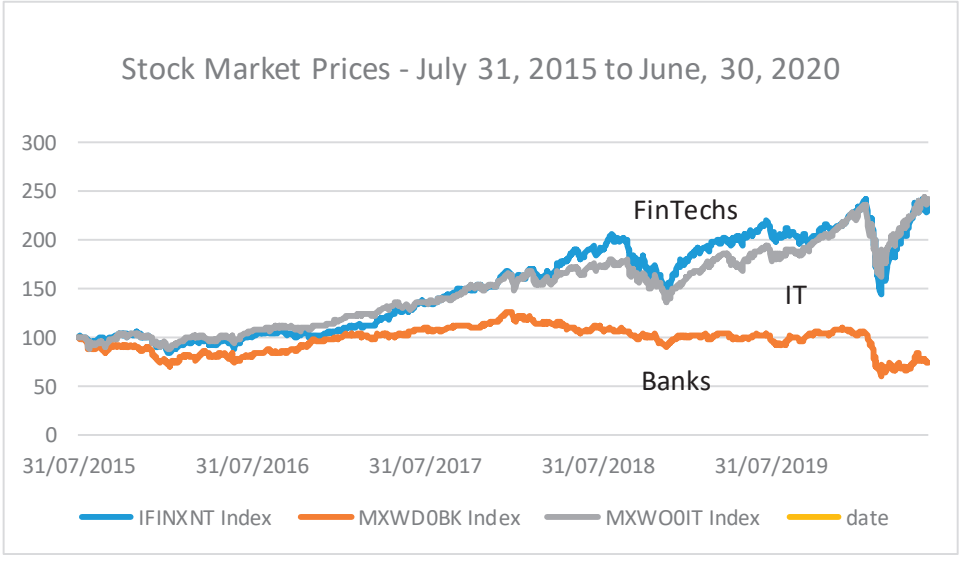

Figure 3. FinTech versus technological and banking Stock Market index. Source: Own elaboration.

From the input stock market data, it is possible to get the correlation matrix in Table 2, also indicating the volatility (standard deviation).

Table 2. Correlation matrix and volatility. Source: Own elaboration.

	FinTechs	Banks	Information Technology
FinTechs	1.0000	-	-
Banks	0.3441	1.0000	-
Information Technology	0.9774	0.2895	1.0000
Standard deviation	45.1167	12.9262	39.1932

Despite the young age of FinTechs, many of these firms are experiencing significantly faster growth than their traditional financial services peers. This reflects in their performance tracked by the Indxx Global FinTech Thematic Index, the underlying index for the Global X FinTech ETF (FINX), relative to the Financial Select Sector Index.

The Indxx Global FinTech Thematic Index (https://www.indxx.com/indxx-global-FinTech-thematic-index-tr) is designed to track the performance of companies listed in developed markets that are offering technology-driven financial services which are disrupting existing business models in the financial services and banking sectors.

FinTechs are slightly more volatile than IT firms and much more volatile than established banks. This finding is consistent with their belonging to a growing industry, compared to a mature sector. Whereas the correlation coefficient (indicating the standardized covariance) with IT firms is close to its theoretical upper limit (+1), there is room for diversification for those who invest in FinTechs and banks or, even more, in banks and IT firms. This finding roughly indicates that the convergence of FinTech and banking business models is still not discounted by the stock market.

FinTechs' higher volatility (compared to banks) has been reflected in March 2020 in a much deeper fall, followed by a more sustained recovery, incorporating the digital resilience typical of most technological firms. Whereas FinTechs and technology stocks have fully recovered the negative peak of 23 March 2020, banks (as of 30 June 2020) were still some 25% below their pre-COVID-19 prices.

The data considered in this analysis cover the last five years, from the inception of the FinTech index to the first semester of 2020. This period of historically low interest rates has sustained the overall stock market performance that, however, needs to be selective and able to discriminate between trendy industries and more mature sectors.

3.2. Market Multipliers

Market multipliers provide some ancillary interpretation of the Fintech-banks comparison, and are extrapolated and re-elaborated from public data collected in the Bloomberg and Morgan Stanley dataset, and represent a sub-sample of seven FinTechs, compared to five banks and three Information Technology firms. This pilot sample is limited to the biggest FinTechs, banks, and IT firms and represents just an analytical interpretation that backs the more comprehensive market indices examined in Section 3.1. A more detailed analysis of market comparables goes beyond the introductory scope of this comparison with stock market data and may be conducted referring to the quoted Bloomberg source or other specialized data providers (e.g., Eikon-Datastream). Econometric modeling with factor modeling of expected market prices may also represent a further investigation pattern.

These indices are important because they allow for a synthetic comparison of the main FinTechs with Banks and IT firms, showing that FinTechs and IT firms have similar stock market trends. Such a comparison would be much more difficult considering several firms (to be put inside the same graph ...). Table 3 is, therefore, complementary to Figure 3 since multipliers give a further interpretation that supports market prices.

Table 3. Market multipliers of a sample of FinTechs, banks, and IT firms. Source: Own elaboration.

Firms	Price/Sales	Price/Earnings (P/E)	Price/(Free) Cash Flow	Price/Book Value	Enterprise Value/Sales	Enterprise Value/EBITDA	Enterprise Value/EBIT	Goodwill	Weighted Average Cost of Capital (WACC)	Enterprise Value—EV	Unlevered Beta
								USD/000		USD/000	
FinTechs											
Adyen NV											
FY 2018	8.47	106.75	37.54	24.11	7.74	70.31	73.86	12,793,400	28.60	12,793,056	n.a.
FY 2019	8.18	106.56	42.26	25.31	7.63	72.60	78.90	20,277,827	13.85	20,157,283	n.a.
27/5/2020	12.21	158.81	63.16	37.74	11.75	111.72	121.43	31,206,358	10.83	31,206,358	0.88
Fidelity National Inf. Serv. Inc.											
FY 2018	3.99	30.76	18.03	3.29	4.97	14.55	28.72	41,872,894	10.22	41,872,922	0.35
FY 2019	5.99	56.76	28.01	1.76	10.18	29.56	106.13	105,181,260	7.62	105,264,756	0.57
27/5/2020	6.09	57.43	28.99	1.71	9.12	26.80	135.95	103,590,099	8.91	103,590,099	n.a.
Fiserv Inc.											
FY 2018	5.12	30.07	25.00	12.58	5.91	14.96	19.62	34,388,825	9.88	34,827,617	0.15
FY 2019	5.81	38.11	28.56	1.38	6.77	20.23	42.31	69,011,775	7.40	102,243,259	0.84
27/5/2020	5.11	40.05	27.25	2.23	7.49	22.18	49.99	93,231,528	9.15	93,231,528	0.67
Intuit Inc.											
FY 2018	8.68	40.06	26.30	18.76	8.55	28.43	33.04	51,541,732	11.05	51,127,591	1.69
FY 2019	10.63	46.99	33.24	19.25	10.30	33.60	37.67	69,846,516	10.01	69,586,783	0.46
27/5/2020	10.74	55.56	39.36	15.52	10.25	38.78	45.35	70,281,672	10.18	70,281,672	1.10
Mastercard Inc.											
FY 2018	13.14	25.35	33.33	36.05	12.88	24.87	26.44	192,548,150	11.67	192,886,660	0.44
FY 2019	17.99	38.46	39.13	51.02	17.91	29.40	31.22	302,391,130	8.96	302,974,610	0.42
27/5/2020	18.04	37.76	37.12	56.42	18.02	29.77	31.71	306,346,558	10.41	306,346,558	0.43
PayPal Holdings Inc.											
FY 2018	6.44	49.13	21.37	6.42	5.93	30.85	41.76	91,610,660	12.47	91,947,020	2.53
FY 2019	7.15	50.60	32.92	7.51	6.84	32.34	44.32	121,638,410	9.21	121,767,397	0.32
27/5/2020	9.45	72.17	39.71	10.80	9.37	46.15	65.22	171,156,649	9.61	171,156,649	0.95
Visa Inc.											
FY 2018	14.92	32.43	25.16	11.65	16.44	24.97	26.15	338,758,350	9.96	340,276,502	3.31
FY 2019	14.96	31.60	28.59	11.62	15.12	22.20	23.17	347,507,740	9.11	349,213,191	0.85
27/5/2020	15.98	34.55	32.06	12.93	16.17	23.55	24.77	386,248,625	9.23	386,248,625	0.73
Banks											
Bank of America Corp.											
FY 2018	2.27	9.22	6.29	0.98	n.a.	n.a.	n.a.	n.a.	12.13	n.a.	0.77
FY 2019	2.91	12.46	5.35	1.29	n.a.	n.a.	n.a.	n.a.	9.65	n.a.	0.64
27/5/2020	1.99	9.92	3.28	0.87	n.a.	n.a.	n.a.	n.a.	10.79	n.a.	0.48
Citigroup Inc.											
FY 2018	1.34	7.92	3.91	0.69	2.91	5.50	n.a.	282,880,392	11.95	286,715,642	0.64
FY 2019	1.74	9.33	n.a.	0.96	3.16	5.63	n.a.	326,895,286	9.99	332,413,364	0.69
27/5/2020	1.01	9.42	n.a.	0.58	2.67	5.22	n.a.	277,572,306	12.61	277,572,306	0.42

Table 3. *Cont.*

Firms	Price/Sales	Price/Earnings (P/E)	Price/(Free) Cash Flow	Price/Book Value	Enterprise Value/Sales	Enterprise Value/EBITDA	Enterprise Value/EBIT	Goodwill	Weighted Average Cost of Capital (WACC)	Enterprise Value—EV	Unlevered Beta
HSBC Holdings PLC											
FY 2018	2.15	13.09	80.81	1.01	n.a.	n.a.	n.a.	n.a.	13.42	n.a.	0.52
FY 2019	1.89	26.17	3.76	0.98	n.a.	n.a.	n.a.	n.a.	9.82	n.a.	0.19
27/5/2020	1.80	26.95	n.a.	0.52	n.a.	n.a.	n.a.	n.a.	8.06	n.a.	0.23
JPMorgan Chase & Co											
FY 2018	2.52	10.83	23.37	1.39	n.a.	n.a.	n.a.	n.a.	11.29	n.a.	0.42
FY 2019	3.15	13.67	74.28	1.83	n.a.	n.a.	n.a.	n.a.	8.87	n.a.	0.49
27/5/2020	2.19	10.96	n.a.	1.27	n.a.	n.a.	n.a.	n.a.	9.97	n.a.	0.33
Wells Fargo & Co											
FY 2018	2.19	11.33	6.13	1.22	n.a.	n.a.	n.a.	n.a.	10.98	n.a.	0.56
FY 2019	2.27	12.60	35.12	1.34	n.a.	n.a.	n.a.	n.a.	8.49	n.a.	0.47
27/5/2020	1.14	8.44	6.50	0.67	n.a.	n.a.	n.a.	n.a.	9.94	n.a.	0.50
Information Technology											
Apple Inc.											
FY 2018	4.21	19.02	17.45	10.02	3.58	11.62	13.41	950,773,539	9.78	967,690,495	1.95
FY 2019	3.88	18.40	17.16	10.74	3.36	11.43	13.68	874,417,901	9.37	891,035,968	1.03
27/5/2020	5.26	24.85	21.14	17.46	4.85	16.49	19.75	1,298,730,925	9.22	1,298,730,925	0.45
Intel Corp.											
FY 2018	3.04	10.49	15.13	2.82	3.10	6.78	9.43	219,790,000	10.99	222,034,000	n.a.
FY 2019	3.69	13.89	15.67	3.32	3.75	8.18	12.25	270,204,200	8.95	273,809,000	0.75
27/5/2020	3.58	12.52	14.97	3.46	3.69	7.69	11.21	279,183,560	8.86	279,183,560	0.68
Microsoft Corp.											
FY 2018	6.88	26.90	23.54	9.15	6.44	15.15	20.17	710,768,970	10.91		1.75
FY 2019	8.17	28.60	26.87	10.01	7.76	17.33	22.61	976,492,280	9.69		0.42
27/5/2020	9.99	32.05	31.94	12.04	9.54	20.02	25.35	1,323,324,245	8.18	1,323,324,245	0.53

The FinTechs listed in Table 3 are mostly active in payments that represent the most mature activity that got first ready for listing, and show the greatest complementarity with banks, even if their stock market behaviour is weakly correlated. Other activities (InsurTech, RegTech, PropTech, SupTech, etc.) are more specific and mostly embodied in promising startups that consider listed FinTechs as an ideal target and whose business model is more distant from that of (traditional) banks. They may, however, inspire further empirical analyses.

Market multipliers are used in relative valuation models, a fundamental analysis valuation method [58] that compares (in relative and not absolute terms) a company's value to that of its competitors or industry peers to assess the firm's financial worth. Relative valuation uses multiples, averages, ratios, and benchmarks to determine a firm's value. Relative valuation models are consistent with the comparison between FinTechs, banks, and IT firms, and have meaningful sustainability implications: stock market appraisal, incorporated in market multipliers, shows how investors perceive the ongoing and perspective value of their investment targets. Firms with good multipliers raise cheaper capital and become more sustainable. The intrinsic self-sustainability of listed FinTechs, appreciated by the investors, improves the strength and resilience of the overall ecosystem, aligning it to the Sustainable Development Goals.

The data reported above are not easy to interpret due to their heterogeneity, even if they show some trendy features which may be summarized as follows:

- The (stock market) price compared to sales (P/sales), expected earnings (P/E), or liquidity (P/cash flows) clearly shows that FinTechs command a significant premium over banks (and a smaller premium over the restricted sample of IT firms). This is a strong rationale behind the higher stock market price of FinTechs.
- The Price/Book Value is a proxy of the Tobin Q (the ratio between a physical asset's market value and its replacement value); whenever P/BV > 1, the firm incorporates implicit goodwill, since the market value of equity exceeds the book value. P/BV metrics in FinTechs and IT firms are significantly higher than those that represent banks. Banks often have a P/BV < 1, meaning that there is a "valuation badwill", since the market value is lower than the book value. This occurrence is unusual in listed stocks and shows the negative attitude of investors towards banks.
- Other multipliers compare the Enterprise Value (EV, the market value of the listed firms, including its financial debt) to sales, EBITDA, or EBIT. The ratio EV/EBITDA is particularly meaningful, being used for the market value estimate (EV/EBITDA * expected EBITDA ≈ expected EV). Even these multipliers show a meaningful premium for FinTechs, against banks (or even, to a lesser extent, technological firms).
- The goodwill and the EV express the cumulated wealth (and tend to coincide).
- The Weighted Average Cost of Capital (WACC) is the rate used to discount operating cash flows (i.e., liquidity before debt service). The higher the rate, the riskier the firm. FinTechs are on average no riskier than banks and IT firms. This is confirmed also by the unlevered beta, a complementary parameter that measures the market risk of the company (sensitivity to the market index) without the impact of debt.

This pilot example of comparables and multipliers can be extended, using the quoted sources, to a wider set of firms and further research may compare different types of FinTechs (that are still mostly unlisted, especially if they differ from the mainstream payment service function) with commercial or investment banks.

4. FinTechs Versus Banks (Growth Versus Maturity)

FinTech has previously grown on its promise to expand access to the financial system by providing services to traditionally unserved or underserved populations. The faster/cheaper/better service models offered by FinTech startups [59] are, however, increasingly disrupting the incumbent banking system. Financial products that traditionally have been the exclusive domain of licensed

credit institutions—payment services and loans, among others—are now offered by FinTechs [60]. These smaller, more agile companies support a greater diversity of products and providers; they promise greater portability of financial products that are now digitized, built on hybrid and cross-industry business models that allow them to access markets often closed to traditional banks and credit offerors. They also offer greater transparency and improved risk management, at least partly enabled by their ability to get instant customer feedback, and use it to power real-time adjustments in the services they offer [61].

As [8] points out, the traditional financial institutions are investing in FinTech in a variety of ways, including partnering with FinTechs or Technology companies, outsourcing FinTech services, providing venture capital to FinTechs, incubating/accelerating FinTech startups, acquiring/buying FinTechs, and developing internal FinTechs in a continuous search for the sustainability of the financial business. Currently, they have a more pronounced impact in the payments market, where firms have expanded their presence in non-capital-intensive businesses such as cross-border transfers, micropayments, and card payments.

FinTechs (especially those focused on payment systems) and traditional banks operate in the same (financial) market and sometimes share common clients. They are also part of a continuous supply and value chain. It is, therefore, worth wondering why they are different (as shown in Section 4.1), and how they may converge thanks to cross-pollination, and scalable synergies (Section 4.2). As [62] points out, FinTech is an important driver of sustainable development; that is why how financial technology affects sustainable development needs to be urgently identified. The traditional barrier between the developed world and emerging markets is shrinking fast thanks to the rapid digitization and development of the FinTech industry, which is a vital driver for the financial and banking sector to face a challenging future by reducing costs and boosting efficiency. In that way, FinTechs have the potential to mobilize green finance and, for instance, enable poorer people around the world to access innovative clean energy projects.

Additionally, FinTechs can unlock greater financial inclusion for new businesses that will deliver both impact and financial returns; mobilize domestic savings at scale by providing channels or platforms for retail investors to access impact investing opportunities; collect, analyze and distribute information on both financial performance and impact performance for better economic decision-making, regulation and risk management; provide financial markets with the level-playing field and market integrity needed for long-term sustainable investments.

Traditional financial and banking sectors as pure lenders and borrowers are deeply affected by sustainable financial targets that must be achieved by extensive changes and reforms, even concerning financial systems. To give full play to the positive effect of FinTech on sustainable development, countries must reform extensive patterns of economic growth [62].

The valuation of FinTechs is a vital part of this process due to the nature of technological providers of financial services. FinTechs can so be assimilated to innovative startups (or, potentially, more mature companies, such as those considered in the stock market panel).

4.1. Why Are FinTechs Different?

FinTechs seem far from the banks even because they have a different business model, as they do not collect deposits and lend money, intermediating credit. The revolutionary changes brought by innovative entrants in the financial services sector have caused severe turbulence in the operational and service activities of the incumbent 'traditional' banking organizations [41].

FinTechs are not hyper-regulated deposit-taking institutions, as they just provide financial services and do not intermediate "money" as a product, and they do not need a supervisory capital like banks. The very fact that FinTechs are not deposit-taking institutions is possibly the main differential factor from banks. Banks are both labor- and capital-intensive, to fuel a business model that still strongly relies on "physical branching" and requires huge compliance-absorbing resources.

The preliminary conclusion that FinTechs follow the evaluation parameters of technological firms has, however, some caveats which may tentatively be summarized as follows:

(a) If those firms are the purchase target of (much bigger and consolidated) ordinary banks/financial intermediaries, then the valuation criteria of the latter predominate, at least after the acquisition (and especially if they are merged into traditional banks).
(b) The underlying market and business model of maturing FinTechs may become less technological and more "client-based".
(c) Some established criteria used in the evaluation of traditional banks are, however, rarely applicable even in perspective (e.g., consideration of "physical" banking branches as a positive element to be incorporated in the internally generated goodwill).

The business model of a bank is vastly different from that of a typical FinTech and this difference reflects in the balance sheet and in the income and cash flow statement.

The balance sheet of a bank is characterized by a binding structure, due to the presence of the supervisory capital and bank deposits (in the liabilities) and loans to customers (within the assets). The assets and liabilities structure of FinTechs are much "lighter", being represented by net working capital (receivables net of payables) and some capitalized assets (tangible and intangible), against equity and financial debt in the liabilities. The income statement reflects these differences:

- The bank has economic margins represented by the interest rate differential and the net contribution of commissions; interest rate margins are still compressed by historically low market rates (due to the soft monetary policy of central banks, to stimulate the economy), and the long wave of the 2008 recession (with huge amounts on non-performing loans); the pandemic crisis of 2020 may fuel new defaults, in a context where low marginality may not be sufficient to absorb growing credit delinquency.
- The FinTech, as it will be shown in Figure 4, has a more standard EBITDA and EBIT, sourced by the difference between operating revenues (from services) and monetary OPEX (to get to the EBITDA) or comprehensive OPEX, including depreciation and amortization, to determine the EBIT. FinTechs business model is less dependent on labor and capital, although more exposed to technological investments, whose returns are intrinsically risky.
- These balance sheet-based and economic parameters are also reflected in the cash flows (starting from the EBITDA of the FinTechs or the intermediation and interest rate margin of the banks) that are then discounted, in compliance with the main valuation approaches described in paragraph 3.

Other differences reflect on systemic risk. Whereas banks are traditionally a major source of contagion, FinTechs are much more segmented and their probability of default (very frequent in startups) is mitigated by their limited leverage. Startups are typically debt-free, and in this case, operating result (EBIT) or operating cash flow tends to coincide with the net result or the net cash flow, cost of equity replaces WACC, and Enterprise Value equals Equity Value [63].

Banks are strictly connected among themselves, with their clients (borrowers), suppliers (depositors), and regulators, and any concern about their stability may have severe systemic implications. Another feature of many banks is represented by the presence of derivatives in their balance sheet. They are uneasy to record and detect, thereby fueling information asymmetries with disruptive effects, as the 2008 financial crisis has shown.

The different business model has strong scalability implications. Whereas the operating profits (interest and intermediation margin) of a standard bank are difficult to scale up (unless the volumes of loans consistently increase, which is highly risky), the EBITDA/EBIT of a FinTech may follow the blitzscaling trend of many successful technological startups.

The intrinsic scalability depends also on the plasticity of the business model that can be extended to many applications (e.g., RegTech, InsurTech, PropTech, etc.), using synergistic technologies and products (e.g., blockchains, artificial intelligence, big data, digital platforms, cloud computing, etc.).

FinTechs, therefore, embody real option features (to expand, contract out, defer their business development) which may ignite scalable growth opportunities (incorporated in market valuations).

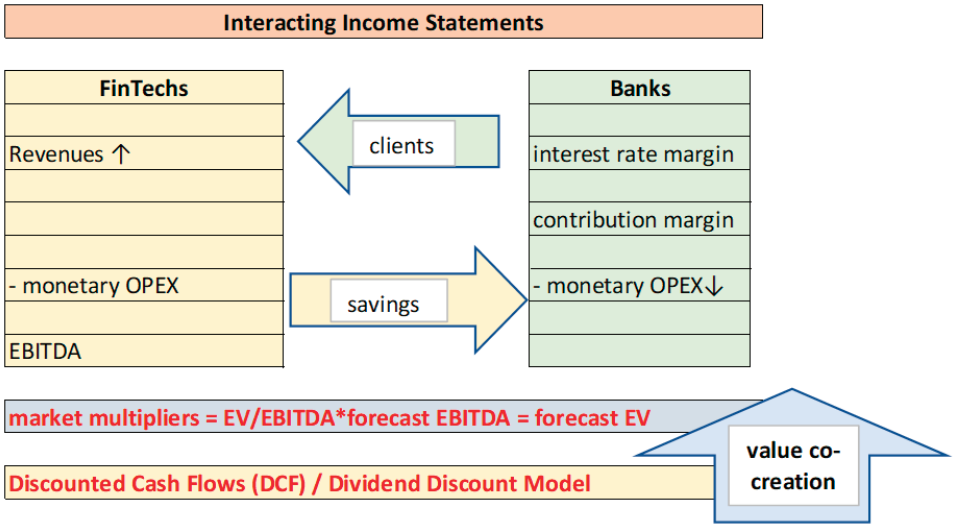

Figure 4. Economic interaction between FinTechs and banks. Source: Own elaboration.

A more analytical explanation of the intrinsic value of FinTechs may be conducted considering classic models like the Economic Value Added, the Residual Income Model, or the Franchise Value Model [64].

The valuation metrics described in paragraph 3, considering the DCF or the market multipliers, record the marginal impact of growth, whose riskier occurrence is, however, to be discounted at a higher rate. According to [65], p. 5, "firms generate cash flows from multiple assets [...] so the discount rates we use should be different for each set of cash flows". The scaling effect which drives the growth rate is difficult to be maintained in the long run, and forecasts of firms with little track-record are intrinsically volatile and so riskier. Technological discontinuity also impacts market risk, threatening the business continuity of incumbent FinTechs. For these very reasons, the discount rate should fairly incorporate this hardly predictable outlook that also reflects potential changes in risk over time. The value creed says rapid growth must eventually peter out.

Traditional banks that operate in a mature market embed in their business model limited growth potential. Mature businesses are typically safer than innovative ones (and that is why scalable growth is discounted at a higher rate of risk), but this may not be the case for old-fashioned banks that front a recession. The market mood, as indicated in Figure 3, Tables 2 and 3, discounts this credit-driven risk that does not appear significantly different from growth (technological) risk.

As shown in Figure 3, Tables 2 and 3, FinTechs and their business models show greater similarity with technological firms. FinTechs are considered as digital disruptors that are usually associated with mobile functionality, simplicity, big data gathering, and processing, accessibility, agility, personalization, and convenience. These technological components are embedded in a business model that resembles that of other Tech ventures in key features as economic scalability, intangible intensity, and prompt flexibility. Hyper-regulated banks with their heavy supervisory capital, high staff costs, and rigid physical branches, are far less related, even if they share similar clients performing complementary activities, especially if considering payment systems.

4.2. Cross-Pollination and Scalability

The different income statements, driven by the respective business model of either the bank or the FinTech, reflect a completely different attitude towards (digital) scalability, as anticipated before.

The interaction with banks can be understood even by comparing their income statements: whereas banks transfer (or share) some of their clients with FinTechs, the latter provide cost-saving solutions that decrease the operational expenditures (OPEX) of banks and improve their resilience. Figure 4 shows the main drivers of this interaction and its impact on valuation, indicating the pivoting role of the income statement in the value generation process, and bringing to the aforementioned main evaluation approaches—market multipliers and DCF.

Figure 4 shows a win-win interaction: if banks share some of their clients with FinTechs, the latter improve their inventive capacity, sharing it back with the banks, and so co-creating value. The clients represent the ultimate "shadow" stakeholder in this triangular relationship and may participate in this value co-creation paradigm with their precious feedbacks which fuels big data and their interpretation and use. This co-opetitive pattern mostly refers to FinTechs involved in the payment segment that is mostly synergic with the traditional banking business.

Banks may internalize this value pattern, buying and merging the FinTech. In this case, the valuation approaches and the business models eventually merge.

FinTechs have a revenue model that is much more scalable than that of a typical bank. Whereas a bank is limited in its growth potential by constraints such as the supervisory capital (a percentage of its loans, weighted for lending risk), huge fixed costs for personnel, and difficult upside in a mature market, FinTechs incorporate a digital potential in an intrinsically scalable business model. Even if FinTechs have a higher marginality potential, they still need the volumes (client base, etc.) and the market caption bound to traditional banks. The positive impact of this cross-pollination on the FinTech EBITDA has a direct implication on the valuation drivers (the market multiplier that incorporates EBITDA and the Discounted Cash Flows influenced by the EBITDA).

5. Discussion (The Dark Side of Valuation)

The inductive reasoning of this study explains why the stock market price of FinTechs is so divergent from that of traditional banks. A complementary deductive methodology, starting from the financial market ecosystem, may provide top-down evidence. The flow is summarized in Figure 5.

The business model comparison between FinTechs and banks is a primary methodology to confront diverging market prices, explaining with fundamental analysis and the intrinsic valuation (exemplified by the reference to the market multipliers summarized in Table 3) the difference between the value and the market prices illustrated in Figure 3. Young or complex businesses are difficult to estimate, as shown in *The Dark Side of Valuation* [66]. Valuation across the business life cycle changes and start-upping FinTechs are quite different from few-but-valuable established ones.

The comparison of this study is somewhat asymmetric, being focused mainly on FinTechs, with little reference to traditional banks. There is, therefore, room for more comprehensive confrontation and integration of the business models, driven by the sharing of similar clients.

Evidence collected so far, and market feedbacks show that listed FinTechs command a premium over traditional banks. However, this consideration does not consider important caveats.

Most FinTechs are still represented by fragile and unlisted startups. Besides, they are mostly unsupervised by Central Bank authorities, especially if they are not involved in deposit collection (that implies a bank license) and lending. Supervision is expensive and time-consuming but reduces the probability of default and provides a parachute, central banks being a lender of last resort to ailing banks. FinTechs may be tempted to pursue circumventive innovation strategies, to get a competitive advantage over hyper-regulated banks.

Stock market prices of FinTechs are sustained by levered expectations of future gains. This bet is intrinsically risky and may be biased by underestimated risk pricing. Market evidence—both in the FinTech index represented in Figure 3 and the subset of listed FinTechs examined in Table 3—is

meaningful and worth considering, even if it unveils just a side of an intricate issue, concerning a heterogeneous ecosystem of variegated firms that are not fully reflected in stock pricing.

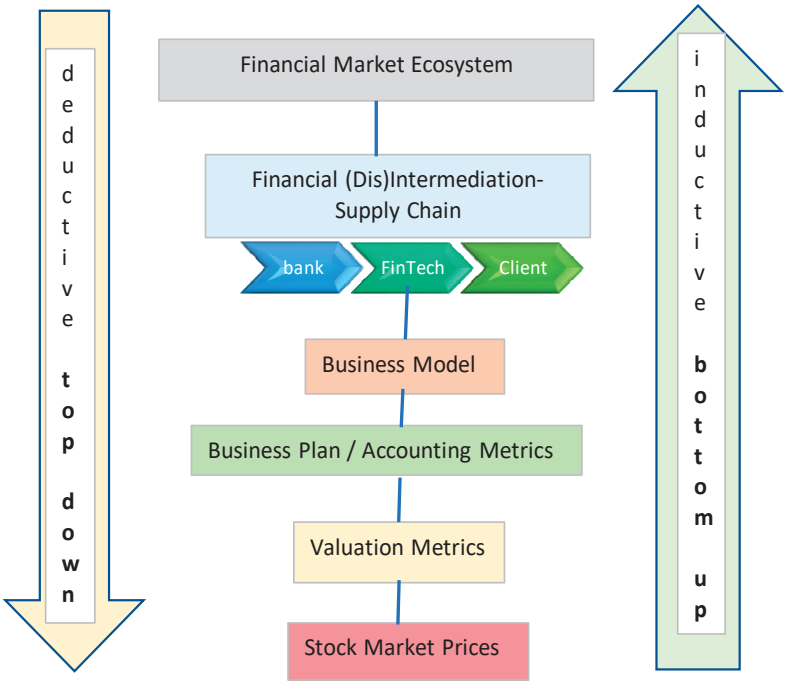

Figure 5. The value-price valuation process, from the financial ecosystem to the Stock Market. Source: Own elaboration.

A further aspect is represented by a well-known property of banks that is almost absent in FinTechs: lending risk. Credit rationing is the limiting by lenders of the supply of additional credit to borrowers who demand funds, even if the latter are willing to pay higher interest rates. It is an example of market imperfection, or market failure, as the price mechanism fails to bring about equilibrium in the market.

Stiglitz and Weiss [67] developed a path-breaking model to illustrate how credit rationing can be an equilibrium feature of the market, in the sense that the rationed borrower would be willing to obtain the funds at an interest rate higher than the one charged by the lender, who will not be willing to lend the extra funds, as the higher rate would imply lower expected profits. It is equilibrium rationing as there exists excess demand for credit at the equilibrium rate of interest.

The reason for that is adverse selection, the situation where the lender is faced with borrowers whose projects imply different risk levels (types), and the type of each borrower is unbeknownst to the lender. The main intuition is that safe borrowers would not be willing to tolerate a high-interest rate, as, with a low probability of default, they will end up paying back a large amount to the lender. Risky types will accept a higher rate because they have a lower chance of a successful project (and typically a higher return if successful), and thus a lower chance of repayment.

The absence of lending risk makes the business model of FinTechs scalable (and so, able to generate high economic and financial margins). Traditional banks face much riskier scalability options: whereas it would be easy for them to expand their borrowing exponentially (approaching billions of unbanked potential customers), they would face marginally growing risk, and higher fixed costs, probably bringing them to negative margins. Bank scalability may, therefore, end up in a boomerang,

especially before and during recessions, when credit quality rapidly deteriorates. In parallel with the risks of traditional banks, FinTechs may increase some costs and reduce the value to the consumer, introducing new conduct of business risks (different ways of miss-selling and misadvising, not least by providers using insights gained from big data to exploit behavioral biases and fears to sell consumers unsuitable products and services); lead to greater financial exclusion and discrimination through big data analytics and the use of personal information and facilitating new types of fraud and data breaches.

Finally, some risk concerns about the FinTech industry cannot avoid the measurement of systemic risks arising from contagion mechanisms between borrowers, focusing on how the development and the growth of financial technologies can make them sustainable, minimizing their possible negative impacts on consumers and investors. This goal can be achieved through the development of appropriate risk management methods and market valuation.

Risk is a primary component of firm evaluations (being incorporated, for instance, in the cost of capital that represents the denominator of discounted cash flows) and is embedded in stock market prices. It is so unsurprising that banks have largely discounted market prices if compared to FinTechs or other technological firms. Consistently with a major thesis of this study, FinTechs have a risk profile that is vastly different from that of banks, and much more like that of technological startups. They share with tech startups a little history and limited track record, and they strongly rely on growth opportunities, scalability, and real options that are intrinsically volatile, and uncertain. Strong competition, technological disruption (uneasy to foresee), lack of a consolidated client base, low competitive entry barriers in the industry, limitations to geographical scalability due to different regulatory issues, represent further risk concerns.

6. Conclusions

The main thesis of this study is that the evaluation of FinTechs follows appraisal approaches that are similar to those of technological startups and differ from those of the (traditional) banks. Even if the underlying industry is represented by bank activities, FinTechs are innovators/facilitators of financial activities and are not personally involved in the borrowing/lending hyper-regulated intermediation business. Due to their nature as technological providers of financial services, FinTechs can so be assimilated to innovative startups.

Empirical evidence shows that stock market prices nowadays reward FinTechs that incorporate steep multiples of earnings and book value if compared to unfashionable banks. Market comparables back this interpretation, although a larger sample of FinTech, IT, and banking firms are desirable and may eventually contribute to a better general understanding of this phenomenon. Reversals of fortune are, however, always possible, as the Roman poet Horace remembers ("many shall be restored that now are fallen and many shall fall that are now in honor"). Additionally, sobriety is the best antidote against irrational exuberance [68] and the legacy of the dot.com bubble of Spring 2000, driven by analysts' distorted valuations [69]. The threat that FinTechs could fall in some speculative bubbles may be softened by watchful cherry-picking, where investors carefully select their investments looking at the fundamentals, without relying too much on mighty multiples that may overstate future expectations.

Furthermore, FinTechs and banks operate in the same financial business (although with different features) and share similar clients. It is also a frequent practice that banks can internalize a FinTech by buying it. FinTechs and traditional banks converge towards a common market, with co-opetition strategies that reduce the conflicts of interest and other governance concerns. This strategic convergence is also catalyzed by the very fact that banks are digitalizing their business models, so reducing their atavistic differences.

M-banking and digital payments represent the most popular FinTech solution and are compliant with contactless pandemic prescriptions. Changes induced by the COVID-19 crises are likely to accelerate existing trends, possibly bringing to a "TechFin" open-banking scenario [70] where unregulated BigTech players (like Amazon, Apple, or Facebook) intermediate data and consumer relationships, using standard interfaces. Though banks can replicate most of what FinTechs can do,

FinTechs benefit from an uneven playing field since they are less regulated than deposit-taking banks, and may be tempted by circumventive opportunistic behaviours.

It is well known that technology is creating value in financial services. The reasons are many [71]. First, costs have been dramatically cut thanks to technology. For example, branchless customers do not need to spend time or energy going to the bank. Second, revenues are increased because banking becomes 24/7: anytime, anywhere, increasing the velocity of transactions [72]. Third, for the whole industry, the emergence of new operators is normally less regulated at the beginning, softening adoption criticalities but underestimating incubating threats.

This study has also analyzed, as a by-product of the main research question, the sustainability features of FinTechs mainly from an economic perspective that assesses long-term viability, being reflected in market valuations. Economic sustainability is considered here as a prerequisite for further sustainability declinations, embracing social and environmental concerns.

FinTechs promote both sustainable development and green finance. According to [73], we are leaving the world of traditional banking and accepting new business models, such as FinTech, which are more and more involved in supporting the Sustainable Development Goals. Financial technology is also an excellent tool to build sustainable communities and lift poverty, as it promotes responsible consumption and production, fostering gender equality in both developed and developing countries. FinTech itself is environmental-friendly facilitating green finance, reducing asymmetric information for investors, promoting efficiency, valuing nature's assets, and backing sustainable lifestyles inspired by a sharing or circular economy. They may, therefore, provide innovative solutions for sustainable finance: SME microfinance, inclusive ownership, international investments, and digital platform solutions (in particular, crowdfunding and peer-to-peer lending and borrowing).

FinTechs are reshaping the banking industry, proposing innovative technological solutions that foster customer-centricity, creating shared and sustainable value. Their valuation, relative to that of banks, provides an indirect appraisal of FinTech-driven sustainable products and services.

Further research avenues may concentrate on the converging business of FinTechs, banks, and BigTechs [74], driven by digitalization [75], disintermediation, customer centricity, and other centripetal forces that support green finance and sustainable development [76,77]. Digital platforms represent a bridging node (interface) that connects the FinTechs, the banks, and the clients within the financial intermediation ecosystem. This ecosystem can be mathematically interpreted with multilayer network theories and fostered with blockchain validation and artificial intelligence algorithms that represent frontier interdisciplinary research.

Financial stability implications from FinTechs [78], and financial integration among different players are crucial for the sustainability of the financial intermediation ecosystem, and also deserve further interdisciplinary scrutiny. The consequences seem relevant for both the academic and professional fields.

This research is limited first by the lack of consolidated empirical evidence from the still young FinTech industry, and by a yet preliminary consideration of the comparative business models of FinTechs and banks, whose synergies remain underexplored. In particular, the market index considered here is recent and the sample limited to a subset of the potential FinTechs, still largely unlisted.

Another current issue is represented by the Environmental, Social, and Governance (ESG) targets [13] that are increasingly requested by green investors and Social Impact Funds, bearing regulatory implications [79]. Even here, the impact of FinTechs may be substantial, especially to improve financial outreach to the unbanked, opening the door to the global digital economy [80].

The contribution of FinTechs to the overall stability of the financial ecosystem is a further issue that needs additional investigation. FinTechs incorporate financial stability risks that require systematic monitoring [81]. The lack of institutional support for new financial technologies is also an important catalyst for the financial industry destabilization and the formation of financial bubbles [82]. A sustainable financial ecosystem can, however, benefit from the disrupting impact of new technologies on incumbent banks and regulators [83].

Finally, as competition develops between FinTechs and established banks, the conservative financial system presided over by incumbent players could become more sophisticated and competitive, fostering financial inclusion. However, it could also become more concentrated, as it is happening with big-tech platforms, generating new risks to financial stability and sustainability that deserve watchful scrutiny from both academics and practitioners.

Despite the small sample used in this preliminary research, this study contributes to the scant empirical literature on FinTechs versus (traditional) banks. This paper also helps revisit the literature on the economic sustainability of FinTechs backed by stock market investments that has never been comprehensively analyzed. Finally, our aim is to continue the research on this "revolutionary" [84] topic by enlarging the sample and collecting data on actual Fintech and (traditional) banks' differences and similarities, outlining their strengths, weaknesses, and convergence patterns.

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An Eco-Systematic View of Cross-Sector Fintech: The Case of Alibaba and Tencent

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Abstract: This paper explores the most recent Fintech (financial technology) phenomenon from an ecosystem perspective. Differentiated from the earlier Fintech evolution led by traditional financial institutions, "cross-sector" Fintech that operates at the intersection of financial services and information technology disrupts existing business models of banks while creating novel ecosystem dynamics. This study explores the Fintech ecosystem composition to understand better business model innovation based on underlying ecosystem dynamics while focusing on the specific role of cross-sector actors. These actors have escaped scrutiny despite being mature and experienced and having strong resource bases. Adopting a comparative case study method by considering the China-based Alibaba Group and Tencent, the study's findings indicate that novel business model developments based on strong technological expertise and scale-based resources by cross-sector Fintech render a functional perspective on fast-developing Fintech industry less practical. Apart from cross-sector Fintech, investors constitute a new dimension in the conceptualization of the Fintech ecosystem. Overall, the interconnectedness of the cross-sector Fintech beyond the Fintech sectors drives the fuzzy boundaries between ecosystems, established business models, terminology definitions, ecosystem actors' roles and relationships, which appear to become more heterogeneous and changeable over time. The study contributes to the scant literature on Fintech ecosystems and their sustainable development.

Keywords: ecosystem; Fintech business model; cross-sector Fintech; financial technology; Alibaba; Tencent; Asia; China

1. Introduction

The intrusion of digital technology into financial services, commonly referred to as financial technology (Fintech), has triggered significant growth in new business models and unprecedented changes in the finance sector [1,2]. Nearly every financial service is nowadays being targeted by Fintech, either to reduce costs or serve customers better, while ultimately disrupting the financial incumbents [3–5]. Fintech has been deemed important as a key driver for financial development, inclusion, social stability and integrity, and consequential sustainable development through building an infrastructure for an innovative digital financial ecosystem [6].

Innovation is a perpetuating part of Fintech's nature base, not only on product-focused logic in financial services [3] but also on building a Fintech ecosystem including customer-oriented logic [6,7]. Tech-savvy customers now expect a seamless experience across various services, responsive and personalized to their needs and wide access [8–10]. New business models arose [2,11,12] often based on value creation for customers that became much more disintegrated both vertically and horizontally, requiring and creating the opportunity for interfirm relations [13]. Fintech not only contributed to major improvements in efficiency and customer orientation by cooperating with traditional incumbents, but they also embarked more recently to differentiate themselves from traditional financial firms with

personalized niche services, data-driven solutions, an innovative culture, and a nimble organization [12]. To keep pace with Fintech market dynamics, sharing development risks, access to synergistic knowledge, and to gain legitimacy, interfirm relations and networks amongst Fintech are important [14,15]. Hence, Fintech differs from traditional financial innovation but fundamentally is disruptive in terms of the financial system and other infrastructures, which in turn impacts the sustainability of economic development as well as societal aspects [16].

While the ecosystem perspective has been advocated to be a particularly useful conceptual framework to capture essential network dynamics between key players and resources [13], the analysis of the Fintech ecosystem is still in its infancy. The scant research largely focuses on Fintech startups and incumbent banks [5,15,17], overlooking the potential role of cross-sectoral technology players operating and offering financial products and services [2,7]. To make the Fintech ecosystem an innovation platform for sustainable economic growth [18], the comprehensive capabilities of these cross-sectoral technology players have been critical. Indeed, Fintech has been seen as important not only for the generation of economic value, but also for sustainable development as they allow for financial inclusion and more balanced sustainable development at the same time [6,16,19].

The purpose of this study is to explore the position of cross-sector Fintech in the Fintech ecosystem composition to better understand its drive to business model innovation and development. We assess the specific role of cross-sector players by carrying out a comparative case study analysis. We map their role to provide a foundation for future predictive or prescriptive analyses on the converging structures and dynamics of the Fintech ecosystems. This furthers our understanding of the role of cross-sector Fintech companies for a sustainable ecosystem that provides lasting benefits for clients and society at large. In addition, the unique focus on empirical research on Chinese Fintech companies helps to contrast Western theory in a new context that, despite a sharp rise in importance internationally, is less scholarly analyzed.

2. Literature Review

Without a doubt, we live in an era where an increased number of actors provide financial services and develop technology faster [20]. Fintech is an enticing phenomenon and has caught the attention of many. A search on Google Scholar on 4 July 2020, found 48,000 results of publication in 0.03 s. The result of the search increased to 48,300 items only six hours later. This number augmented to 52,800 publications on 7 August 2020 with a 9.3% increase in 34 days, meaning an average of 141 new scholarly publications per day. However, the surge in interest and publication is accompanied by ambiguity over just what the term Fintech covers [21]. For our study, we adopt the straightforward definition by Dorfleitner, Hornuf, Schmitt and Weber, according to which Fintech is "companies [...] that combine financial services with modern, innovative technologies [...], offer[ing] Internet-based and application-oriented products" [22] (p. 5). To understand the existing literature of the Fintech ecosystem, we first searched the literature on Web of Science (WoS) with keywords Fintech, ecosystem, and their related terms. From the identified literature, we further extended the literature review to the related fields. As innovation is an inherent part of Fintech's nature since its inception, differing from traditional financial innovation [16], we next share the broader understanding of the field about Fintech and its business model innovation before discussing the relevance of the ecosystem perspective to understand better the Fintech phenomenon and the role of cross-sector actors in Fintech business model innovation.

2.1. Fintech and Its Business Model Innovation

The use of the term Fintech dates back to the early 1990s' "Financial Services Technology Consortium" to foster technological cooperation amongst banks [20]. In a broad sense of Fintech, regarding the evolution of Fintech 1.0 (1866–1967, analog revolution) and Fintech 2.0 (1967–2008, global and digital era), banks took the lead in technological innovation to grow the banking and financial services [20,23]. This technological innovation led to product innovation thereby not only provoking

organizational process transformation to adapt to new technology, but also generating new business models to maximizing the value appropriation of the returns created by the innovation.

However, since Fintech 3.0 (2008-present) [20], Fintech start-ups rather than traditional actors have led the Fintech business model innovation which is characterized by strong customer-oriented digitization [7]. Fintech applications are centered around customers and their processes, which redefined the previously product-centered logic. Traditionally, consumers accessed financial services through one or more large institutions, which typically offered a broad product portfolio including retail, private, commercial, investment and transaction banking, along with wealth, asset management, and insurance, also called the "universal model" [24]. Nowadays, consumers, rather than relying on a single institution for their needs, are beginning to pick and choose services they would like from a variety of Fintech companies, rendering the bank-based model less relevant [8,12,24]. Today's customers are more informed, demand a higher level of transparency related to products and services; they are more tech-savvy and expect an all-in-one and flowing experience across various services, responsive and personalized to their needs, while accessible any time [8–10,25]. This demand for seamless experience requires business transformation at the system level, rather than singular product innovation. Hybrid and overlapping forms of interaction-based customer processes and journeys became the center of present-day financial products and services design [7,26]. Financial services were increasingly digitized through mobile wallets, payment apps, automated wealth and retirement planning advisors, crowdfunding, online lending platforms amongst others [27–29].

The strong impact of digitization of the financial service industries is explained through the fact that the financial sector products and services are closely tied to information, if not to say almost exclusively [7]. For instance, payment transactions and credit contracts tend not to require any physical component; online payment or stock trading processes are almost entirely implemented without any physical interaction [3,7]. Even traditional client advisory tasks, which tended to include more personal interaction as part of the customer relationship management, can now be automated through robo-advisors or the use of artificial intelligence [3,11]. Some of these advancements have become even more popular due to COVID-19, with people across the globe fearing touching cash [30]. Moreover, banking and insurance are highly transaction-based industries that create large amounts of data. The automatic processing of the generated data allows Fintech to operate far more efficiently and enables them to make use of technologies, such as data analytics or artificial intelligence, to retain and expand their customer base while managing their risks [31].

These technological advances vastly improve the connectivity that exists within financial services and explain Fintech's success and its disruptive potential [5]. At the same time, they also explain the incursion of cross-sector actors amongst Fintech [7]. The strong technological component in these developments, which digitally transformed other segments of the economy such as tourism (AirBnB), retail (Amazon, Alibaba), telecommunication or multimedia (Apple, WhatsApp, Netflix), have allowed such technology companies to enter into financial services, across the world. These firms exploit their technological expertise to their competitive advantage. Puschmann, for example, points to the cooperation between O^2 Telefonica and Fidor Bank, a German online bank [7] and highlights the increasing cross-industry competition with formerly pure technology companies such as Apple or Alibaba to develop financial services on their own platforms [15,17].

The rate of technological change has been exponential and hence novel technology itself hardly creates a sustainable competitive advantage when implemented as a standalone element [32]. By contrast, novel business models and their designs enable the reconfiguration of business capabilities to adapt the firm to the changing business environment and thereby constitute a key ingredient toward Fintech success [33]. Research on Fintech business models has grown fast in recent years with 1013 citations in 2017, in contrast with only 14 in 2007 [34]. As an emerging field of research, however, it is not surprising that Fintech has been categorized in various forms and Fintech business models have also been interpreted differently [1,2,11,35,36]. Fintech can be classified according to subsectors or from a functional perspective [11,35]. For instance, Arner et al.'s typology of the Fintech industry comprises

five categories, finance and investment, internal operations and risk management, payments and infrastructure, data security and monetization, and customer interface [19]. Palmié et al. take a broader approach and identify six business sectors, which are called Fintech applications, including banking, payments, crowdfunding, InsurTech, RegTech, and wealth management [5]. Other scholars start to categorize the ever-growing number of Fintech according to their distinct business models, as these reflect better the specific value propositions and operating mechanisms of the firms [12]. Lee and Shin identify six business models—payment, wealth management, crowd-funding, lending, capital markets, and insurance services [12]—while Liu, Li and Wang integrate extant conceptualizations and employ their scientometric analysis on nine business model categories: Online lending/online peer-to-peer lending/P2P lending, crowdfunding/crowd investing, transaction and payment terminals, personal finance management, digital currency/cryptocurrency, mobile point of sale, Robo-advisors, e-banking, and InsurTech [34].

Though terminology used for Fintech business models varies depending on the scholars, Liu, Li and Wang conclude that traditional theories largely no longer apply to understand the Fintech sector [34]. In the beginning, Fintech focused on improving specific parts of the so-called "universal model", where Fintech revolutionized financial services with major improvements in efficiency, customer orientation [1,3]. However, Fintech then embarked to differentiate themselves from traditional financial firms with personalized niche services, data-driven solutions, an innovative culture, and a nimble organization [12]. These continuous dynamics in the financial service sector, particularly driven by the rapid spread of mobile phones, rendered Fintech´s ability to adapt and to innovate in personalized services [37], based on platform- and system-level transformation. To facilitate such adaptation and innovation processes, Fintech acquires, combines, integrates and develops internal and external know-how [38]. Hence, an understanding of Fintech and its business model innovation can be better approached from a Fintech business ecosystem perspective. The conceptualization of industries and markets as business ecosystems is an established perspective both in the management and strategy academic or practitioner-oriented literature [39,40]. In service science, this perspective has been particularly advocated as a conceptual lens to capture the essential network dynamics between actors and resources [13].

2.2. Fintech Ecosystem and Its Business Model Innovation

Ecosystems, in the biological literature, are communities of organisms interacting over time and space, with other organisms and adopting by themselves. Business strategist James Moore adopted this biological concept by comparing companies operating in the increasingly interconnected world of commerce to a community of organisms adapting and evolving to survive [39]. Moore suggested that a company needs to be viewed not as a single firm in an industry, but as a member of a business ecosystem with participants spanning across multiple industries. Adopting an actor-to-actor orientation, the ecosystem perspective assumes that markets consist of a heterogeneous, interconnected, and continuously evolving set of actors that adopt specific roles, co-create value, and depend on each other for development and existence [13,41].

Typical business ecosystems are characterized by a few prominent actors (keystones) and many smaller ones (complementors and niche players) [12,39]. With the increasing complexity of Fintech products and services, value creation is disintegrated both vertically and horizontally, requiring and creating the opportunity for interfirm relations across the network of unique relationships among Fintech startups, key industry partners, financial regulators, investment community, B2B partners and end customers [13]. These interfirm relations are found to be particularly valuable in highly dynamic and newly created markets as they permit actors to share risks in the development, have access to synergistic knowledge, and to gain legitimacy [14,15]. Indeed, the Fintech ecosystem has been shown to be an effective organizational form to improve firm performance, innovation speed, and sustainable economic growth [17,18,40], since external knowledge apart from internal R&D is important for innovation and sustained business success [42,43]. To support innovation, companies enter cooperation, bring their

expertise to and benefit from other companies' knowledge, technologies, and resources [44]. However, the ecosystem actors are far from being homogeneous; they are differently motivated and respond in a different way to changes [45]. Hence, effective value creation and customer delivery require a cautious orchestration between these actors [40]. Business model innovation in the Fintech ecosystem is about "multilateral negotiations with multiple stakeholders that have potentially diverging preferences" [46] (p. 477). A symbiotic Fintech ecosystem is instrumental for Fintech business model innovation as the actors need to take themselves into account when developing services and adapting the organization [15,44].

At the same time, the evolving innovation occurring in the Fintech sector strengthens the platform building and eco-systematic effects in the financial industry. It is commonly acknowledged that Fintech's innovativeness impacts the entire financial sector, and even all areas of business [47–50]. This is evident in the alterations and changes in products and service offerings, market segments, operations, organizational structures, risk management, consumer experiences and industry dynamics [51]. The disruptive impact of Fintech is so profound that the competitive structure of the financial industry and the Fintech ecosystem is spreading across such areas as insurance and investment decision making [52]. Fintech companies are devoting on ecosystem building to amplify their business expansion opportunity, converting into technology providers not only for financial institutions, but also for insurance, agriculture, transportation, manufacturing, and so on [53–56].

The Fintech ecosystem is unique in the sense that an established industry with large actors (banks) is being transformed not only by the entry of small players across a variety of market segments [1], but also by cross-sector players all of which develop Fintech solutions [7,15]. The latter may have a profound impact not only through the creation of new products, services, and business models, but also on the financial services value chain [55,56], which would change the collaborative and competitive fabric of the overall ecosystem [25,57]. At the present day, the interactions of these cross-sector players with other actors within the Fintech ecosystem are just beginning to come out. The popular conceptualization of the Fintech ecosystem by Lee and Shin includes five elements, including Fintech startups, technology developers, government, financial customers, and traditional financial institutions [12]; and thereby leaving aside cross-sector Fintech. While there is an increasing number of studies focused on the structure and dynamics of business ecosystems [58,59], research on the Fintech ecosystem is still in its infancy [1]. Extant scant Fintech ecosystem research focuses on the evolution of the Fintech ecosystem [5], its characteristics [12,37] and its further cultivation [17,34] largely with a focus on Fintech startups. Research at present has hardly articulated the role of larger cross-industry actors, normally technology companies entering the financial market by developing in-house Fintech [2,7]. This is surprising because these cross-sector actors such as Apple, Alibaba amongst others not only possess the appropriate technologies and the capability to develop them further, but also have a large existing customer base as potential targets for their Fintech services.

Additionally, Fintech startups need to compensate for their lack of technological capabilities and engagement in R&D activity by relying on the market to drive changes and by subsequently engaging in new marketing, design, or organizational practices [60,61]. The cross-sector actors, by contrast, have often access to central company resources to rely on R&D activity and to drive Fintech innovation. They are experienced eco-system players with brand recognition, scale economies and resource leverage, while Fintech startups often confront a "liability of newness", in other words, they struggle for visibility, influence and legitimacy within a competitive market [15,62].

3. Research Methodology

3.1. Case Selection

Haddad and Hornuf consider that Fintech occurs more frequently in well-developed economies or more fragile financial sectors [63]. However, we infer that these may not necessarily be conditional factors for the occurrence of Fintech. China, for instance, is an emerging market economy [64], while its

financial sector is relatively well established with tight central control and a highly developed banking system; The Banker magazine had Chinese banks taking the top four spots in their 2020 ranking of global banks based on Tier 1 capital, a key measure of banking strength [65]. However, China has been at the forefront of Fintech growth and is the largest Fintech market in the world [66]. The 2019 Fintech100 report indicates that Chinese Fintech has continued to lead the Fintech 100 [67]. According to the UBS Group, 80% of smartphone users in China pay by mobile, the highest rate in the world [68]. Most users (54%) employ third-party mobile payment providers, most commonly WeChat Pay (Tencent) and Alibaba's Alipay [64]. Therefore, we selected Chinese cross-sector Fintech companies for the purpose of this study.

Moreover, it can be said that since the publication of The Principles of Scientific Management by Fredric Taylor, management theory has been dominated by Western thinking [69]. Despite the rising research interests and publications of the Chinese context [70], the proportion of English publishing articles on Chinese businesses, including Fintech, is still disproportionate, compared to Chinas relevance and rise as the second-largest economy in the world. Given the Fintech ecosystem is still in the infancy stage, and cross-sector Fintech is under-studied, we employed a multiple case study design. This design allows for exploration and is deemed to be advantageous because the subject Fintech is a recent and underexplored phenomenon that requires documentation, interpretation and explanation [71].

With respect to Fintech, Alipay and WeChat Pay are two major actors in the Chinese Fintech sector which started as mobile payment service providers. Alipay belongs to Ant Group, which is part of Alibaba Group, while WeChat Pay belongs to Tencent. Mobile payments expanded to other financial services. In 2018, WeChat Pay and Alipay processed an incredible 1.7 billion transactions per day, enabling both companies to evaluate consumers´ creditworthiness based on transaction data. With this information, WeChat Pay and Alipay began to lend to consumers and moving into B2B, focusing on small businesses [64]. Alibaba's and Tencent's influence extends beyond the Chinese economy and both rival each other, scrambling for new growth opportunities outside China [72]. By 2019, Alipay and WeChat Pay users spanned 54 and 49 countries respectively [64]. Alipay gained more prominence recently as it expected to become the most valuable Fintech company in the world when listed in Hong Kong and Shanghai stock exchanges [73]. Hence, we consider it would be important to explore the cases of Alibaba and Tencent to understand their Fintech business model in building Fintech ecosystem.

The Chinese contextualized cases may also provide an opportunity to further extend theoretical development generated in the Western Fintech ecosystem field. We intend to explore both the similarity and differences across these two cases, providing their high level of comparability (see Table 1).

Table 1. Comparative Data of Alibaba and Tencent.

	Alibaba	**Tencent**
Founding Time	1999	1998
Original Business	E-Commerce	Messaging
Cross-sector Fintech	Yes	Yes
Other Main Businesses	Entertainment, Logistics, Travel, etc.	Entertainment, Social Networking, Literature, etc.
Business Position	Top Ranked	Top Ranked
Employees Number	117,600	62,885
Comparative Annual Employees Number Change	15%	16%
Revenue 2019	509,711 million RMB	377,289 million RMB

Table 1. *Cont.*

	Alibaba	Tencent
Comparative Annual Revenue Change	+35%	+21%
Net Income	140,350 million RMB	98,888 million RMB
Total Assets	1,312,985 million RMB	963,986 million RMB
Market Capitalization	558.30 billion USD	459,621 million USD
Market Capitalization July 24 2020	633.55 billion USD	670,977 million USD
Mobile MAUs *	846 million	1164.8 million

Note: All data are of 31 December 2019 for Tencent, and of 31 March 2020 for Alibaba, except stated otherwise. 1 USD = 7.09886 CNY (RMB) as mid-market rate on 31 March 2020; 1 USD = 6.98708 CNY on 31 December 2019. * MAUs = Monthly Active Users. Source: Own elaboration based on data collected from Company website, Annual reports, Macrotrends.net, and Statista.com.

3.2. Data Collection and Analysis

Though there is justifiable and growing interest in exploring Chinese Fintech, extant research remains fragmented, partially due to the application and testing purpose of Western theories. To provide a more encompassing picture of the eco-systematic view on the cross-sector Fintech business model, we collected data via multiple sources to triangulate data to strengthen the validity of the case study evaluation [74]. A comprehensive and integrative review of the literature was conducted to collect existing scholarly works about Alibaba and Tencent in Fintech. Given that research publications often have some time lag with the business reality, particularly for the digital economy where change is accelerating at a faster pace than traditional business contexts, we complemented the review with appropriate authoritative publications such as reports by international institutions, e.g., the OECD, or Reuters news via Google Search or other snowball search means to create a database for comprehensive analysis. As the main data sources are secondary data, we also invited field experts and Fintech users to provide feedback and comments. Such analyst triangulation aimed at contrasting the secondary data [74].

In order to ensure the reliability of the data quality in data source triangulation, we controlled the source of the secondary data. The scholarly work for review was retrieved from the database of Thomson Reuters' Web of Science (WoS). WoS contains Social Science Citation Indexed (SSCI) journals, which guaranteed a certain level of research quality and sequentially their reliability. We approached WoS through a Chinese university because WoS in China contains not only the classical WoS Core Collection, but also the Chinese Science Citation Database. As Alibaba and Tencent are China-based, we consider it relevant to incorporate Chinese scholars' quality research work and their insights but who may be held back from international management journals due to linguistic barriers.

The search was conducted on 22 June 2020, with the keywords defined in the area of themes: (Alibaba or Tencent) AND (Fintech or financ* or bank*). The search results showed 71 outcomes covering the period of publication from 2008 to 2020. We applied the inclusion criterion of using WoS Core Collection and Chinese Science Citation Database, and in this way the results were reduced to 60 items, covering the research domain of social sciences (51), science technology (39), and arts humanities (3). We further filtered the 60 articles by screening their manuscripts' title, abstract and full text to identify the relevance of the content for our study focus. We consequently categorized them into three clusters: core (24), peripheral (14), and marginal (22). In addition, we collected 95 documents from company websites, annual reports, industrial reports, and journalistic type of contents, complemented the scholar review. In order to ensure the reliability of the information, we only took data for analysis once it could be traced to a reliable or reputed source. That is, official sources like company's web pages or annual reports, or from industry experts like Deloitte, Goldman Sachs, Boston Consulting Group, and KPMG, or from reputed media like Forbes, Nikkei Asian Review, Independent, Fintech News, BBC, Bloomberg, Techinasia, EqualOcean and Wall Street Journal. If the encountered data were

not from a reliable or reputed informant, we traced the information in an attempt to triangulate its reliability from other credible sources. If this was impossible, we did not incorporate these data for analysis. Indeed, this occurred during the data collection process with some data which were not incorporated for further analysis due to the disconformity of data reliability.

We focused on the thematic content analysis of selected 24 core papers and 95 documents, to identify the Fintech business models and the eco-systematic relationship of these two studied cross-sector Fintech companies. We first deployed the Fintech business model innovation definition of Liu et al. and complemented with Palmié et al. to codify the Fintech innovative business models of the two studied cases [5,34]. The choice of these two Fintech definition and categorization lists is mainly due to their recentness, published in 2020 in a high-quality journal of the field. As the Fintech phenomenon evolves rapidly, it is critical to refer to the latest publications which comprehend the updated literature. Then, we extended the codification of relationships with multiple stakeholders that the studied cross-sector Fintech companies interact with, within their Fintech ecosystem and interconnecting with their business ecosystem. In order to secure the internal construct validity, two researchers contrasted the preliminary findings with the conceptual definition checked with a Fintech expert, which resulted in an agreement level at the ratio of 92%. Further discussions were carried out to debate on the data and analysis with the final consensus reached. A third researcher participated in the further step of analysis and results discussion with a final agreement of 100% reached among three researchers.

3.3. Studied Cases: Alibaba Group and Tencent

3.3.1. Alibaba Group

Founded in 1999 by 18 people, led by Jack Ma, the Alibaba Group (hereafter Alibaba) successfully launched an initial public offering (IPO) in 2014 on the New York Stock Exchange, making it more well-known than ever in the global business world [75]. Its IPO was a record, surpassing previous ones and beating e-commerce rivals like Amazon and eBay [76].

Known as an e-commerce giant, Alibaba indeed has grown to a multi-channel platform embedded with multiple platforms for various business sectors [77,78]. Its major businesses like Alibaba.com, Taobao Marketplace, Tmall, 1688, Alibaba Cloud, Alimama.com, AliExpress, Ant Financial and CaiNiao cover the online business of B2B, B2C, auction, travel, games, software, technological infrastructure, social networking, logistics and financial services [79].

Ant Financial Services Group (hereafter Ant), also called Ant Group on LinkedIn, is to be changed to Ant Technology after the approval received from a Chinese regulator in June 2020 [80]. As the Fintech business unit of Alibaba, Ant is defined as a technology company offering inclusive financial services, and targeting consumers, and small and micro businesses [79]. Ant family includes Alipay, Ant Fortune, Zhima (Sesame) Credit, MYbank, and Ant Financial Cloud [81]. Ant filed for an estimated 150 to 200 billion USD valuation in its 2020 IPO, raising 30 billion USD, making it the biggest IPO ever, at the time [73].

Alipay is China's leading online third-party payment solution provider, supplying in-store payment, online payment, red packet QR code (promotional tool), and solutions (industrial specific solutions) to their customers [82]. Yu'e Bao, a money market fund, part of Ant Fortune, was the world's largest in 2019 [83].

MYbank, as a Chinese leading online private commercial bank, has served 29 million small and medium sized enterprises (SMEs) in its five years of foundation, by leveraging Ant's AI, computing and risk management technologies. It takes less than three minutes to apply for SMEs financing via mobile phone, less than one second to get approval, and zero human intervention (so-called 310-model). Reportedly, 98% of SMEs repay the loans on time with an average loan size of about 5000 USD; 80% of them had never received any business loans from banks before [79].

3.3.2. Tencent

To our surprise, Tencent is much less studied in academic work compared to Alibaba. According to our WoS searches, only 3 out of 24 core papers address Tencent while the remaining 21 manuscripts concern Alibaba's Fintech business. Founded in 1998 in Shenzhen, the firm has become a major technology conglomerate, with USD 47 billion in revenues in 2019, USD 14 billion in operating profits, 54,309 employees in 2018 and the fifth market capitalization among Internet companies in the world (USD 481 billion as of February 2020) [64], not far from giants such as Google, Amazon or Alibaba Group.

Initially notorious for its instant messaging service QQ, Tencent turned into a multinational conglomerate with an all-in-one internet platform serving entertainment, artificial intelligence and technology products around the globe. Tencent's WeChat (WeiXin in Chinese) is now the most popular messaging app with over 1.2 billion monthly active users [84]. In addition, Tencent has developed a substantial market share in the gaming industry and social networking in China [64].

With respect to its Fintech activity, Tencent strives to drive payment innovation, add payment use cases, and expand the wealth management portfolio. Tencent has been strengthening its leadership in mobile payment services, via WeChat Pay, by improving the penetration rate among offline merchants. By the end of the fiscal year 2019, there have been more than 1 billion daily average transactions, covering more than 800 million monthly active users (MAUs), and 50 million monthly active merchants (MAMs). WeChat Pay scores enhance the user's purchase propensity and loyalty to merchants. LiCaiTong is its wealth management platform, which had increased the aggregate customer assets by over 50% year-on-year according to the latest annual report; WeBank also rapidly increases its loan balances of micro-loan products [85]. Today, Tencent is one of the most active investors in Fintech along with Alibaba Group and Ant Financial [86].

The original success of Tencent in Fintech lays on the mobile payment. Tencent's WeChat Pay is one of the two most popular mobile payment methods in China along with AliPay [64]. In December 2018, the total daily transaction volume of Tencent's mobile payment services exceeded 1 billion. Upon receiving approval from the Hong Kong Monetary Authority in May 2019, Tencent entered the Fintech market in Hong Kong [85]. Business can launch promotional events via the mini-program of "in-app apps" through Red Packet QR to obtain virtual coins which can be exchanged for real currency. The "in-app apps" mini-program platform of WeChat allows Tencent to own an "app store" without owning a mobile operating system (OS) and ties its users to its expansive ecosystem. Recently Tencent sets up the MiniShop tool which simplifies largely the process to facilitate vendors build their WeChat Shops quickly without the need to request external developers' help. This accelerates the merchants of all sizes to access and sell their products on WeChat and expands the e-Commerce business unit of Tencent [84].

4. Empirical Results and Findings

4.1. Fintech Business Model Innovation

We started to categorize Alibaba and Tencent's Fintech activities according to the conceptualization of Fintech business models by Liu et al., complemented by Palmié et al. [5,34]. This process of classification was less straightforward than expected. We identified conceptualization overlaps and omissions in the pre-established definition and categorization by contrasting with Alibaba's and Tencent's Fintech business models. It indicates that even the most recent conceptualizations are outpaced by actual Fintech developments and may not explain the activities by cross-sector players. While credit rating is a relevant Fintech activity for both Alibaba and Tencent, it has been largely omitted in most current Fintech business model categorization. Many other definitions and categorization discrepancies were also discovered. The definition and categorization challenges of innovative Fintech business models exist. The next subsections describe these findings and Table 2 presents the Fintech

business models that Alibaba and Tencent have been actively involved in together with corresponding examples illustrated in the same row.

Table 2. Fintech Business Models of Alibaba and Tencent.

Fintech Business	Alibaba Examples	Tencent Examples
Electronic Payment	Alipay launched as an online payment platform (2004) Joint project with the Bank of China for quick payment with a credit card (2010) International remittance service empowered by blockchain technology (2018)	TenPay launched as an online payment system (2005)
Mobile Payment	Mobile payment service launched (2009)	WeChat Pay launched (2013)
Electronic Point-of-sale (POS)	Dragonfly as a facial recognition payment device (2018)	Frog Pro, POS machine allowing shoppers to make transactions by scanning faces at checkout (2019)
Digital Currency	N/A	Tencent QQ Coins (Q Bi) launched (2002, Virtual Currency)
Wealth Management; Micro Investing; Personal Finance Management	Yu'E Bao launched with Tianhong Wealth Management, even if with RMB1 (2013)	LiCaiTong (Wealth Management Platform) launched (2014)
E-Banking; Online Lending; Micro Finance	Alibaba Microfinance Company established (2010) MYBank received license from the China Banking Regulatory Commission (2014) MYbank established with a focus on SME financing (2015)	WEbank cofounded (2014) MOU with Asian Digital Bank Corporation to develop cloud-based financial services (2020, e-Banking)
Credit Rating	Aliloan in partnership with ICBC and CCB * to help SMEs with limited assets or credit history based on transaction histories and credibility rating at Alibaba (2007) Sesame Credit established as the first Chinese credit agency (2015)	Tencent Credit launched (2017)
InsurTech	Co-invested in Zhong An Insurance, the first Chinese online-only insurer (2013) Alihealth Internet insurance cofounded (2016)	WeSure cofounded as an insurance platform (2016) Tencent led investing in WaterDrop, a healthcare crowdfunding platform (2016, Crowdfunding)
RegTech	Uncovering insurance fraud conspiracy with NetWork Learning	ProGuard system for malicious accounts detection in online promotion with virtual currency (2015) e-Receipts Solution launched with Zi Tax Innovation Lab, cofounded with Shenzhen Tax Bureau (2018)

Note: * ICBS is Industrial and Commercial Bank of China; CCB is China Construction Bank. Source: Own elaboration based on data collected from Company website, Annual reports, other public sources or magazines like Forbes, Financial Times, CNBC and Bloomberg.

4.1.1. Electronic Payment and Mobile Payment

Liu et al. classify the payment-related Fintech business models into two categories: Transaction and payment terminals, and Mobile point of sale. From the data collected at Alibaba and Tencent, we found Electronic payment, Mobile payment, and Point of Sale (POS) [34]. Liu et al. define "Transaction and payment terminals" as "Software on the mobile devices that allows consumers to store their credit and debit cards digitally to pay for things at retailers" [34]. We found that this definition corresponded more to the mobile payment definition. From the case of Alibaba, we could see that Alipay was initially

established in 2004 as an online payment method to facilitate the e-commerce of Alibaba's mainstream business units. It was not until 2009 mobile payment was launched. Similarly, in the case of Tencent, TenPay was launched as an online payment in 2005 but WeChat Pay as a mobile payment in 2013. We refer to the former as electronic payment as any kind of payment transaction transfers (both to B2C or B2B) via electronic means. Thus, we consider mobile payment as part of electronic payment, but due to its specificity of utilizing mobile devices for payment and the popularity of the utilization of this mode, it is classified separately. In the studied cases, we also identified the differences from Liu et al.'s definition of storing "credit and debit cards digitally" [34], which both Alipay and WeChat Pay also do by recharging from an online banking account, recharge code, and call charge card while accomplishing the transaction. This adds to customers' convenience as many in developing countries do not have a debit card or credit card, and also reduces the transaction cost

4.1.2. Electronic POS

Palmié et al. include this function in the category of payments [5]. In the categorization of Liu et al., only the mobile point of sales is enlisted with the definition "The ability to process payments with credit cards or contactless with a smartphone and a credit/debit card reader" [34]. Both Alibaba and Tencent have recently developed facial recognition POS devices (Dragonfly and Frog Pro respectively) which allow consumers to scan their faces at checkout to make the payment. In this case, no credit cards or contactless, or mobile device is needed for POS. Therefore, we classify this innovative Fintech business simply as POS and define it in a broader way: Electronic POS is the ability to process payments with credit or debit cards or contactless with a smartphone and a credit/debit card reader, or any specialized devices such as facial recognition linked to financial payment data.

4.1.3. Digital Currency

Palmié et al. implicitly include digital currency and cryptocurrency in the payments category [5], while Liu et al. classify the category separately and define it together with them; "Alternative stores of value to established currencies. Many of them are encrypted" [34]. Though Alibaba and Tencent do not possess their own cryptocurrency, Tencent has a kind of virtual currency, called QQ Coins for value exchange in the communities and interchange with real currency. We also differentiate it from what commonly digital currency is understood, and the Chinese central bank launched an official digital currency to reduce the dominance of Alibaba and Tencent in the payment Fintech area [87]. As it plays a role in value and good exchanges, we include it within this category.

4.1.4. Wealth Management and Micro Investing

While Palmié et al. as well as Lee and Shin set wealth management as a category of the Fintech business model [5,12], Liu et al. only highlight robo-advisors in the Fintech business model [34]. In the case of Tencent and Alibaba, both have wealth management through their online platforms, not specifically focused on Robo-advisors, but investment platform, portfolio management, etc. Remarkably, Ant's Yu'E Bao allows customers to invest her idle balance in the money market fund with a minimum investment of RMB1 and no time restrictions or maturity regulations for fund redemption. Since its launch in June 2013, Yu'E Bao enjoyed a huge surge in popularity in China, and by February 2014 it has accumulated more than RMB500 billion of assets, with around 81 million investors, becoming the largest money market fund in China [88,89]. Along with the general wealth management through Fintech, micro-investing has been less discussed as a Fintech business model. Allowing platform users to invest at a minimum level of 1 unit of currency disrupts the current traditional investment fund model which requires a minimum amount. In this way, micro-investing collects a large amount of disposable money and makes its powerful source of money market fund. The flexibility that the platform offers with a high return—above 6% in 2014 annualized interest rate—makes it attractive [88], in addition to the trustworthiness that the giant tech company offers to back it up [90].

4.1.5. E-banking, Online Lending, and Microfinance

Liu et al. set e-banking, online lending/online peer-to-peer lending/P2P lending, and personal finance management into three separate categories [34], while Palmié et al. include banking Fintech with digital lending, personal finance, online and mobile banking, P2P lending, and investment management [5]. The Tencent and Alibaba affiliated e-banking are WEbank and MYbank which are online-only banks. Like online banks, both mainly concentrate on the small number of loans as investments, and personal finance has been taken care of by other digital financial products like Yun'E Bao. It is especially in microfinance where they outcompete with loan services from traditional banks. Of SMEs, 80% have not received any loan from bank previously [79]. Therefore, our studied cases blend micro-finance, online lending with e-Banking rather than separating them into different categories. Again, like in micro-investing, microfinance has relevance in the social and inclusive financial services providing, which has been overlooked in most previous Fintech business model studies.

4.1.6. Regtech

Liu et al. do not have any category of RegTech for Fintech business model definition [34], while Palmié et al. do consider it as a Fintech application, referring it as helping customers with the compliance process, providing tools for implementing and monitoring compliance with regulations or reforms using innovative technology [5]. We consider Tencent's ProGuard system, e-receipts for tax management (partly also e-finance) are part of Regtech activities. Giving the rapid disruption of Fintech in financial services, the growth of the digital economy and the virtualization of money, governments and regulators have been working on new regulations in different countries. Therefore, including Regtech into the Fintech business model is a necessity.

4.1.7. Credit Rating

Neither Liu et al. nor Palmié et al. have discussed credit rating as part of Fintech business models or applications [5,34]. The studied cases have highlighted the relevance of credit rating for Fintech businesses of both Tencent and Alibaba. It is especially in terms of loan lending and microfinance where most SMEs have no previous credit record which impedes their loan from a traditional bank. However, with the credit rating system of Sesame Credit (Alibaba) and Tencent Credit, their online banks can process lending in seconds with an efficient and low-cost manner. Credit rating has been considered a relevant issue, especially after the 2008 financial crisis. We consider it necessary to establish a "credit rating" as a separate category in the Fintech business model.

4.2. Fintech Ecosystem: Components, Drivers and Interrelations

The findings from the comparative case analysis lead to a refinement of the ecosystem conceptualization initiated by Lee and Shin [12] (see Figure 1). The scope and scale of Fintech activity by Alibaba and Tencent provides a strong argument to extend the current conceptualization of the Fintech ecosystem by adding cross-sector Fintech and investors to the extant five elements (Fintech startups, technology developers, government, financial customers, and traditional financial institutions). Outside of the ring of the Fintech ecosystem, there is another broader ecosystem of business. Thus, our conceptualization of the Fintech ecosystem is much wider involving a large business ecosystem composed of a value chain of suppliers, enterprises and consumers in addition to the Fintech ecosystem envisaged by Lee and Shin [12]. Table 3 exhibits the cross-sector Fintech ecosystem mapping with examples from the studied cases.

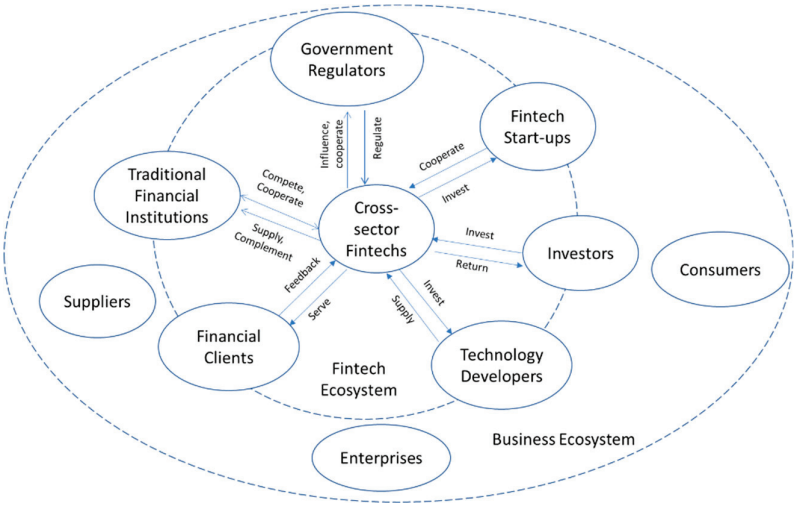

Figure 1. An Eco-Systematic View of Cross-sector Fintech.

Table 3. Cross-sector Fintech Ecosystem Mapping.

Eco-Systematic Relation	Alibaba Examples	Tencent Examples
Business Ecosystem	Alibaba founded as an e-Commerce platform (1999) Environmental protection initiatives announced (2010, environment responsibility) Agriculture finance business implemented (2014, interconnection with a sustainable business ecosystem)	Online avatar product QQ Show launched (2003, entertainment provider) QZone launched for social networking service (2005, networking service provider) Tencent Charity Foundation established (2007, social responsibility) WeChat launched as social media platform (2011)
Financial Investors	Yu'E Bao launched with Tianhong Wealth Management, even if with RMB1 (2013, micro investor) Investing in One97 Communications, an Indian Fintech startup that operates Paytm (2015)	Naspers purchased 46.5% of Tencent (2001, investment reception as Fintech Startup) Tencent led investing in WaterDrop, a healthcare crowdfunding platform (2016)
Fintech Startups	Alipay launched as online payment platform (2004) Mobile payment service launched (2009)	TenPay launched as online payment system (2005) WeChat Pay launched (2013)
Traditional Financial Institutions	Aliloan launched in partnership with ICBC and CCB to help SMEs with limited assets or credit history based on transaction histories and credibility rating at Alibaba (2007, cooperate) Joint project with the Bank of China for quick payment with a credit card (2010, supply)	LiCaiTong (Wealth Management Platform) launched (2014, compete) WEbank cofounded (2015, complement) Tencent Credit launched (2017, supply) MOU with Asian Digital Bank Corporation to develop cloud-based financial services (2020, cooperate)
Financial Clients	Alipay's "Online Inquiry System" for online customer service (2005) Alibaba Microfinance Company established (2010)	Wexin Red Packet launched (2014, serve SME clients) WEbank's Particulate Loan gave credit to over 10 million people with transaction amounts over7 billion RMB in 10 months after launching (2015)

Table 3. *Cont.*

Eco-Systematic Relation	Alibaba Examples	Tencent Examples
Government Regulators	Ant Financial established to take over Fintech business of Alibaba due to the regulation restriction (2014) Green Digital Finance Alliance, an international alliance with UNEP (2017, cooperate) Ant Financial changed to Ant Technology due to regulation sensitivity to financial (2020)	Tencent limited the functionality and usage volume of Q Bi (Virtual currency) after governmental regulation (2007) e-Receipts Solution launched with Zi Tax Innovation Lab, cofounded with Shenzhen Tax Bureau (2018, cooperate)
Technology Developers	Sesame Credit established as the first Chinese credit agency (2015, Big Data application) International remittance service (2018, blockchain technology) Dragonfly as a facial recognition payment device (2018, electronic POS technology development)	Tencent Cloud services launched (2013) ProGuard system for malicious accounts detection in online promotion with virtual currency (2015) MiniPrograms launched for E-Commerce advertising (2017, Super Apps technology)

Undoubtedly, cross-sector Fintechs are active participants in a Fintech ecosystem than the economic geography approach proposed in Lai and Samers [55], and Wojcik [56], as an unfolding of "Fintech Cube". Our findings clearly confirm that the role of cross-sector players evolved over time and they adopted specific roles, co-create value and depend on other actors for development and existence. Both Alibaba and Tencent initially developed business activities such as e-commerce and instant messaging before launching into Fintech. However, weak credit card penetration prompted Alibaba and Tencent to look for other solutions to expand their business in the Fintech area [64]. With the expansion of their corresponding business and diversification, both entered the field of Fintech for its prosperity and related strategic diversification needs. Launching Alibaba's Alipay, in 2004, and Tencent's Tenpay, in 2005, facilitated their e-commerce and other purchasing transactions, in addition to ensuring a better purchase convenience and security. Due to the close relation to e-commerce, it proves advantageous for e-commerce-related high-tech companies to enter the Fintech area, and become cross-sector Fintech, through electronic payment in this case, with the adoption of related technology in online transactions [89]. The justification of cross-sector extension enables us to solidify the true impact of what we call the "cross-sector Fintech" as exemplified by Alibaba and Tencent, with the following characterizations.

4.2.1. Size

Cross-sector Fintech played a major role to drive the Fintech sector development and growth, instead of traditional financial institutions, or Fintech start-ups. The influence of giant tech companies like Tencent and Alibaba's participation in the Fintech sector is so large that their sheer scale and speed had made differences. Their mobile monthly active users are respectively 1164.8 and 846 million according to the last annual reports (see Table 1), larger than the population of any country other than China and India. Both have market capitalization higher than 500 billion USD in July 2020, more than any traditional financial institution in the world. Brackert et al. highlight that global retail banking is racing for relevance and scale [91], whereas cross-sector Fintech had already achieved such relevance and scale.

4.2.2. Multiple Relationships

The multiple relationships between cross-sector Fintech and traditional financial institutions are more varied than the current debate on cooperation and competition [45,92]. They compete, cooperate, supply and complement; thus, mere analytical focus on cooperation and competition in relationships would be incomplete. Though the two studied cross-sector Fintechs have been regarded as a principal

business threat for traditional banks with some collaborations, Alibaba and Tencent are also technology developers, providing traditional banks with digital platforms for social media, big data analytics, cloud computing, artificial intelligence, and so on. As a supplier, the credit rating agencies Sesame Credit (Alibaba) and Tencent Credit offer their Fintech services to traditional banks to improve the incumbents' accuracy in credit assessment and loan lending decisions. In addition, much of the online microfinance lending carried out by WEbank and MYbank, is targeting SMEs that never received any loan from traditional banks. Cross-sector Fintech thereby covers a niche market whose needs were unattended before with a complementary role to the existing competitors.

4.2.3. Financial Inclusion

In the cross-sector Fintech ecosystem role of investors is noteworthy; we identify two types: major investors and micro investors. Alibaba received significant financial investment from Softbank, a major high-tech investing company based in Japan, to support its initial launch and continuous development, including for the expansion of its activities in Fintech. Alibaba also established a direct interlocking directorate with its principal investor to gain greater coherence in business actions and to facilitate a community of interest among Fintech actors [93]. This direct interlock ended in May 2020. Likewise, Tencent depended on venture capitalists' investments and, later, Naspers' investment. Once established as significant players and active in the Fintech ecosystem, both actors become frequent investors in other Fintech start-ups. Examples are Tencent in Indonesian Gojek, and Alibaba and Ant Financial in Indian Paytm Karo [86]. Other types of investors in the ecosystem are the numerous micro investors who are often financial customers or business clients or social media users at the same time. Here, the cross-sector players monetize their enormous customer or user base and allow them to invest in the financial market without an established minimum limit, drastic deviation from traditional investment business models that commonly require a minimum amount in order to participate. These inclusive financial activities of cross-sector Fintech are also reflected in the above microfinance to SMEs who were used to be excluded from bank loan obtaining.

4.2.4. Interconnectivity and Flexible Technology Platform

Both Tencent and Alibaba function within a larger business ecosystem rather than limiting themselves to the Fintech ecosystem. Indeed, the Fintech ecosystem and business ecosystem interconnect and interact for mutual benefits. Tencent's slogan is connecting ecosystems, from connecting people, services and devices, to connecting enterprises and future technologies, fostering win-win ecosystems for everyone [87]; while Alibaba specifies that their ecosystem consists of four layers of platforms, which are independent but also interconnected [79]. These two players have developed what is called "Super Apps" by designing single technology platforms that allow ecosystem entities to smoothly plug-in their own "Mini-Apps", to run a more efficient system to grow than the individual entities can do. At the bottom of this Super App ecosystem, there is cloud intelligence and data technology to provide general support for an efficient and advantageous ecosystem business model. Above this layer, there are financial services, which closely link with technology innovations providing competitive advantages in the Fintech sector. The competitive financial service relies on the higher-level layer of logistic and supply chain management to make the channel to market smoothly. The final but not the least important layer is the platform of customers, which is on the top of the whole ecosystem driven by four elements: online sales and distribution, data-driven product innovation, digital marketing and branding, and channel management [94,95]. Red Packet is one of these examples that both WeChat and Alipay launched. As an innovative Fintech product, Red Packet is a virtual red envelope containing money for gift-giving, which is very particular in China. However, more than simply a means for money transfer, Red Packet has provoked a social phenomenon and attraction, and has become an effective promotional tool for business.

4.3. Fintech Ecosystem Evolution: Fuzzy Boundaries

From the studied cases, we found government regulators play an important role in the evolution of Fintech business model innovation and ecosystem development. Sender describes that two tech giants had special love from the People's Bank of China (PBoC) which allowed them to grow into monsters, while all the banks and the China Banking Regulatory Commission (CBRC) complained [82]. Without the green light of the regulator, it would have been impossible for Alibaba and Tencent to have such rapid growth in Fintech areas, as many activities require government-issued licenses to legally operate. Recently, however, PBoC is experimenting with a new digital currency, hoping to reduce the dominance of Alibaba and Tencent in digital payment [87].

In addition to its large population size, Revesz reported that Chinese consumers' trust and willingness to accept new technology is higher and faster than any other country [96]. Trustworthiness is a crucial element for financial services, especially for Fintech, as it influences the repurchase intention of consumers [89,97]. The scale and relevance that Tencent and Alibaba possess have been due to their ethical and social values embedded in their corporate culture. Compared to Fintech startups, the cross-sector players do not have a "liability of newness" [63], but constitute a competitive advantage in attracting financial clients [5,15]. Chong describes the trustworthy reputation building of Tencent's and Yu'E Bao (Alibaba) by having people believe that "WeChat and Alibaba are big companies; their scale already guarantees that they won't steal your money" [90] (p. 300). Cross-sector Fintech enjoys this reputation and trust from users generated from their earlier experience and size. Because cross-sector Fintech operates at the intersection of financial service and technology, the boundary of the two is very fuzzy. We can identify several forms of fuzziness.

4.3.1. Finance vs. Tech

Indeed, both Alibaba and Tencent have changed their corresponding Fintech brands from financial to technology in 2020. Ant changed its name from Ant Financial to Ant Technology in 2020, in order to present them as technology companies to prevent regulation scrutiny and expand further into technology business areas; top executives even prefer to call them "techfin" instead of "Fintech" to emphasize their technology prowess over financial services [98]. Alibaba and Tencent created their integrated business ecosystem with multiple applications to serve a variety of customers within a single platform. Red Packet QR and facial recognition POS are some of these Fintech examples with underlying common technologies like blockchain which could be applied in other business contexts. Chinese Fintech like Alibaba and Tencent are top-ranked in terms of Fintech patent applications [99]. In a digital-enabled platform or a platform of multiple platforms, Pollari and Ruddenklau highlight the Fintech emergence as blurring of traditional industry boundaries around the customer, i.e., the industries converge and players from adjacent sectors invent business models to solve customer problems or remove friction points in expanding financial services offering [67].

4.3.2. Terminology

Fuzziness in cross-sector Fintech occurs due to terminology and categorization as well. As discussed in Section 4.1, questions may arise on whether microfinance could have its own category, or be part of the online lending category; whether online lending in a separate category or being part of e-banking; whether there should be a category of e-banking, and so on. A similar question could be asked regarding credit rating, micro-investing, wealth management, securities trading with the capital market business model, Insurtech and Regtech, etc.

4.3.3. Role

Traditional Western business models often explicitly define the role of different stakeholders in the value chain, e.g., investors, consumers. In the case of Yu'E Bao, the innovative business model provides customers a double-account service [88]: Consumption payment and investment, which bundle the

services on the same users to maximize the performance. Additionally, a supplier of an e-commerce portal could be a customer of financial credit services. A buyer of a retailing business could be a cash depositor as a source for financial investment. It may be Fintech ecosystem specific or cross-ecosystem like the example illustrated in the above to have e-commerce suppliers as users of supply chain finance.

4.3.4. Stakeholder Relationships

Due to the multiple roles involved, the relationships between different stakeholders also become fuzzy. For instance, Ant, as a cross-sector Fintech, has well discovered the financial services to the end consumers but is also supplying its technology to 200 other financial institutions as a technology developer [100], with whom they also compete to attract financial clients, and cooperate in many occasions to build common projects to serve (e.g., contactless lending initiatives during COVID-19). In the area of SMEs lending, the majority of their clients are first-time borrowers which is a niche market uncovered and complementing traditional banks' offering. Similarly, an individual may start the relationship with Tencent as a QQ account user, moving then to WeChat messaging service where they start with WeChat Pay as a mobile payment user. Yu'E Bao's users are investors and Alipay users at the same time. This relationship fuzziness creates complexity in stakeholder management.

5. Discussions, Conclusions and Limitations

5.1. Conclusions and Propositions

The purpose of this study was to explore the position of cross-sector Fintech in the Fintech ecosystem domain to better understand its drive, business model innovation, and development. The findings not only show that the Fintech ecosystem continues to evolve due to the dynamic changing of player structures. Moreover, the findings demonstrate that cross-sector players such as Alibaba and Tencent are different from traditional Fintech startups due to their maturity levels, resources and capabilities, economy of scale, and being experienced ecosystem players. They require the attention of academics and practitioners alike due to their importance for sustainable development and for providing lasting benefits to people and society at large. With respect to business model innovation and development, our study revealed three key issues in the Fintech ecosystem and Fintech business models enabling us to derive 3 propositions, as below.

First, the competitive advantage in the Fintech sector is no longer solely based on finance specific technical knowledge but also on technological expertise and innovative business models. When Wilson and Campbell propose analyzing the Fintech phenomenon from a functional perspective [101], they adopt Merton and Bodie's six core financial functions: clearing and settling payments, pooling resources and subdividing shares, transferring resources across time and space, managing risk, providing information, and dealing with incentive problems [102]. This definition also differs from existing terminology commonly used for categorizing Fintech business models. Our research shows the overlapped and fuzzy conceptualization of categories, which were largely ignored in most previous Fintech ecosystem studies.

We infer that the rapid pace of technological change renders such categorization rapidly obsolete when applied to cross-sector Fintech. Our findings reinforce the call of Gimpel et al. according to which researchers should consider alternative taxonomies for a better understanding of the Fintech phenomenon and the role of cross-sector Fintech [11]. Consistency of terminology and approach is claimed to be important as "if there were agreement and standardization of what is meant by "functions", this would enable greater comprehension of the system and between systems operating in different countries thus enhancing oversight and regulation" [101] (p. 419). Fintech researchers have not unified the terminology to be used in Fintech business models or functions as yet. Therefore, we propose the following proposition for future research or eventual conversion into hypotheses for quantitative testing:

Proposition 1. *The fuzziness of the Fintech business model conceptualization impedes the appreciation of changes and innovation in business models in the Fintech sector.*

Second, the role of cross-sector players in Fintech to compete with traditional incumbents creates a large scale impact on society. The Fintech applications by Alibaba and Tencent provide financial services at an affordable cost to all parts of society, aiding their financial inclusion [6], apart from supporting economic growth through increasing financial resources to support real economic activity, particularly for individuals and small and medium enterprises. For instance, the capability of Yu'E Bao to accumulate more than RMB500 billion of assets in nine months of its launch in a post-2008 financial crisis-era largely supports the financial sourcing for economic growth. Its involvement of 81 million investors as micro-investors, with the majority holding thousands of RMB in the account, illustrates the democracy in the Fintech market, with most of those included having never invested in the money market before. Similar to MYbank, Tencent's WEbank has also addressed inclusive finance targeting SMEs. Its small business loan, WeiYeDai, debuted in 2017, with 66% of clients who had never borrowed money before. This inclusive financing opportunity provided jobs to more than 2 million people [103]. While the emergence of the cross-sector players also brings new challenges and risks, the potential benefits to sustainable economic value creation and financial inclusion are considerable. Qu, Zhang and Ding's study suggests that Chinese banks cooperate with high-tech industries to improve the technical quality of patents and learn Alibaba's international patent strategies to increase the overseas patent application quantity, expand market share, and gain competitive advantages [104]. This suggestion is proved by the fact that Chinese insurer Ping'An ranked first in 2019 in terms of Fintech patent applications according to the World Intellectual Property Organization (WIPO), ahead of Alibaba [99]. Our current data could not verify if such a learning process occurred. Thus, further research on the relationship and network among Fintech and traditional financial institutions is desirable to understand the underlying ecosystem creation and development as well as the potential societal implications, such as the risk of a new digital divide between the technologically able and others [6].

The technology capability and scale-based resources of cross-sector Fintech allowed Alibaba and Tencent not only to fill a gap in the market offerings to new customer groups, complementing extension of existing services, but most importantly, to become technology drivers for processes of traditional actors. Though it is fair to say that Chinese enterprises are better at business model innovation than breakthrough technological innovations [105], Alibaba and Tencent are some of the Chinese enterprises which broke this stereotype. Alibaba filed 798 Fintech patents in 2019, ranked second in WIPO Fintech ranking [99]. In 2018, Tencent Foundation donated 1 billion RMB (about 143 million USD in July 2020 value) to set Xplorer Prize award for young scientists in areas of basic science and cutting-edge technologies [85]. Data from April 17, 2020, shows that Alibaba (Ant) and Tencent are two top-ranked enterprises in the global blockchain patent applications. Alibaba has been in this first position since 2017 with 1005 patents in 2019; WeBank of Tencent was also ranked fifth on this list [106]. Innovation capability in terms of technology, product, process and business model seems to be integrated into cross-sector Fintech. Further integrated innovation studies in the Fintech ecosystem is necessary to better understand the trends, terminology and categorization of Fintech. As the Fintech's payment evolution illustrated, payment methods using QR codes replaced cash and cards in a period of five years. It is very probable that in the next few years, new and better products will replace QR codes, according to a top manager in Tencent [107]. Therefore, we propose the following:

Proposition 2. *Technological, product, process and business model innovation are integrated in the cross-sector Fintech ecosystem, which leads to more democratic financial activity participation and inclusive finance for multiple stakeholders.*

Third, the participation of cross-sector actors is relevant for Fintech ecosystems to be a key player rather than a niche player as most Fintech startups do. This also brings several boundary fuzziness in the finance vs. tech, terminology, role, and stakeholder relationships, as presented in the

finding section. For example, 83% of financial institutions reported that their businesses are at risk of Fintech in some aspects [8]. Further, banks are facing an existential crisis [4,23], in contrast to earlier studies, which highlighted cooperation and coexistence between Fintech and traditional commercial banks [88,92,104]. Our findings extend their relationships further by adding a dimension of supply and complementarity to the Fintech ecosystem. The multiple roles among different stakeholders in the cross-sector Fintech create network relations and build synergetic and integrative effect for sustaining competitive advantages. The network effects in the multiple role platforms and ecosystems in a large business ecosystem deserve further investigation on their interdependent effects and co-evolutional development.

The development of electronic finance (e-finance) rapidly advanced after the 2008 financial crisis by combining internet technologies, social networking, artificial intelligence, and big data [12]. Furthermore, cross-sector Fintech leads the Fintech transformation which broke down the boundary of several industries between banking, insurance, social media, e-commerce and IT; in addition to fostering business model innovation in numerous sectors like retailing, logistics, food delivery, and restoration. The recent COVID-19 pandemic has triggered worldwide deployment of remote work, social distance, and contactless practices which challenges several industries with profound impacts [108]. The financial industry is one of them and Fintech has taken a much larger role since then and the Fintech ecosystem has become an irreversible trend for the future. Therefore, we suggest the following proposition:

Proposition 3. *Multiple roles and boundary fuzziness in the cross-sector Fintech ecosystem foster network accessibility among Fintech actors with the opportunity to gain and sustain competitive advantages.*

5.2. Discussions and Limitations

All of this indicates that the sustainability of the Fintech sector is currently driven by technological firms rather than the traditional bank and financial-institution-based systems [19]. This is a dramatic change in Fintech ecosystem dynamics. Palmié et al. argue that disruptive innovations often originate at the ecosystem or system level rather than in individual firms, and the Fintech ecosystem's disruptive innovation needs and deserves further attention [5]. Therefore, the eco-systematic approach to Fintech that we take in this paper confirms and goes beyond what Anand and Mantrala claim: the most recent trend is a coopetition and co-existence relation between Fintech and traditional banks rather than competition and substitution [23]. A much more complex relationship between cross-sector Fintech and traditional banks, also with other stakeholders like Fintech startups, is presented in this study along with a co-existential eco-system to co-evolve.

As innovation has been the essence of the business development and corporate culture of the studied firms, we can also observe their positive social effects for business sustainability in a critical moment like COVID-19. China's economy has been largely affected since late January 2020, triggering a series of lockdowns, social distancing practices and travel restrictions, as well as in the rest of the world. Enterprises have been concerned with business continuity, supply chain disruptions, cost reductions, new opportunity identification, cash flow improvement, and remote workforce management. Affected but also taking it as an opportunity, Alibaba made a 20% revenue increase as the close of the fiscal year on 31 March 2020. Together with Ant and other partners, they have implemented a comprehensive set of financial and business supports to alleviate some near-term challenges. As of 30 April 2020, approximately RMB130 billion (about USD 18.4 billion with the value of the day) has been provided to merchant customers to provide liquidity, and over RMB 12 billion in twelve-month loans with preferential interest rate. Billions of RMB in value in the form of subsidies and technical support have been provided such as waivers of platform technology fees, annual service fees and warehouse fees, and reductions of commissions and logistics costs. The further program was launched in April 2020 to develop digitalized manufacturing clusters, accelerate the digital transformation of China's agriculture sector, and alleviate financing challenges of SMEs, etc. [79]. The social dimension of the cross-sector

Fintech ecosystem has been understudied in general. However, due to the cost-efficiency provided by big data analytics and other technological advancements, Fintech has empowered less resourceful segments to have a better opportunity to sustain business and alleviate poverty. The further exploration of this dimension will be fruitful for creating a more harmonious, democratic and sustainable society.

Palmié et al.'s study on the disruptive innovation in the Fintech ecosystems has remained at the level of disruptive and non-disruptive innovation, arguing the need for further study on how different types of innovation relate to ecosystems, for instance, competence-enhancing versus competence-destroying innovation, architectural versus generational innovation, and incremental versus disruptive innovation [5]. Though we do not follow the innovation typology that Palmié et al. propose, we do add new insights from the viewpoint of an alternative innovation approach to Fintech ecosystems as business models. From a business and management perspective, business model innovation is gaining more and more attention from scholars and practitioners as it breaks through the traditional market status-quo [109]. Alibaba and Tencent provide the example of this Fintech-driven ecosystem evolution, essentially based on their innovative business models tackling untapped market demands supported by technological efficiency and effectiveness, converting technological innovation into product innovation, process innovation and, dramatically changed, whole business models.

Organizations must blend digital and human capabilities to succeed in the digital transformation era [91]. The future of the financial industry seems to center on the customers, creating a trend for a platform-based industry structure with multiple layers, and a race for relevance and scale among banks and new entrants. Whether Fintech normalizes, or incumbent banks will consolidate to take over the customer interfaces, may vary depending on the market and country context. Our study context is China, a leading emerging market with regulator support and a huge population to allow cross-sector Fintech to gather scale at a fast pace. Large cross-sector Fintech may drive the Fintech ecosystem in a more global context. Regardless, the drivers of extraordinary innovation around the world going to be critical for underlying sustainable development.

Due to space restrictions, we concentrated on exploring the differentiated innovative Fintech business models of Chinese cross-sector giants, and their interrelations from an eco-systematic view. This limits the possibility to further understand the cause and generation process of these innovative Fintech business models within and beyond the existing ecosystems. We call for further discussions on the categorization of Fintech business models from the ecosystem perspective on the one hand, and the critical determinants for the interaction of Fintech ecosystem and business ecosystem development on the other hand. Our limitation also lies in the employed methodology though deemed appropriate for the current study purpose. For example, in analyzing the Fintech ecosystem composition to better understand business model innovation and development, our study employs multiple case study data from China and does not involve studies from other countries. In future research, we aim to conduct a comparative analysis of the impact of Fintech on sustainable business model innovation from emerging markets and developed country organizations. A quantitative survey study could also contribute to collect extensive data to test hypotheses once the Fintech categorization and ecosystem frame are better established. Indeed, the complexity of business model innovation driven by cross-sector actors has enabled the possibility of a mixed-method approach for future studies. In addition, an exploration between the Fintech ecosystem and sustainability is worthy of further attention. The evolution of Fintech-related technology has made inclusive finance more feasible than ever, even in emerging market economies. Micro-investing and microfinance through efficient access and evaluation are some of these examples for financial inclusion.

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Digital Entrepreneurship in Finance: Fintechs and Funding Decision Criteria

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Abstract: After the 2007–08 global financial crisis, research flourished on entrepreneurship through digital innovation in the financial market as well as on investors' influence on digital technology-based entrepreneurs' funding decisions. This study combines these two research streams to analyze the decision-making criteria for funding financial technology companies (fintechs), hybrid companies that combine digital entrepreneurship, technology, and banking. The study first uses prior literature to derive important characteristics to define fintechs and then uses 12 expert interviews to elaborate on decision-making criteria in funding. Except for smaller peculiarities, fintech funding does not appear to differ from that of other digital entrepreneurship in different markets, and—as with most digital business models—scalability was identified as a key criterion. Additionally, by serving as a major provider of money for young companies, banks have changed their role and positioning in funding new financial technology entrepreneurs. Through developments in digital technology, banks have shifted from traditional money-lending activities (i.e., debt-financing) to becoming stakeholders in fintechs and, hence, equity investors. We also describe how these formerly distinct fields have converged due to regulatory requirements, digital newcomers, and a need for constant innovation, with their future sustainable development dependent on sharing and collaboration.

Keywords: digital entrepreneurship; fintech; funding; decision criteria; success factors; startups; venture capital; investors

1. Introduction

In the previous decade, traditional banks have struggled to maintain their market and have faced competition from an increasing number of financial start-ups—an issue of the greatest interest to investors [1]. These financial technology companies (fintechs) are gaining momentum, fueled by drivers such as the sharing economy [2,3], and include peer-to-peer lending platforms that have opened marketplaces for multiple economic actors and enabled the co-creation of value as Uber has for cars [4,5]. Between 1990 and 2008, 450 venture capital deals occurred in financial services, thus ranked among the 10 most important industries [6]. After the 2007–08 global financial crisis, however, fintechs started to apply new technologies in the financial market and have changed the way of doing business in all sectors of finance [7]—a development that is still ongoing. Fintech investments doubled from 2017 to 2018, with approximately US$112 billion invested globally in 2018, and the amount invested in Europe tripling during the same period [1].

Mainly driven by cost and risk expectations, investors strive to minimize the principal-agent problem [8] and overcome information asymmetries between entrepreneurs and investors [9], meaning that providing investors with sufficient information is a prerequisite, as are additionally influencing criteria (e.g., [10]). Although fintechs are gaining increasing attention from all types of investors, the current literature predominantly focuses on start-ups in general and not specifically on

the digital economy with its rapidly changing financial environment. To address this research gap, this paper (1) identifies criteria for investors' decision-making and (2) analyzes these criteria in the context of the financial technology industry to answer the research question:

Which components attract investors most when they are deciding whether to invest in a fintech company?

Thereby, we contribute to the existing literature by using insights from investors and startups to highlight new aspects of decision-making criteria for funding and fintechs, demonstrating how funding stage and investor type induce the application of different investment criteria and that decision-making criteria should not be assessed in isolation. Additionally, we identify the interdependency and changing role of banks as fintechs' investors, partners, and competitors; unlike other startups, fintechs are not solely investment objects for banks.

We recommend collaboration and trust-based relationships to mutually benefit fintechs and established banks. In this regard, and contrary to most other industries, fintechs must be operated by experienced founders with a clear vision since investors expect founders to run the business successfully from Day 1. To stay competitive, especially internationally, digitization and technologies should be promoted both by governmental institutions and companies themselves. With scalability as one of the key criteria identified, fintechs should maintain their ability to implement new processes in an agile, rapid way to succeed beyond their domestic markets [11].

Based on the results of the theoretical review, we developed an interview guide covering the most important factors for funding decisions from current research. The insights from the literature were challenged through semi-structured interviews with 12 industry experts, including founders, investors, and advisors. We then used qualitative content analysis [12] to analyze these experts' main statements and answered the research question using both the literature and the empirical findings. This paper first describes the results from the literature review and the interview methodology before discussing the empirical results, limitations, and finally suggested directions for future research.

2. Selected Literature Review

2.1. Fintechs and the Traditional Banking Market

Fintechs are the focus of increasing investment and interest, with a KPMG study on the fintech market finding the value of global deals in the first half of 2018 had already exceeded the total amount for 2017 [1]. New regulations like the German Second Payment Services Directive (PSD2) and the European General Data Protection Regulation (GDPR) have boosted fintech development [1], and the costs of implementing new regulations have provided the foundation for disruptive technologies that provide more efficient and compliant systems [13]. Following the definition of Arner et al. [7], this study examines the "Fintech 3.0" phenomenon that began after the 2007–08 global financial crisis [7,14]. The largest fintech market developed in the United States, followed by the United Kingdom (the largest, most relevant fintech market in Europe) [15]. Since fintechs in Europe and the United States began to evolve after the global financial crisis, their characteristics and backgrounds differ from Asian fintechs, which in particular offer solutions for lack of existing banking infrastructures [7].

According to Haddad and Hornuf [15], fintechs can be established more easily in well-developed economies, where the infrastructure and market regulations already exist; this infrastructure, plus affordable technology, is critical to creating financial innovation that is sustainable and unique [16]. Haddad and Hornuf [15] also argue that fintech formation takes place more often in economies in which access to loans is more difficult. Following this argumentation, scalability plays a key role in new financial start-ups and fintechs' profits remain quite small until a scalable number of customers has been convinced. This scalability of processes can be achieved by platform creation, which leads to economies of scale and, hence, reduced costs and user networks being built—a key concept applied in the sharing economy [17]. Additionally, Ozili [18] notes that financial inclusion can positively affect the economy in terms of poverty reduction and economic growth, and innovations in digital finance can positively influence banks' performance and profitability. Fintechs' key advantages are greater

control of customers' personal finance, rapid financial decision-making, and the ability to make and receive payments within seconds [18,19], although this results in a "trade-off between efficiency and [data] security" [18].

In terms of the economy's effect on fintech development, Claessens et al. [20] found the country's GDP and a less competitive banking system boost fintech activity, especially in the field of credit. From a regulatory perspective, the greatest challenges are then to ensure both consumer and investor protection and to guarantee financial stability. Claessens et al. [20] also analyzed fintechs to address the principal-agent problem (e.g., in crowdfunding or lending in general) by offering real-time data via platforms, with the platform "act[ing] as an agent for the investor" and hence helping the investor balance risks.

Most fintechs specialize in one market segment, with the main advantage of new technologies and data use being lower transaction costs and more convenient processes [20]. However, fintechs can create value in all fields of the financial sector, using different business models and in both the business-to-business (B2B) and business-to-consumer (B2C) markets. The most common models are:

- Payment business models
- Wealth management business models
- Crowdfunding business models
- Lending business models
- Capital market business models

Hence, the business itself is comparable to traditional banking but faster, safer, and at a lower cost [2]. Within this context, there are different approaches to define the structure and characteristics of fintechs. Zavolokina, Dolata, and Schwabe [21] found that fintechs create value not only for banks but in all fields of the financial sector, with the main conditions for fintechs being that technology, organization, and cash flow are needed to create new or disrupt existing, products and services. Fintechs combine technological innovations with the financial sector and contribute to the change from a product to service industry in finance, they write.

The financial market is characterized by the costs of risk aversion due to asymmetric information, resulting in the demand for "new products, services and instruments that can better satisfy financial system participants" [17]. Thus, financial innovations should lead to better investor decisions and, hence, greater investment [17]. Using big data and digitized solutions [22], fintechs present several key advantages: reduced costs for both companies and fintechs and the ability to conduct and see all actions in real-time [13]. Financial technologies strive to make financial services more accessible, efficient, and affordable for customers and change the way traditional services are provided. Hence, fintechs represent the digitization of the financial industry [23].

As with other sectors of the digital economy, fintechs often exploit regulatory loopholes or "conduct business as if the rules did not exist and ask for forgiveness" [24]. Nowadays, customers choose the best service from a variety of companies, and traditional financial institutions increase their investments in external financial start-ups to stay competitive—meaning a noticeable migration from traditional financial services to fintech services. Collaboration between fintechs and established players can take different forms (e.g., partnering, outsourcing, or investment as a venture capitalist).

Fintechs significantly improve service quality by using technologies to build up networks using big data [25], and in this way, real-time data value-creation plays an important role in trust management for potential customers [26]. For traditional financial institutions, fintechs can hence be an excellent source of new innovation in competition. Additionally, fintechs can create technical processes for banks to improve their data security and privacy, meaning banks can use fintechs as an alternative to adopting their own processes according to new regulatory requirements, and start-ups can create new services to meet the demand for risk reduction, privacy, and data security [26].

Goldstein, Jiang, and Karolyi [27] underscore the changing pace of new technologies and suggest that start-ups collaborate with established information technology (IT) companies to introduce new

products and services. The greatest advantage of these new businesses, especially in the digital economy, is the ability to save costs and hence enhance efficiency [28]. Networks, which are provided by platforms, create new methods to add information and reduce asymmetries, which improves trust. Since there is no clear definition for the term "fintech," Figure 1 provides an overview of the most important characteristics identified.

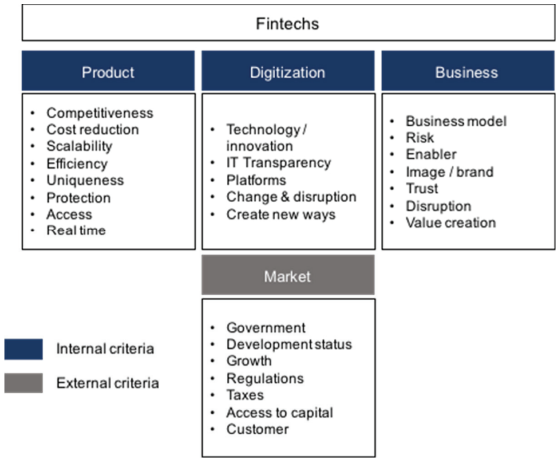

Figure 1. Characteristics of fintechs (own representation based on prior literature).

2.2. *Investor Decision-Making*

A broad range of literature is available on decision-making criteria for funding new start-ups. To create a suitable framework, we have collected all criteria from the literature and then assigned each to a category based on earlier research (e.g., [11,29–33]) or on the context in which the influencing factor is mentioned within the respective paper. Since the business is mainly affected by both organizational factors and the company's environment [3], each criterion adheres to either an internal or an external effect or characteristic of the business [34].

2.2.1. Internal Decision-Making Criteria

Management Team/Founder Criteria

Studies have observed the importance of the founder or management team, finding these individuals to be the most important decision-making criterion for investors [35]. According to the literature, both "soft" and "hard" factors related to the team interest investors, such as the team's experience in terms of the business and industry [11] and the team's personality and characteristics [30,36]. Thus, investors' most important activity prior to funding is to obtain a full picture of the founder and each team member [37]. Additional important criteria for investors are social networks and the reputation of both the business and management team. Networks play an especially important role based on the platform-building for new businesses in the sense that a community of supporters and motivators can be built. This networking idea is affirmed by Gerber and Hui [38], who analyzed decision-making in crowdfunding campaigns (which is also a way for new businesses to become funded); in this regard, founders' social ties are the main influence behind the investment decision [9]. Examining the differences between B2C and B2B businesses, Jovanovic, Brem, and Voigt [39] affirm the positive effect of management team skills for investments only in the B2B market; they found the team does not have a significant effect on investment decisions in B2C businesses.

Business and Deal Criteria

Depending on the stage—and particularly for screening—the business plan can be especially important due to the deep business insights it can provide to potential investors, according to Fried and Hisrich [37]. Additionally, the significant challenges in terms of the business model can be evaluated and weighed by screening the business plan. Due to young business' high degree of flexibility and changes, the business plan can hence help investors evaluate performance estimates and the amount of involvement that would be needed [40]. However, Kirsch et al. [36] determined the business plan has only a ceremonial character and found no evidence that it affects the investment decision; although some content elements do influence investors, the business plan alone is insufficient for communication purposes.

Product Criteria

Especially in B2B businesses, the product is the key decision criterion [39]—not only the product itself but also its development status, the technology behind it, and protectability, among other factors. In nearly all the papers screened for this study, investors use product-related evaluation as a criterion during their decision-making process. For example, Hoegen et al. [33] underscore the importance of technology in current investment decisions in their study on the differences between traditional financing and crowdfunding. Although their study focuses on crowdfunding rather than general investment, other research demonstrates the trend of technology-driven businesses (e.g., [41]) and that products' technology contributes to the uniqueness of services and hence builds competitive advantages within the market (e.g., [9,29,41]).

Financial Criteria

Most important for investors in terms of financials are potential returns [29,32], with Brem and Wassong [42] and also Gerber and Hui [38] finding this estimated return can even have a greater effect on investors' decisions than the product offering. Alongside this monetary return, companies must consider the exit, which is an investor's opportunity for liquidity [37]. Estimated potential and access are always correlated with the risk of loss, meaning financial motives can lead to syndication on the investor's side due to risk-sharing opportunities [43]. Potential value mainly depends on the general market situation, which operates cyclically; especially in periods of high risk, businesses are more likely to fail but will create comparatively more value when succeeding [44,45]—a financial evaluation validated by a significant body of research on the determinants and key performance indicators surrounding financial decision-making criteria [11].

2.2.2. External Decision-Making Criteria

Market Criteria

In their study on the connection between labour regulations and venture capital, Bozkaya and Kerr [6] found that, in contrast to employment law, labour market regulations and employment protection can have a negative effect on investors' decisions. In this regard, venture capitalists see labour adjustment costs as a significant negative influence on their decision. Bozkaya and Kerr [6] argue that "strict labour regulations hinder venture capital investments, especially in sectors with high labour volatility." In addition to the market and industry conditions [6,11,29,41,46], market criteria also include the investment opportunity's strategic position, according to Muzyka et al. [31]. In this regard, the market's growth potential has been identified as the key factor [35,47], with Tyebjee and Bruno [48] developing a decision-making framework that includes market attractiveness (including the market's size, need, and growth potential, as well as access to the market).

Investor Criteria

Both hard and soft factors are important to consider in terms of investors themselves. Basic characteristics such as gender, age, and background impact attitudes around risk and, hence, investor behaviour [49]. Additionally, individual experience and preferences affect investment [41,44], and one significant criterion mentioned in the literature is the new business' geographical proximity to the investor. Investors mainly support nearby projects that can then also benefit them [42],

although Agarwal, Catalini, and Goldfarb [50] found proximity itself is not the key consideration but rather social networks, which are often mainly located in close physical proximity. Additionally, according to Schwienbacher [51], the percentage of investors who prefer investments with regional connections is even higher in Europe (53%) than in the United States (43%). A core finding of the current literature is that an investor's focus when evaluating a business depends on the type of investor. Taking financial criteria as an example, the financial model could affect the evaluation [11], but empirical evidence also shows that finances are not considered that important by early-stage investors [47].

In terms of information asymmetries due to the principal-agent problem between investors and entrepreneurs, these asymmetries can be overcome by providing sufficient relevant information for investors to thoroughly evaluate the company [52]. The investor's peer group also offers orientation in terms of which companies they consider trustworthy [53,54]. As described by Pollari and Ruddenklau [1], significant differences exist between the stages and the investment amount—meaning with the amount invested rising, the criteria for the funding decision become more complex. This could also be a reason that more literature exists on venture capital investments compared to other types of investments.

Figure 2 summarizes the funding criteria identified in this section and demonstrates the importance of personal and people-oriented characteristics on both on the investor's and founder's side. Subjective negative feelings cannot be compensated for through other criteria: The investor needs to trust the abilities and experiences of the management team, while the founder needs to be open to external ideas and input [40,41]. This personality-oriented approach could part of the reason that no consensus exists on precise investor decision-making criteria [46].

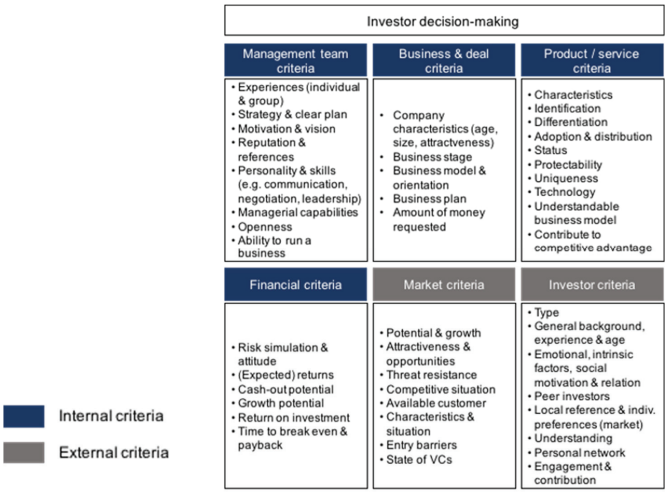

Figure 2. Investor decision-making criteria for start-up funding (own representation based on prior literature).

3. Materials and Methods

Following the approach of Brem and Wassong [42], this research uses a literature review and expert interviews. All relevant criteria in terms of investor decision-making and defining fintechs were collected in the literature review, which was used to create a guide for the interviews.

3.1. Data Collection

3.1.1. Interviews

Conducting interviews has been a widespread method in research to analyze venture capital decision-making criteria (e.g., [29,47]). This study involved conducting 12 interviews with advisors, founders, and investors in the field of fintechs based on an interview guide. All but two interviews were conducted by telephone, and the interviews were generally standardized but flexible in terms of additional questions and focus-setting. Following Bell, Bryman, and Harley [55], the interview guide covers a broad range of questions organized into three sections, starting with the most general questions, leading to the topic-related specific questions as the main part.

An important reason to use the semi-structured interview approach is because, in structured interviews, questions need to be asked at the same point in each interview [55]; thus, to avoid the question order bias, questions need to be asked twice to maintain the original order and ensure interviews are comparable. For semi-structured interviews, the interview guide can be used as a checklist to ensure all required information has been obtained [56]. The interviews in this study were designed as a combination of expert interview and semi-structured interview, consisting of open questions based on the theoretical background [56]. During a semi-structured interview, the interviewer can change or adjust the questions during the conversation, and it is possible to add or skip questions or change their order, following the interviewee's response. Hence, the results include much of the interviewee's subjective experience [57].

3.1.2. Sample Selection

Expert selection criteria were based on Meuser and Nagel's [58] approach. The main characteristic of an expert is specialized knowledge in the relevant research field, which is not accessible to everyone [58]. Although one's position is not the only source of knowledge, privileged access to information in fintechs is based on experience, meaning expert criteria for this study could include their being responsible for the drafting, implementation, or control of a solution to a problem in line with Meuser and Nagel's criteria [58]. Table 1 summarizes information on the interview sample and the interviewees.

Table 1. Interview sample (F = female; M = male).

# Gender	Date (dd/mm) 2019	Current Position	Background/ Experience	Location	Interview Length (in mins)	Medium
1 M	26/06	Fintech Advisor	Board Member, Mentor, Conference Host	Germany/Singapore	38:13	Phone
2 M	05/07	Member of Advisory Board	Board Member, Speaker, Co-Founder, CEO, Advisor	Germany	47:43	Phone
3 M	10/07	Fintech Co-Founder, CEO	Consultant, Financial Analyst, Advisor	Switzerland	n/a	Written
4 M	16/07	Fintech CEO	Positions in Different Companies, Business Angel	Germany	23:15	Phone
5 M	16/07	Fintech Advisor, Consultant	Consultant, Strategic Advisor, Co-Founder	Germany	29:35	Phone
6 M	19/07	Fintech CRO	Head of Risk and Other Positions in Banks	Germany	28:35	In-person
7 M	21/08	Fintech Co-Founder, President, CFO	Board Member, CFO, Consultant	United States	23:51	Phone
8 M	19/09	Founder of Venture Builder	Consultant, Co-Founder, Board Member	Finland	39:37	Phone
9 F/M [1]	24/09	Strategy (Fintech), Consultant (Bank)	Project Management	Germany	28:01	Phone
10 M	25/09	Board Member, Investor	Investor, Board Professional, Business Angel	Finland	31:18	Phone
11 M	25/09	Venture Capitalist, Entrepreneur	Founder, Board Member, Advisor, Mentor	United Kingdom	31:34	Phone & Written
12 M	18/10	Manager—Fintech, Innovation, Digital Transformation	Different Positions in Marketing and E-Business	Germany	51:35	Phone

Note: [1]: During Interview 9, two interviewees with very similar positions answered the questions. As their answers were congruent and only enhanced each other, the interview was handled and evaluated as one interviewee.

3.2. Data Evaluation

In accordance with Gläser and Laudel [59], all interviews were recorded and transcribed. Verbal statements were the main focus of transcription, and non-verbal expressions were only transcribed if they changed the interviewee's meaning. In preparation for analysis, all interviews were anonymized [59].

Qualitative content analysis of the interviews followed the approach of Mayring and Fenzl [12] and involved statement categorization as the most important analytical instrument. Top-level categories were broken into additional subcategories [12], allowing for large amounts of data to be analyzed while maintaining consideration of individual pieces of text. The results were analyzed and interpreted [60] following an inductive approach, with the interview statements summarized to find categories that could be assigned to the information prior derived from theory [12]. Qualitative content analysis is a rule-based method of evaluation [12], and we followed the analytical steps defined by Mayring [61]; each interview corresponded to one evaluation unit, with the level of abstraction for building the categories in Table 2 directed intuitively toward—but always oriented on—the categories derived from the theoretical background [60].

Table 2. Category system.

Type of Category	Name of Category	Description
Top Category	***Internal***	***All criteria related to the company itself***
Main Category	Management Team/Founder	Criteria related to the characteristics and experiences of the management (team)/founder, both in terms of the company/business and the operating market
Main Category	Business	Criteria describing the business in terms of key facts and general orientation
Main Category	Product/Service	Criteria related to the product and/or service offered by the company (including, for example, distribution channels, marketing activities, and product differentiation)
Main Category	Technology	Criteria describing the new business innovations and advantages resulting from new disruptive approaches and development (focusing on technologies related to the financial industry and products across financial areas)
Main Category	Financials	Criteria defining the financial situation and the outlook of the business and its products, including financial risks
Top Category	***External***	***Criteria determining the business externally related to stakeholders or conditions***
Main Category	Economy	Criteria defining the market in which the company is operating, including economic developments and conditions
Main Category	Investor	Criteria describing the investor, his/her character, and his/her business-related background and experiences, which affect his/her decisions; the degree of involvement is also covered

To ensure validity and repeatability, four interviews were coded by a second person (unfamiliar with the topic) to test the logic of coding. The second individual's coding was fundamentally identical to the study coder's (one of the author's) coding, and thus, the remaining interviews were evaluated by only one person. Nevertheless, a second intrapersonal coding took place for all interviews [60]. Based on the results of the 11 prior interviews, the authors returned only to Interviewee 12 to achieve clarification on some statements.

4. Results

As Table 3 illustrates, the interviews indicate that investment decisions mainly depend on the team of founders, the criteria describing the business, the product or service offered, the technology, the financial criteria, the economic determinants, and the investors.

Table 3. Results from advisor's and startup's point of view.

	Economy	Investor	Management Team/Founder	Product/Service	Financials	Technology	Business
Advisors	Regulation & politics (I1, I5, I8, I9)	Background (I8)	Amount of information (I1)	Idea (I1)	Earnings (I1), in the long run (I2)	User experience (I5)	Business plan evaluated carefully (I9)
	Government to push change (I1)	Bad experience w/trad. banks (I2)	Ability to attract investors (I2)	Current & past developments (I11)	Profit (I2) & rate of return (I11)	New data usage (I10)	Business model (I1, I10)
	Benefits for customers (I2, I5, I9)	Connection (I10, I11)	Ability to demonstrate growth (I11), sales (I2)	Attractiveness (I2) & customer centricity (I1)	Create value (I8)	Differences b/w B2B & B2C (I10)	Flexibility (I9), innovation & agility (I5)
	Customer's risk aversion (I11)	Contribution (I10)	Technical knowledge (I9), know-how & drive (I1)	Price included in process (I8)	Cash flows (I10)	Disruption & extension to new industries (I9)	Less complex (I5)
	Data security no disadvantage (I9)	Friends & family unusual (I5)	Ambition (I11) & independence (I1)	Niche (I9)	Forecast (I5)	[Internal (I5)] efficiency (I10)	Development capacity & speed (I9)
	Data protection (I10)	Interests (I8)	Vision & clear strategy (I9), clarity/idea (I8)	Marketing (I1) & make customers willing to pay (I8)	Key performance indicators (I11)	Innovation (I5, I9) & Innovation power (I10)	Speed in business development (I1, I5, I9)
	Instability (I11)	Involvement (I1), at board level (I5)	Connected (I8), to market (I8)	Prototype (I5, I9)	Margins (I11)	Internet-based (I11) & mobile services (I1, I9)	Customer relationship (I9)
	Mass audience (I11)	Involvement (board & operation; network & experience) (I10)	Experience (I5, I8, I11) & market know-how (I9)	Product demo (I5) & development (I1)	Sales (I1) & revenue (I1, I5, I9, I11)	Financial Inclusion (I1) & beyond banking (I9)	Targets & traction (I8), B2B (I5) & B2C (I9)
	Competition (I1, I5), location (I5)	Location (I1), depending on fund (I5)	Heterogeneity (I9) & gender (I1)		Mass/scalability (I2)	Data protection as enabler (I5)	Global approach (I5)
	International development (I5), Language (I11)	Other investors & herd instinct (I11), herd instinct (I1, I9)	Independence (I1)	Solution (I1, I9) of meaningful problem (I11)	Scalability (I1, I5, I9), by going international (I11)	Platform (I1, I5), connection through platform (I11)	Capital requirements (I5)
	Market entry barriers (I5), market access (CLV & CAC) (I8, I11)	Personality (I1) & strategy (I9)	Personality (I10) & self-confidence (I1)	Niche (I9), unique selling point & value add (I2)	Burn-rate (I11)	Technical possibility to realize things (I9)	Entity (I5), corporate culture or governance (I2)
	Market conditions (I5), size (I8) and market growth (I1)	Risk attitude (I1, I5, I9, I10)	Less influence of character (I8)	Viable commercial model & MVP (I11)		API (I8) & automation (I5)	Customer relationship (I9)
	Market changes (I2, I5), lead to uncertainty (I1)	Stage (I2, I5) & type (I1, I2, I11)	Language (I9) & similarities in culture (I10)	Rewriting & retooling of existing services (I11)		New methods (I5), offerings in a new way (I2, I10)	
	Market reputation (I5)		Personal contact to team (I5) & team qualities (I1)				
			Trustworthiness (I5) & reputation (I11)				
			Understanding (I11) & timing (I10)				
Startups	Customers (I6) & available market (I7)	Type (I6), e.g., sweats for equity venture capitalists (I7)	Skills (I4) & experience (I3, I6, I7)	Idea (I4)	Cost Advantage (I4)	Innovative solutions & customer enablement (I6)	Business model & business plan (I7)
	Data security (I6)	Business Angel (Type) (I4) & BAs directly involved (I3) / ongoing interaction (I3)	Impression (I4)	Designed for enhancements (I4)	Efficiency (I3, I4)	Progressive strategy (I4), efficiency (I3), easier & faster (I6)	Business stage (I7)
	Data protection leads to value add (I4)	No (I7) / Careful with family & friends (I4)	Independence (I4)	Marketing mix (I6)	Return (I7)	Software (I4) & IT (I6)	Business information (plan & personal) (I3)
	Regulations (I4) as a risk (I7)	Location (I7), [close (I4)] relationship & involvement (I7)	Network (I3)	Simple (I6) / MVP (I7)	Risk & valuation (I4)	Mobile & digital applications (I6)	Create brand (I7)
	Market changes (I6)	Herd instinct influence trustworthiness (I7)	Passion & [clear (I4)] vision (I3)	Utilize technology to service (I7)	Scalability (I3)	Platforms (I7) as ecosystem (I4), Data (I4) ecosystems (I7)	Quick decisions & speed (I6)
	International developments & risks (I7)	Newsletter for friends & family (I3)	Personality, e.g., during direct pitching (I3)	Distribution model (I4)		Connection through website as platform (I3)	Speed in business growth (I7)
		Stage: strong long-term relationship, later more related to numbers (I7)	Age (I7) & CV (I7)			Transparency (I3, I4) & regulations as benefit (I7)	B2C (I6)
		Strategy about time to fund (I4)				Open access (I3) & service integration (I6)	

4.1. Internal Criteria

Management Team/Founder

The management team/founder's importance changes over time. The management team plays a key role in particular at the beginning of the funding process. As Interviewee 10 noted, "In the first phase, it is the case that the funds do not have such great interest. First of all, there is no financial data. Often there is no product and the turnover is zero. It's only about investment to develop the technology. So, there is actually only the people behind the company." The management team forms the basis to successfully promote a technological product that is solving a customer problem, with management's experience, age, and CV having been mentioned by interviewees as especially important; these factors are mostly correlated and interdependent, and the management team should have high heterogeneity in terms of know-how to cover diverse business fields.

Business

For fintechs, rapidity is important both in terms of market entry and in terms of finding collaboration partners or investors. In this regard, it can be essential to be the first player and grow quickly. Due to specialization and collaboration with banks, most fintechs are active in the B2B market environment, although B2C fintechs can be more successful from a revenue perspective (but require greater up-front investment). Since the capital requirements for a new financial start-up are quite high in general, most fintechs offer their services to banks and businesses instead of directly to consumers. Compared to established players, fintechs are more flexible in terms of adapting to changing market conditions. For investors, the business stage determines their decision as to investors' investment focus.

Product/Service

Fintechs' products and services should generally solve a customer problem, and most products serve a niche market. The problem of product imitation is not currently visible in the market for several reasons: The high complexity of IT makes it difficult for competitors to copy, and only companies with a unique selling point will survive—meaning patents can be seen as an advantage but are not a key criterion for potential investors or partners. Alongside the product itself, distribution and market positioning must be clear.

All interviewees said the product is essential to prospective investors' decision and is seen as the first touchpoint with the potential start-up partner. Interviewee 9 said, "The solution will definitely appeal to me; that's why I'm talking to this fintech or they're talking to us." In the beginning, it is not only about paper-based pitching but also presenting a prototype, which does not need to work perfectly but must highlight the product's basic functions. To ensure customers' willingness to pay, the product needs to be easily understandable. Hence, from the investor's point of view, most lucrative services adapt existing ones in a new and easier way.

Technology

Fintechs' technological advantage over traditional financial institutions is their key driver of success and competitive advantage. Fintechs' technologies should have a value-add for the customer ("customer-centricity"), and mobile and data-based services can enhance efficiency. Another characteristic of fintechs is their ability to connect people or services through platforms: "[W]hen you create a meaningful connection between, like, two endpoints interacting through your platform, then you can charge sometimes exorbitant fees and benefit from this connection" (Interviewee 11). Web- and data-based platforms are important for creating new services. Hence, products or services can be connected with other services from different industries, which leads to value creation for customers. Since the technology should be usable, it needs to be easy, fast, and understandable. Therefore, technological complexity needs to be reduced.

Financials

A key requirement of fintechs' new technologies is the scalability of products and services. Scalability is based on having a notable number of lucrative customers who use the technology and generate sales and revenue. Investors use different key performance indicators to determine scalability, which requires companies to first generate data or sell products. Hence, financial criteria can only be

used at a later stage of the investment process, and a financial plan (e.g., a business plan) can provide a first impression, albeit one that should be used carefully.

Financial success is generally achieved by a well-established company that also delivers on the other criteria. Interviewee 10 notes, "[Doing] the right thing at the right time and well packaged, then you can achieve cash flow pretty quickly." Heavy competition also means businesses "that work globally will always triumph over regional suppliers" (Interviewee 5), and so the global approach is a major driver of success.

4.2. External Criteria

Economy

The majority of interviewees mentioned the competitive context shaping the fintech market, including both new start-ups and traditional banks. Diverse international developments in fintech markets are the result of banking-market infrastructure differing between developed and developing countries. Comparing Europe and Asia (and specifically from developing countries in Asia) illustrates this contrast: Europe fintechs are mostly an addition or collaborative partner for banks, while Asian financial start-ups build a new base for banking because "beyond Germany . . . 2.5 billion people have no access at all to money and an account" (Interviewee 2). Hence, the missing banking infrastructure pushes fintech development forward and speeds it up.

This process is also subject to regulatory requirements, which differ significantly among countries. Whereas potential investors and partners in Germany prefer start-ups that are already familiar with regulatory requirements, for example, this familiarity plays a subordinate role in some markets (e.g., the United States). Almost all European interviewees mentioned the current regulatory situation as a strong influence on investment. For fintechs, regulations and other barriers to market entry can have an enormous effect on their success and attractiveness to potential investors. Interviewee 12, for example, highlighted the importance of regulatory status and mentioned German regulations to be a potential threat to fintech development. Furthermore, the most important element for investors is an available market in terms of scalable customers. Interviewee 2 recommended, "Don't look at the relationship with your investor; look at the relationship with your customer." There are international differences as well. For example, German customers have a high level of risk aversion and so data-security rules play an enormous role in this market; Interviewee 5 believes that "it is especially a German problem that data is always dramatized in such a way."

Investor

The study sample included a diverse range of investors, and the differences in their responses indicate how different types of investors value decision-making criteria differently. Regarding geographical proximity, most interviewees said that it is not about the location itself but rather the investor's network in a specific area and the cultural and language similarities. Interviewee 10, in particular, discussed the importance of the investor's influence and involvement, as well as the investor's desire to contribute to the company and bring in his network and contacts to manage the fintech successfully in his role as a business angel (an individual who is usually involved in the company early and want to contribute to and have a close relationship with the company). Interviewee 4 emphasized investors' influence and said from his experience as a business angel, early-stage investors help companies establish contacts and both advise and participate in decisions on strategic development.

A balance must be struck between involvement and independence. Most investors also want to see who is already involved and what other connections exist, and several interviewees mentioned decisions based on this "herd instinct." The most important result in terms of the investor is that involvement depends mainly on the stage at which they enter the business and the type of investor. Especially at the beginning, investors want to bring their connections and experience into the company; at a later stage, though, the management team should be able to act independently and investors only advise. In fintech, banks are both providers of money and collaborators. Bank groups in particular

partner with fintechs to ensure their technological development and innovativeness, collaborating to build new, more disruptive business models and enhance their portfolio through new services (e.g., beyond banking products).

Table 3 demonstrates that investors have a much broader picture of the entire decision-making process and of influences in the fintech market than founders do. Many similarities exist between funding decisions in financial start-ups and those in other businesses, and the investment decision is determined by both hard and soft factors. Figure 3 depicts the founding cycle and highlights that the most critical criteria depend on the respective investor type.

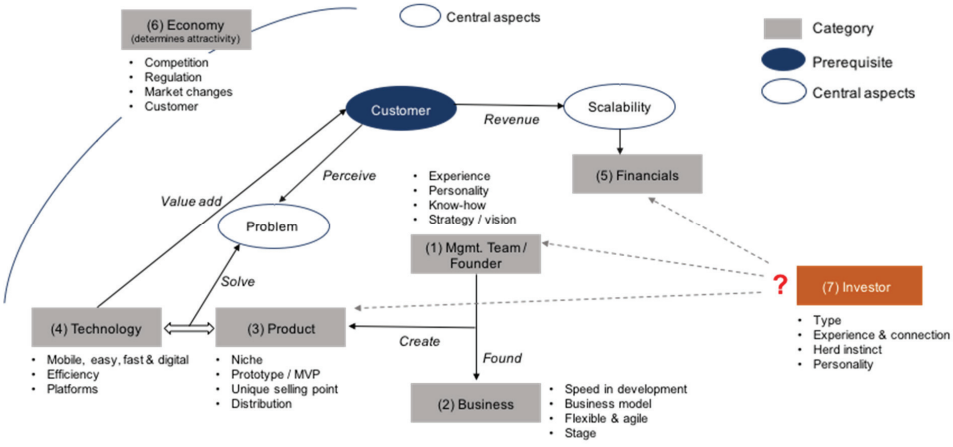

Figure 3. Grouped interview results on decision-making (own representation).

5. Discussion, Implications, and Limitations

This study aimed to combine decision-making and trends related to new fintech start-ups to determine *which components attract investors most when they are deciding whether to invest in a fintech company*. A key result is that this question has different answers depending on the funding stage and investor focus. Both the literature and the empirical results demonstrate the importance of the *management team* for early-stage investors, which is true for most businesses in the digital economy. The management team must have a clear vision and a strategy for running the business successfully to earn investor trust; in particular, founders with broad subject experience and relevant market experience can gain investors. During pitch sessions, team members must be able to convince potential investors of their ability to distribute the product and find further investors. Nevertheless, depending on the business' stage and position, the management team could be replaced as a leading criterion by other criteria, such as generated revenue. Business angels' interest in founders' personality in particular results from their close connection and collaboration during the business' initial stages, with gender also to surface as thereby impacting investors' decisions.

Regarding investors' involvement in the company, no clear consensus emerges. For some interviewees, direct involvement and responsibility (e.g., on the board) are of the utmost importance; others, however, feel the management team should be able to run the business successfully on their own. Therefore, this study cannot fully affirm the results of earlier research [62,63]. Although regular meetings and discussions should take place, later-stage investors do not want to proactively influence management decisions. The empirical results also do not see geographical proximity as an important factor in the decision to invest [42], although investment mostly does have a local character that is not due to the location but rather to cultural consistencies and an available network. In general, investors are open to investing in companies located far from their original market if all other determinants meet their expectations. Whereas for the founders funding through friends and family is mentioned as a

useful source of capital at the beginning, investors see this kind of funding critical, providing no clear indication of its general relevance in funding decisions [64].

Depending on the business' maturity, the type of investor fundamentally determines the investment decision. This result is found both in the literature [42,65] and this study's empirical findings. Trust between founder and investor is key to a successful partnership; this is in line with Harrison and Mason [62] and with Moritz et al. [53], who found that an investor's decision is subject to emotional and intrinsic motivation. Another phenomenon affirmed by this study is that investors follow investment trends.

Additionally, in line with the findings of Angerer et al. [32], this study found that financial data is one of the investors' main motivations. Along with the few key performance indicators described in available research, this study's interviewees underscored the importance of efficiency to generate the expected revenues, as financial performance measures are scarce for innovation activities [66]. Interviewees also said scalability is of the utmost importance in generating revenues. The literature also mentions scalability and growth potential [35,47], and thus, fintech start-ups should strive to set up their business with scalable products, as scalability is one of the key characteristics of digital economy business models [67,68]. Based on customer availability, investors focus on scalable products for which the customer is willing to pay. Therefore, potential investors are especially interested in seeing prototypes—a requirement that is not yet included in the literature. Modern investors are no longer only focused on potential numbers but also on existing prototypes and processes, which fits Kirsch et al.'s [36] finding that fintechs' business plans have only a ceremonial effect. Nevertheless, this study cannot fully resolve uncertainty about the business plan's role since the plan has been mentioned by interviewees as an essential source of information but a clear focus also exists on a product prototype and method of using technology to service. Despite this technological part, the protection of this service, as analyzed by Maxwell et al. [11], was not confirmed during the evaluation of this study's empirical results. Although it can be seen as positive, investors do not appear to care much about this criterion.

In terms of the banking sector, this study's results enhance the current state of the literature in highlighting that fintechs serve a niche market and, unlike traditional banks, focus on a special product or service. Additionally, prior literature has focused on general digital aspects of technology in the financial industry and changes to existing services by using new technologies (e.g., [14]). This study deepened insights in this field and highlights that from a technological perspective, fintechs should enhance the efficiency of services and reduce costs to attract investors. Technological implementation, related digital economy business models, and integrating services from different areas allow businesses to provide offerings beyond the traditional banking boundaries. Both the literature and empirical evidence indicate that based on digitization and the implementation of platforms, fintechs can offer new ways of doing business in the banking market.

Market-related research exists on how economic conditions affect investors. In banking, companies' current situation is shaped by uncertainty and instability, resulting in an increasing amount of regulations in this sector. Regulatory requirements are seen as having a significant impact on both the business environment and technological opportunities, while companies in the digital economy often exploit regulatory loopholes [13,24]. Related to market potential [11], investors want to see how customers can be accessed and do not focus on technological protection from imitation in their discussions. Nevertheless, the study analysis reveals that protection by building market entry barriers [41] is important.

In general, the study findings related to fintech investors' decision-making are in line with findings from prior literature in the field of business angel and venture capital investment, showing few differences between fintechs and other digital economy business models or more traditional markets. However, including banks as investors in this discussion offers a different perspective: Since banks are not only investors in fintechs but also often stakeholders, their position has changed compared to that with other start-up investments. Little research focuses on banks' business funding compared

to traditional debt investments even though banks are a major source of funding for start-ups and remain the largest investors in business funding [69]. In general, banks can boost the start-up market by providing easy access to money in both developing and developed countries [70]. According to this study and earlier research [2], regulation is a driver of technological development—especially in the banking environment—and can be converted easily by fintechs in the digital economy. In this regard, a major advantage of young businesses is their more rapid and agile development capacity, which makes them an intriguing partner for traditional banks. Hence, this study demonstrates, banks and fintechs' current interdependence is due to valuable support in implementing new regulatory requirements. Therefore, unlike with other start-ups in the digital economy, banks are not solely investors but also partners (or competitors). Whereas in other markets, start-ups ask banks purely for funding, fintechs can be seen as essential for banks to increase their innovativeness and to help to meet and implement regulatory requirements.

5.1. Implications

Implications for Research

This study examines current research in the field and enhances it in terms of decision-making criteria for funding fintechs. By providing deep insight into investor behaviour, this study highlights that investors' decision-making criteria mainly depend on the type of investor and that the business stage plays an important role in the decision to invest due to changing objectives. Criteria for investment are interrelated and should not be considered separately. Additionally, in the context of the significant changes currently occurring in the banking market, the study results underscore the importance of technological development amidst market uncertainty. Although the body of literature on decision-making is already well-established, this study found additional criteria for the financial industry and found the context surrounding fintechs to differ from the available literature in terms of confirmed factors. The broad range of interviewees also provides insight from different perspectives to gain a clear and complete view on the topic, and the study notes the lack of research on bank investors and includes the changing position of traditional banks within the current market and the digital economy.

Implications for Practice

Companies should provide omnichannel offerings and create new solutions for customers combining services (beyond banking). As with many markets in which new entrants from the digital economy operate, specializing in single services could lead to future consolidation in the financial market. Fintechs and banks would both benefit from collaboration founded on trust, and government entities and companies should push digitization and technologies to remain competitive, including internationally. Fintechs must maintain their ability to implement new processes in an agile, rapid manner to remain an interesting partner for banks and receive investor attention, as "the sharing economy will become more fully embedded in financial services" [71]. Additionally, founders must consider a range of aspects when starting their business, including market determinants. Somewhat different from other endeavours in the digital economy, this study found, fintech businesses should only be started by experienced founders with a clear vision of how to begin and operate. Even though early investors are willing to support and invest in fintechs, as with other digital economy business models that can quickly become scalable, founders should be primarily able to run the business by themselves.

5.2. Limitations and Directions for Further Research

In terms of limitations, the characterization of venture capitalists depends on their business style, specialization, and firm size [8]; the age and experience of the venture capital firm itself and its geographical proximity to the fintech affect the method of investment significantly [51]. Hence, our experts represent only a selected sample. Additionally, this study's theoretical background is based on a broad range of literature from different areas of study and time periods. Technology firms in general, and fintechs and other digital economy business models in particular, operate in

a rapidly changing environment, meaning prior literature might not be up to date in terms of the latest developments.

It is also important to note that, following Swider, Barrick, Harris, and Stoverink [72], the interview's first few minutes are the most important in developing the interviewee's impression of the interview. Hence, the interviewer-interviewee relationship is largely created at the beginning of the interview and results are subject to these initial impressions. Additionally, although the study avoided this whenever possible, any interviewer intervention could influence the interviewee's response [55].

Despite extensive research on decision-making, the connection to certain industries and businesses is still underrepresented in the literature. Currently, research exists on B2B and B2C businesses in general (e.g., [42]) but without a focus on specific sectors. Decision-making in specific industries would be an interesting avenue for future research specifically in terms of stakeholders' changing positions and sector-specific singularities in the decision-making process. Especially in the continuously changing market environment (due to, for example, digitalization and technology), industry-related research can foster development in diverse fields to better understand approaches to create new offerings [28]. With respect to investment decisions, researchers and companies alike would thus better understand the prerequisites to successfully attracting investors.

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Sustainable Development of Fintech: Focused on Uncertainty and Perceived Quality Issues

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Abstract: Despite high expectations for the growth of Fintech, it has not reached the expected growth in the real world. As Fintech is innovative but inherently unpredictable, customers are still hesitant to adopt and use Fintech, which ultimately affects its growth. To achieve the sustainable development and growth of Fintech, an in-depth investigation of Fintech continuance intentions is required. To investigate continuous-use behavior in a Fintech context, this study focuses on two relevant issues: uncertainty and information technology (IT) quality. Uncertainty is more critical in Fintech than in traditional e-banking transactions because Fintech transactions are complicated and less predictable. IT quality is also crucial to Fintech success because IT plays a key role in Fintech transactions. This study mainly explores the relationship between uncertainty and IT quality, both of which significantly affect Fintech continuance intentions. For the purpose, we integrated an IT quality–based perspective with a trust-based model to investigate Fintech continuance intentions. Our results demonstrate that system quality is negatively related to perceived risk, whereas information quality is positively related to trust. Service quality is the most important quality factor for controlling uncertainty and encouraging continued use of Fintech. We found a more extended role of IT in Fintech than in other digital services. This study provides Fintech providers with the practical guidance in the design and implementation of Fintech innovation, thereby achieving the sustainable development of Fintech.

Keywords: Fintech; trust; perceived risk; system quality; information quality; service quality; Fintech continuance intention

1. Introduction

Fintech is revolutionizing traditional financial transactions. Fintech is fundamentally disruptive because its major innovations of the existing financial systems and other infrastructure lead to diverse, new financial business with their own sustainable ecosystem [1,2]. Fintech is also regarded as an engine for a sustainable economic growth as a new industry having different characteristics from the traditional financial industry. With high expectations for the growth of Fintech, global Fintech investments have increased significantly. KPMG [3] reported that global investment in Fintech has doubled more than six times, from USD 18.9 billion to USD 111.8 billion between 2013 and 2018. Although the acceptance and use of Fintech among financial customers is gradually increasing, in the real world Fintech has not reached the expected growth. As Fintech is innovative but inherently unpredictable like both sides of the same coin, customers are still hesitant to adopt and use Fintech, which ultimately affects its growth. Fintech providers have faced a challenge to retain users and promote post-adoption use. To achieve the sustainable development and growth of Fintech, an in-depth investigation of Fintech continuance intentions is required.

To investigate continuous-use behavior in a Fintech context, this study focuses on two main issues: uncertainty and information technology (IT) quality. Uncertainty is more critical in Fintech than in traditional e-banking transactions because the disruptive nature of Fintech make them less predictable. Much uncertainty exists because Fintech intrinsically involves no supervision of central authorities, the lack of safety nets along with opportunistic behavior of Fintech providers, region-specific financial regulation, financial fraud, criminal usage and hacks, all of which can lead to monetary losses and social damage [4–6]. Thus, the uncertainty makes users hesitant to adopt and use Fintech, and eventually affects the speed and scope of the transition toward a sustainable development of Fintech. Uncertainty can be effectively reduced by building high levels of trust and low levels of perceived risks, satisfying customers' expectations and retaining their loyalty [7–9]. In prior studies, the uncertainty in online and mobile transactions has been typically investigated by positioning trust and perceived risk [7–9]. Thus, to precisely investigate uncertainty in the Fintech context, both trust and perceived risk of Fintech need to be identified as well as their relationship with Fintech use. Although many studies have explored the effect of trust and risk on various digital services, little attention has been paid to theoretical and empirical validation in a Fintech context.

According to Arner et al. [10], Fintech is a financial sector innovation in which IT is a key element. Shin and Choi [11] pointed out that Fintech refers to IT-enabled financial solutions. Ernst and Young [12] highlighted the growing role of IT in Fintech, which is that of a true innovator, not a facilitator or enabler. They asserted that IT in Fintech transcends existing value chains and transforms services rather than simply improving efficiency. Given the key role of IT in Fintech innovation, customers may perceive IT quality as representative of overall Fintech quality; if users perceive that IT quality in Fintech is high, the likelihood of future use of Fintech may increase. That is, IT quality might be a crucial factor that facilitates the user's willingness to use Fintech, leading to the long-term sustainability of Fintech. Although many studies have underlined the importance of IT in Fintech, an empirical study of the effect of IT on Fintech use has not yet been explored.

Although uncertainty and IT play critical roles in a sustainable development of Fintech, few studies have explored the relationships among uncertainty, IT, and Fintech continuous use. A deeper understanding of the interrelationships among uncertainty, IT, and Fintech continuous use can help Fintech providers to effectively attract and retain users, thereby accelerating the popularization of Fintech. Therefore, we investigated Fintech continuance intentions by applying an IT quality based perspective to a trust-based model. To evaluate overall perceptions of IT quality in Fintech, this study employed three IT quality dimensions (i.e., system, information, and service qualities) proposed by DeLone and McLean [13]'s information systems success (ISS) model. We then examined how IT quality can improve trust and reduce perceived risk to improve user willingness to continue using Fintech. Given the key role of IT in Fintech, IT quality may directly affect users' continuance intentions by providing simple and speedy financial transactions, lower transaction costs, and temporal and spatial flexibility using mobile applications [5]. To validate the direct effect of IT on Fintech use, we conducted a mediation test of trust and perceived risk between IT quality and Fintech continuous use. That is, if no mediation effect exists between trust and perceived risk, IT quality should directly affect Fintech continuance intentions, demonstrating that high-quality IT by itself can retain Fintech users and facilitate Fintech use. However, a full mediation effect implies IT quality has only an indirect effect on Fintech continuance intentions, leaving no true innovator role for IT in Fintech innovation. Therefore, this study aimed to (1) investigate the direct effect of user trust and perceived risks on Fintech continuance intentions; (2) examine the direct effect of IT quality on user trust and perceived risk; and (3) determine the direct effect of IT quality on Fintech continuance intentions.

Drawing on data collected from 218 Fintech users in South Korea, we empirically validated the interrelationships among three IT qualities, trust, perceived risk, and subsequent Fintech continuance intentions. To ensure a sustainable development of Fintech in the long term, this study provides timely insight into how trust and perceived risk affect the diffusion of Fintech innovations and how IT quality affects uncertainty and subsequent user intentions of Fintech. Our study can help practitioners

and policy makers appropriately incorporate IT into their service development to improve innovation success, thereby achieving the sustainable development of Fintech.

2. Theoretical Background

2.1. Fintech Viewpoint

The pace of technological change is ever increasing and ever more transformative. IT innovation accompanied by process disruption and service transformation has dominated the financial service industry in recent years [14]. The term "Fintech" refers to financial sector innovation, which relies on IT-enabled business models aimed at disintermediation of financial transactions. Disintermediation, an essential characteristic of Fintech, means bypassing or removing traditional financial institutions in finance transactions.

Fintech involves more uncertainty and risks compared with traditional e-banking or e-commerce transactions because the risks in Fintech are not limited to privacy and security, but extend to multidimensional concepts such as performance, transaction processes, and legal, social, financial and time-loss risks [4,5]. For example, peer-to-peer (P2P) lending arrangements can result in bankruptcy during economic recessions because the profitability of P2P lending is highly dependent on the loans they intermediate, putting their balance sheets at risk [15]. For payment services, the anonymity, speed, and global reach of some cryptocurrencies such as Bitcoin can facilitate money laundering, tax evasion, and the funding of illegal activities [4]. Fintech providers who offer global remittance services across multiple countries are struggling with region-specific financial regulations [14]. As a result, the unpredictability of Fintech transactions makes some users fearful of Fintech usage. Researchers have pointed out that Fintech is more likely to be complementary to traditional financial institutions than a competitor because of the former's high levels of uncertainty and risk [4,14]. The key to success in Fintech business is simultaneously improving customer trust and reducing risk.

Furthermore, a link between financial services and IT was originally applied to the back-end of financial transactions in traditional financial institutions. However, Fintech has expanded financial innovations from the back-end to front-end payments, cross-border transfers, retail banking, lending, and cryptocurrencies [14]. Ernst and Young [12] pointed out that IT in emergent Fintech is a true innovator that disrupts and transforms existing services, transaction processes, and delivery channels, leading to fundamental changes. Because IT has a greater impact in Fintech than it does in traditional e-banking, users may perceive IT quality as representative of overall Fintech quality. Although IT plays a key role for the sustainable development of Fintech, little attention has been paid its effect on continuous use and other factors in a Fintech context.

2.2. Trust and Perceived Risk

Trust is more essential in Fintech than in traditional e-commerce and e-banking transactions because of the implicit uncertainty and risk in Fintech transactions. Previous research has identified two roles of trust in financial transactions. First, trust is fundamental for capturing user behavior. Kim et al. [16] reported that trust can provide users with high expectations for their successful transactions, and they will use services with high satisfaction rates. Trust can positively influence customer intentions in various digital service contexts, such as e-commerce [16], internet banking [7], online social networks [17,18], mobile shopping [19,20], mobile banking [21,22], and mobile payments [23,24]. Fintech companies can simultaneously retain existing users and attract potential users if they supply a trustworthy environment in which users feel secure and are convinced their transactions are secure. Second, trust can reduce uncertainty and risk in an uncertain environment. Previous reports indicated that trust can reduce risks in e-commerce [16,25,26], internet banking [7], mobile shopping [19,27], mobile banking [28], and mobile payments [23,29]. Trust in financial transactions in particular can alleviate privacy and security concerns [30,31] as well as the risks associated with the opportunistic behavior of Fintech providers [19]. Trust is critical because trust drives Fintech-use behavior while reducing

uncertainty and risk, and it has become a reliable strategy for effectively handling risky and uncertain financial transactions. Previous literature revealed that trust is defined as a user's belief that a service provider will meet user expectations without introducing risks [32]. Hence, we defined trust as a user's belief that a Fintech company will fulfill its transactional obligations to meet a user's expectations.

Perceived risk is an important impediment to use behavior. Perceived risks come from users' feelings of uncertainty or concerns about the behavior and possible negative outcomes associated with using a product or service [29,33]. Perceived risk is reportedly considered a negative factor in overall behavioral intentions across digital service contexts such as mobile payment and internet banking [7,23]. Security and privacy have been traditionally considered the main issues when it comes to risk [31], but more recent studies embrace a multidimensional concept that includes financial, performance, social, psychological, physical, and time risks [27,28,34–36] when consumers make transactions. In this study, perceived risk is defined as a user's belief about the uncertainty leading to a potential negative outcome from a Fintech transaction. Although many studies have investigated the incorporation of trust and perceived risk during the adoption and use of technology, few have identified the relationships among trust, perceived risk, and Fintech behavioral intentions. Deep understandings of the effects of trust and risk on Fintech continuous use will help Fintech businesses meet their sustainable development goals.

2.3. IT Quality

The ISS model developed by DeLone and McLean [37] has been employed widely to examine user adoption and use in numerous digital services [38]. The ISS model introduced two success factors (i.e., system and information qualities) that are positively correlated with the use of digital services and user satisfaction; each has individual and organizational impacts. More recently, DeLone and McLean [13] extended their original model by incorporating a service quality factor that reflects the effectiveness of the service providers. Consequently, the ISS model consists of three quality dimensions: system, information, and service. System and information qualities are important factors to consider when measuring the success of individual IT system, and service quality is crucial for assessing the overall success of an IS (information systems) department [13].

Substantial studies have been carried out by integrating the ISS model with trust or perceived risk to predict continuance intentions in e-commerce [33,39,40], business-to-business data exchange [8,41], information exchange virtual communities [42], mobile banking [21,22], and mobile payment applications [23,38]. Given that the three quality dimensions of the ISS model were found to significantly influence user trust and perceived risk as well as behavior in online and mobile environments [7,8,23,31,33], the ISS model was a suitable tool for validating our research concept. In our proposed model, we conceptualized the three quality dimensions as potential trust facilitators and risk mitigators that indirectly influence continuance intentions in Fintech.

3. Research Model and Hypotheses

To examine the relationship among uncertainty, IT, and continuance intention in a Fintech context, we applied an IT quality perspective to a trust-based model. We employed the three IT quality dimensions (i.e., system, information, and service qualities) proposed by the ISS model to measure IT quality in Fintech. Our proposed model then attempted to investigate Fintech continuance intentions by adopting the three IT quality dimensions as antecedents of trust and perceived risk based on a Nicolaou and McKnight [8]'s model. To control for the effect of perceived benefits on Fintech continuous use, we added a perceived benefit construct to our model by referring to a trust-based decision-making model proposed by Kim et al. [16]. Finally, the mediation effect of trust and perceived risk between the three IT quality dimensions and Fintech continuance intentions were determined. The overall research model is shown in Figure 1.

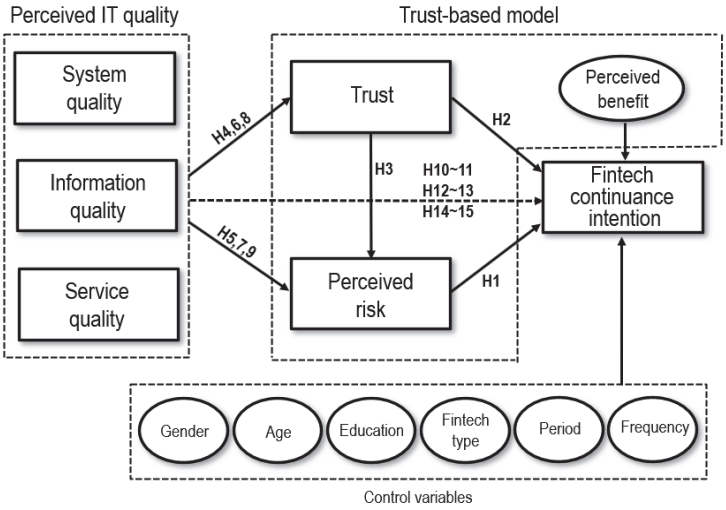

Figure 1. Research model.

The theory of perceived risk suggests that perceived risk has a negative effect on users' behavioral decisions with respect to various digital services [8,27,28]. Customers face risks when they use an emerging digital service such as Fintech, because their transactions may not go as expected. For example, with respect to P2P lending and crowdfunding, there are no guarantees that Fintech providers will not act immorally and opportunistically. Fintech providers may misappropriate personal and financial data, including names, social security numbers, phone numbers, addresses, and even bank account and credit card information [5]. Moreover, Fintech users may suffer from financial losses because their financial transactions may not perform as anticipated or may be associated with tax evasion, money laundering, and the funding of illegal activities [4]. Fintech users therefore pay attention to the risks that might result in potential negative outcomes and such risks may weaken their willingness to continuously use Fintech. We therefore formulated the following hypothesis:

Hypothesis 1 (H1). *Perceived risk negatively affects Fintech continuance intention.*

Recent IS research has described trust as a primary predictor of technology adoption and usage rates. Because Fintech is not a face-to-face financial service, the concerns of users about their financial transactions extend beyond the privacy and security issues of traditional financial services. In Fintech, trust becomes an important element in controlling uncertain and unpredictable situations. Trust occurs when users believe that Fintech providers provide high-quality services [43] that benefit their customers. For example, if Fintech providers offer users security and stability; updated, accurate, and comprehensive information; and high-quality services that meet users' expectations, they can reduce user fears and build trust in their products.

In addition, trust can help reduce perceived risk because users can overcome uncertainty or anxiety regarding provider behavior and possible outcomes [44]. As more users trust mobile transactions, less risk is perceived [29,45]. Trust reduces the possibility that a Fintech company will engage in opportunistic behavior. Trusted Fintech providers can also reduce environmental uncertainties and risks related to financial infrastructure. That is, if users perceive that Fintech transactions are unpredictable and providers are opportunistic, their willingness to use Fintech can decline. Trust strengthens user confidence in a technology and attenuates perceived risks regarding Fintech transactions, the associated Fintech infrastructure, and Fintech providers. We therefore made the following hypotheses:

Hypothesis 2 (H2). *Trust positively affects Fintech continuance intention.*

Hypothesis 3 (H3). *Trust negatively affects perceived risk.*

System quality refers to perceptions derived from the overall performance of IT systems [13,21,46]. System quality reflects a system's technical characteristics, including accessibility, ease of use, response time, reliability, and stability. Lee and Chung [47] claimed that users first impressions are based on their experience with IT systems. Poor system quality and challenging user interfaces can cause Fintech users to doubt the overall competence of a Fintech provider, leading to a decrease in trust and an increase in perceived risks. In contrast, users of high-performing Fintech systems are likely to trust Fintech, leading to continued use and a willingness to pay for the service [44]. The effect of system quality on user trust has been identified in e-commerce, internet banking, mobile banking and mobile payments [9,38,40]. Users' perceptions of risk are also linked to technical support [36]. If a Fintech system is slow, difficult to use, unreliable, and unstable, Fintech users are more likely to worry about the release of their personal and financial information, malfunctions in Fintech systems, and non-performance caused by system failure [5]. With low-quality IT systems, users may conclude that Fintech providers lack the ability to provide high-quality services in general, which leads to lower trust and higher perceived risk in Fintech. We therefore developed the following hypotheses:

Hypothesis 4 (H4). *System quality positively affects trust.*

Hypothesis 5 (H5). *System quality negatively affects perceived risk.*

Information quality refers to an individual's perception of service providers' abilities to meet the user's needs [13,21,46]. High information quality is relevant, accurate, helpful, and comprehensive [31]. Nicolaou and McKnight [8] stressed the importance of information quality in building trust in online interactions because users tend to depend on service providers for current, relevant, timely, and insightful information. When service providers provide higher-quality information, user trust increases. For example, although customers expect to pay for products or services and receive payment information through mobile applications anytime and anywhere, insufficient, inaccurate, or outdated information can lead customers to doubt the information management abilities of Fintech providers [42,47]. Prior studies have indicated a significant and positive relationship between information quality and trust in online and mobile environments [8,23,38,41]. Moreover, information quality can help reduce uncertainty because shared, accurate, current, and relevant information can mitigate unpredictable outcomes. As high-quality information meets users' needs, confidence in information quality can weaken perceived risks. We therefore proposed:

Hypothesis 6 (H6). *Information quality positively affects trust.*

Hypothesis 7 (H7). *Information quality negatively affects perceived risk.*

Service quality is defined as an individual's perception of the level of support received from an IS department and its IT support system [13,40,46]. Service quality generally represents service providers' abilities and benevolence, reflecting reliability, responsiveness, assurance capacity, and personalization [23,31]. A positive effect on user trust has been linked to service quality in previous IS studies [7,22,23,31]. Trust in Fintech is driven by users' confidence that providers can carry out financial transactions, keep their promises, and are sensitive to users' interests, not just their own [26]. For example, when providers offer quick responses and proficient service, users come to believe that a provider can satisfy their expectations. Moreover, personalized and professional services that use mobile applications can reduce the time and effort involved in financial transactions and provide users with enjoyable experiences, leading to increased user trust [23]. Service quality can be a distinguishing

characteristic for Fintech providers and improve users' trust. It also has a negative relationship with perceived risk in digital services [7,33,48]. For example, if a Fintech provider offers slow, unreliable, and unprofessional service, users may greatly increase the perceived risk associated with the provider. We therefore hypothesized that:

Hypothesis 8 (H8). *Service quality positively affects trust.*

Hypothesis 9 (H9). *Service quality negatively affects perceived risk.*

The three quality factors in the ISS model (i.e., system, information, and service qualities) were found to be fully mediated by trust and perceived risk in various digital services [7,31,33,41]. However, in the real world, and given the expanding role of IT in Fintech, the three dimensions of the ISS model may directly affect Fintech continuance intentions by lowering transaction costs, providing simple and speedy processes, and adding economic benefits [8]. Previous studies provided no empirical evidence for the mediating effects of trust and perceived risk among the three types of IT quality and intentions to use Fintech. That is, while it is likely that trust and perceived risk have significant mediating effects, they may not fully mediate the effects of the three dimensions of IT quality in every setting. For example, high-quality Fintech systems by themselves may attract and retain Fintech users and there may be a partial mediation effect of trust and perceived risk between system quality and Fintech continuance intention. We therefore developed the following hypotheses:

Hypothesis 10 (H10). *The effect of system quality on Fintech continuance intention is partially mediated by trust.*

Hypothesis 11 (H11). *The effect of system quality on Fintech continuance intention is partially mediated by perceived risk.*

Hypothesis 12 (H12). *The effect of information quality on Fintech continuance intention is partially mediated by trust.*

Hypothesis 13 (H13). *The effect of information quality on Fintech continuance intention is partially mediated by perceived risk.*

Hypothesis 14 (H14). *The effect of service quality on Fintech continuance intention is partially mediated by trust.*

Hypothesis 15 (H15). *The effect of service quality on Fintech continuance intention is partially mediated by perceived risk.*

4. Research Methodologies

4.1. Measurement Development

Survey items were developed from an intensive literature review to ensure content validity. Multiple item measures of seven constructs were developed from a review of previous innovations and IS reports. We measured three items of both trust and perceived risk from Featherman and Pavlou [49] and Kim et al. [16]. The three IT quality dimensions in the ISS model, namely system quality, information quality, and service quality, were each measured by four items drawn primarily from Bharati and Chaudhury [50]. Measurement of Fintech continuance intentions as a dependent variable was based on four items from Chen [48] and Lee [51]. All measures were based on a seven-point Likert

scale that ranged from "extremely low (1)" to "extremely high (7)." The structure of all survey items is shown in Appendix A.

Based on the trust-based model proposed by Kim et al. [16], perceived benefit was controlled in our proposed model because perceived benefit is an important factor in determining behavioral intentions regarding digital services [5,52,53]. Perceived benefit is defined as an individual's perception of the possible positive outcomes resulting from using a product or service. Previous studies have pointed out that perceived benefit is particularly crucial to Fintech continuance intentions because real-world Fintech users may engage in risky behavior, despite a low level of trust, if the expected benefits are sufficiently attractive. For example, Bitcoin users engage in speculation because of expectations of high rates of return, although they recognize that Bitcoin speculation is inherently risky. In this study, the perceived benefit was measured by three items from Kim et al. [16] and Ryu [5]: (1) using Fintech is beneficial to me; (2) using Fintech is useful for me; (3) using Fintech yields a more superior outcome quality than traditional financial services.

Gender, age, education, Fintech type, period of use, and frequency of use were also employed as control variables in our research model. Dapp et al. [54] indicated that Fintech adoption and its use differ by gender, age, education, income, and the personal propensities of the users because gender, age, and education are considered important demographic variables in technology acceptance research [55,56]. Gender was measured by the respondents answering that they were either male or female. Age and education were measured with ordinal scales (five categories for age, six categories for education, respectively). Fintech type was controlled using a dummy variable consisting of four Fintech services (i.e., mobile payment, mobile remittance, P2P lending, and crowdfunding). As recent studies have identified period and frequency of actual use as important factors affecting Fintech-use intentions [57,58], we also controlled for the period and frequency of Fintech use using ordinal scales (six categories for period, seven categories for frequency, respectively).

4.2. Data Collection

A pre-test was conducted to determine the reliability and validity of all variables by focusing on 30 respondents who had experience using Fintech. The pre-test resulted in a significant refining and restructuring of the questionnaire as well as establishing the initial face and internal validity of the measures. After the pre-test, questionnaires of a main survey were distributed to 1000 participants as a panel pool for three weeks in April 2017. The survey targeted users who had actively used Fintech for more than three months. If inconsistency was detected during a response in the panel, the data were discarded, and the respondent was excluded from the panel pool. With this initial screening question, we confirmed that respondents fully understood the survey context and whether they were current Fintech users. Among the 1000 participants, 262 responses were collected, and 218 responses were found to be useful for this study, corresponding to a response rate of 21.8%. Table 1 summarizes the respondent characteristics. As shown in Table 1, many responses came from mobile payment (28.9%), mobile remittance (26.6%), crowdfunding (24.3%) and P2P lending (20.2%) uses. Our sample consisted predominantly of those who used Fintech monthly (35.8%) or within one year (76.7%). The sample also showed a large proportion of respondents aged 40–49 years (30.3%) with a bachelor's degree (59.2%).

Table 1. Sample characteristics.

(a) Gender			(b) Fintech Type		
Gender	**Frequency**	**Percent**	**Fintech Type**	**Frequency**	**Percent**
Male	98	45.0%	Mobile payment	63	28.9%
Female	120	55.0%	Mobile remittance	58	26.6%
			P2P lending	44	20.2%
			Crowdfunding	53	24.3%
Total	218	100%	Total	218	100%
(c) Age			**(d) Education**		
Range	**Frequency**	**Percent**	**Range**	**Frequency**	**Percent**
Under 20	0	0%	Under high school	1	0.5%
20–29	48	22.0%	High school	25	11.5%
30–39	53	24.3%	College/associate	37	17.0%
40–49	66	30.3%	Bachelor	129	59.2%
50 over	51	23.4%	Master	24	11.0%
			PhD	2	0.9%
Total	218	100%	Total	218	100%
(e) Period of Use			**(f) Frequency of Use**		
Range	**Frequency**	**Percent**	**Range**	**Frequency**	**Percent**
~3 months	81	37.2%	Daily	1	0.5%
~6 months	52	23.9%	Weekly	60	27.5%
~12 months	34	15.6%	Monthly	78	35.8%
~18 months	10	4.6%	Every 3 months	40	18.3%
~24 months	15	6.9%	Every 6 months	20	9.2%
≥ 24 months	26	11.9%	Once 1 year or less	12	5.5%
			Once 2 year or less	7	3.2%
Total	218	100%	Total	218	100%

5. Analysis and Results

We examined the proposed model and its hypotheses using the partial least squares (PLS) tool. Considering the small sample size (n = 218) and an initial stage to develop a theoretical model for the effect of IT quality on trust, perceived risk, and Fintech continuance intentions, the fit of PLS to the exploratory study appeared to be favorable [59]. Based on Gefen et al. [60], this study employed a two-step approach to conduct data analysis. The first step analyzed the measurement model and the second step involved a structural model test. Smart PLS version 3.20 was employed to analyze the measurements and structural models.

5.1. Measurement Model

Following a two-step approach developed by Gefen et al. [60], the measurement model tested the content, convergent, and discriminant validities. To validate content, several pre-tests and pilot tests were performed [61]. For the responsibility test, we evaluated Cronbach's alpha, the composite reliability (CR) and average variance extracted (AVE) for each construct.

As seen in Table 2, all Cronbach's alpha and CR values exceeded the recommended threshold of 0.7 and all AVE values exceeded the 0.5 acceptance level [62], supporting convergent validity. The square root of AVE (SAVE) was used to determine discriminant validity [62]. As shown in Table 3, SAVE values of all constructs exceeded the correlation with the other constructs. We found variance inflation factor (VIF) values ranged from 1.458 to 1.884, a low level of multicollinearity [46]. Finally, to control for common method variance (CMV) [63], we applied Harman's single-factor test; no excessive CMV was found. These results indicated that the measurement model was appropriate for further analysis.

Table 2. Results of reliability and validity test.

Construct	Item	Cronbach's Alpha	Composite Reliability	Average Variance Extracted	Loading	T-Statistic
Perceived risk	PR1	0.802	0.879	0.709	0.821 **	17.629
	PR2				0.815 **	17.590
	PR3				0.887 **	56.008
Trust	TR1	0.804	0.885	0.721	0.775 **	20.668
	TR2				0.906 **	61.397
	TR3				0.861 **	24.920
Perceived benefit	PB1	0.824	0.895	0.739	0.864 **	31.174
	PB2				0.884 **	47.801
	PB3				0.831 **	27.837
System quality	STQ1	0.881	0.919	0.740	0.910 **	78.111
	STQ2				0.896 **	43.111
	STQ3				0.863 **	33.691
	STQ4				0.765 **	19.326
Information quality	IFQ1	0.865	0.908	0.711	0.865 **	48.757
	IFQ2				0.847 **	35.537
	IFQ3				0.812 **	14.724
	IFQ4				0.848 **	36.574
Service quality	SVQ1	0.893	0.926	0.757	0.868 **	33.623
	SVQ2				0.878 **	38.947
	SVQ3				0.872 **	33.095
	SVQ4				0.862 **	31.880
Continuance intention	CI1	0.899	0.929	0.767	0.887 **	51.416
	CI2				0.853 **	29.536
	CI3				0.896 **	50.815
	CI4				0.867 **	38.177

Note: ** $p < 0.01$.

Table 3. Results of correlations test with square root of AVE.

Construct	Mean (SD)	1	2	3	4	5	6	7
1. Perceived risk	3.754 (0.953)	0.842						
2. Trust	4.344 (0.772)	−0.321 *	0.849					
3. Perceived benefit	5.372 (0.945)	−0.356 *	0.301 *	0.860				
4. System quality	5.140 (0.922)	−0.415 *	0.412 *	0.626 **	0.860			
5. Information quality	4.891 (0.806)	−0.361 *	0.555 *	0.588 *	0.769 *	0.843		
6. Service quality	4.811 (0.839)	−0.420 *	0.529 *	0.482 *	0.663 *	0.785 *	0.870	
7. Continuance intention	4.687 (0.835)	−0.446 *	0.587 *	0.510 **	0.579 **	0.662 *	0.714 *	0.876

Note: * $p < 0.01$, ** $p < 0.01$.

5.2. Structural Model

In the second step, the structural model was estimated using PLS. Figure 2 depicts the results of PLS in the proposed model, including path loading and significant levels of the paths. As a control variable, the perceived benefit positively influenced Fintech continuance intentions ($\beta = 0.342$, $p < 0.01$), which was consistent with previous studies [5,16,52,64]. Of the other six control variables, only Fintech type showed a significant and positive relationship with continuance intention ($\beta = 0.189$, $p < 0.01$). The research model accounted for 33.5% of the variance in trust, 24.4% of the perceived risk, and 54.0% of the Fintech continuous-use intentions.

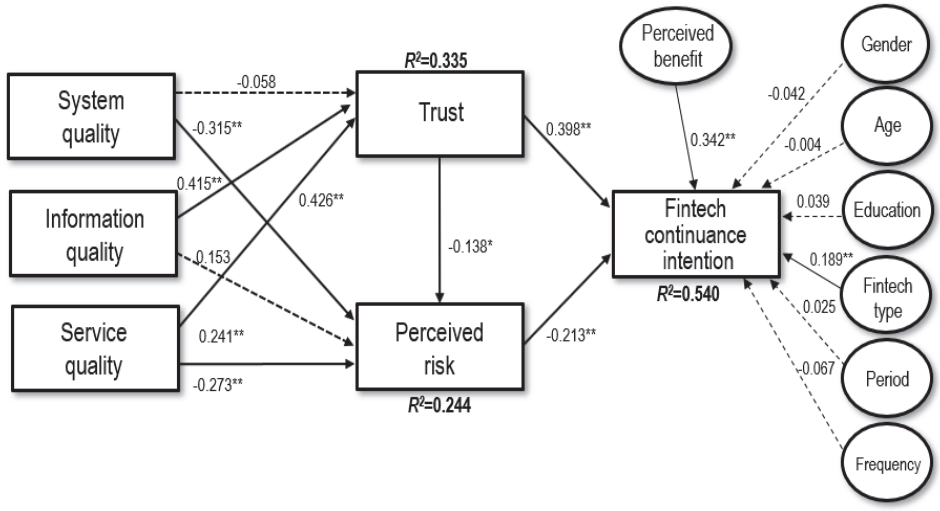

Figure 2. Results of the proposed research model. Note: *$p < 0.05$, ** $p < 0.01$.

Figure 2 shows that the perceived risk negatively influenced respondents' willingness to continuously use Fintech ($\beta = -0.213$, $p < 0.01$), *supporting* H_1. Trust was positively related with Fintech continuance intentions ($\beta = 0.398$, $p < 0.01$), *supporting* H_2. These results indicated that trust had a significant and positive effect, but perceived risk had a significant and negative effect, on the Fintech continuance intentions. The effect of trust was stronger than that of perceived risk, indicating that users were willing to continue using Fintech. Moreover, trust had a significant negative effect on perceived risk ($\beta = -0.138$, $p < 0.05$). Therefore, H_3 *was supported.* This result showed that building trust helped significantly mitigate the effects of perceived risk.

The results also demonstrated that system quality had no significant effect on trust, whereas system quality had significant and negative effects on perceived risk ($\beta = -0.315$, $p < 0.01$). Therefore, H_4 *was not supported* but H_5 *was*. Information quality positively affected trust ($\beta = 0.415$, $p < 0.01$), but exerted no significant effect on perceived risk. Contrary to system quality, it provided *support for* H_6 but *not* H_7. Service quality positively affected trust ($\beta = 0.241$, $p < 0.01$) but negatively influenced perceived risk ($\beta = -0.273$, $p < 0.01$). The results therefore *supported* H_8 and H_9. This finding showed that service quality was associated with both trust and perceived risk while system quality was more related to perceived risk than to trust, and information quality was more related to trust than to perceived risk.

Because we assumed that user IT quality perceptions directly and indirectly affected Fintech continuance intentions through trust and perceived risk, we validated six mediated paths (i.e., $H_{10–11}$, $H_{12–13}$ and $H_{14–15}$) in two different ways. First, a Sobel test was conducted to validate the mediation effects of trust and perceived risk in the proposed model [65]. As described in Table 4, four out of all six mediation paths via trust and perceived risk were significant at p values of <0.01, <0.05, and <0.10. The results suggested that trust statistically mediated the links between the two quality dimensions (i.e., information and service) and Fintech continuance intention ($z = 2.896$, $p = 0.002$; $z = 2.107$, $p = 0.035$) as shown in rows 3 and 5 of Table 4. Perceived risk also significantly mediated the relationships between two IT qualities (i.e., system and service) and Fintech continuance intention ($z = -2.132$, $p = 0.033$; $z = 1.828$, $p = 0.068$) (rows 2 and 6).

Table 4. Results of Sobel test of mediated paths from quality to Fintech continuance intention.

Mediated Path	Path Coefficient	Standard Error	*z*-Value	*p*-Value
System quality→Trust→Continuance intention	−0.057 0.341	0.096 0.057	−0.591	0.555
System quality→Prisk→Continuance intention	−0.313 −0.169	0.098 0.059	−2.132 **	0.033
Information quality→Trust→Continuance intention	0.410 0.248	0.101 0.060	2.896 ***	0.002
Information quality→Prisk→Continuance intention	0.158 −0.180	0.122 0.059	−1.192	0.233
Service quality→Trust→Continuance intention	0.240 0.242	0.100 0.055	2.107 **	0.035
Service quality→Prisk→Continuance intention	−0.273 −0.123	0.092 0.053	1.828 *	0.068

Note: Prisk: Perceived risk, *$p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Second, we identified direct, indirect, and total effects of all paths in the research model, as shown in Table 5. Consistent with the results of a Sobel test, four out of all six indirect effects of mediation paths were significant at a 0.05 level. The results also showed that system quality was mediated by perceived risk ($\beta = -0.315$, $p < 0.01$) but not by trust (rows 5 and 6), whereas information quality was mediated by trust ($\beta = 0.415$, $p < 0.01$) but not by perceived risk (rows 7 and 8). Moreover, service quality was mediated by both trust and perceived risk ($\beta = 241$, $p < 0.05$; $\beta = -0.273$, $p < 0.01$) (rows 10 and 11). However, we also found direct effects between quality dimensions and Fintech continuance intention. Information quality and service quality had significant direct effects on Fintech continuance intention ($\beta = 0.144$, $p = 0.020$; $\beta = 0.161$, $p = 0.003$) (rows 9 and 12), whereas system quality had no direct effect on Fintech continuance intention (rows 6). It meant that system quality was fully mediated by perceived risk, information quality was partially mediated by trust, and service quality was partially mediated by both trust and perceived risk.

Table 5. Direct, indirect, and total effect of all paths.

Path	Direct Effect	Indirect Effect	Total Effect
Prisk→Continuance intention	−0.213 ***	-	−0.213 ***
Trust→Continuance intention	0.398 ***	0.029	0.427 ***
Trust→Prisk	−0.138 ***	-	−0.138 ***
System quality→Trust	−0.058	-	−0.058
System quality→Prisk	−0.315 ***	0.008	−0.307 ***
System quality→Continuance intention	-	0.042	0.042
Information quality→Trust	0.415 ***	-	0.415 **
Information quality→Prisk	0.153	−0.057	0.096
Information quality→Continuance intention	-	0.144 **	0.144 **
Service quality→Trust	0.241 **	-	0.241 **
Service quality→Prisk	−0.273 ***	−0.033	−0.305 **
Service quality→Continuance intention	-	0.161 ***	0.161 ***

Note: Prisk: Perceived risk, ** $p < 0.05$; *** $p < 0.01$.

Consequently, as shown in Table 6, the results of these two mediation tests revealed that system quality was fully mediated only by perceived risk, providing *no support for* H_{10} and H_{11}. The findings also indicated that trust partially mediated the effect of information quality on continuance intentions. H_{12} *was therefore supported* but H_{13} *was not*. Both trust and perceived risk partially mediated the effect of service quality on continuance intention, *supporting* H_{14} and H_{15}.

Table 6. Test results of six mediated paths.

Mediated Path	Hypotheses	Type of Eediated Eath	Test Eesults
System quality→Trust→Continuance intention	H_{10}	(insignificant)	Not supported
System quality→Prisk→Continuance intention	H_{11}	Fully mediated	Not supported
Information quality→Trust→Continuance intention	H_{12}	Partially mediated	Supported
Information quality→Prisk→Continuance intention	H_{13}	(insignificant)	Not supported
Service quality→Trust→Continuance intention	H_{14}	Partially mediated	Supported
Service quality→Prisk→Continuance intention	H_{15}	Partially mediated	Supported

6. Discussions and Implications

6.1. Key Findings

As the disruptive nature of Fintech results in uncertainties as well as new innovations, Fintech has faced critical problems in achieving sustainable development. Therefore, this study attempted to understand the relationship between uncertainty, innovation (IT), and subsequent Fintech behavioral intention. Given that IT plays a key role in Fintech innovation, we assumed that IT quality directly and indirectly influences Fintech continuance intentions through uncertainty. For this purpose, we developed the proposed model by integrating an ISS model with a trust-based model. Ten out of fifteen hypotheses were supported.

First, our findings suggested that system quality is negatively related to perceived risk, whereas information quality is positively related to trust, which is consistent with previous research [8,22,23,38,40]. The results indicated that system quality primarily mitigates perceived risk, leading to improved Fintech continuance intentions, but has no direct effect on trust. Poor system quality makes Fintech users anxious about transaction security and therefore reluctant to continue using Fintech. However, user trust does not rely on high system quality itself, as users often believe that high system quality is integral to Fintech providers. Information quality is the most consequential positive factor for building trust in Fintech use. Zhou [22] indicated that information quality represents service providers' trustworthiness. If information quality is low, users may assume Fintech providers lack the ability to provide quality service, leading to a decline in trust. Our findings indicated that users depend primarily on information quality to develop trust and rely largely on system quality to mitigate perceived risk, which ultimately affects Fintech continuous use.

Second, we found that high levels of service quality simultaneously improve trust and reduce perceived risk, which had the strongest effect on Fintech continuance intentions among the three quality dimensions. Previous studies showed that service quality is critical to facilitate behavioral intentions in many e-banking and e-commerce services [7,23,33,66]. Consistent with extant studies, our results indicated that service quality significantly affects both trust and perceived risk, although service quality is slightly more effective at mitigating perceived risk ($\beta = -0.273$, $p < 0.01$) than improving trust ($\beta = 0.241$, $p < 0.01$). For example, high service quality, such as immediate responsiveness and a willingness to help, breeds confidence among users that Fintech transactions are trustworthy, resulting in a willingness to continue using Fintech. Fintech that offer high service quality can therefore reduce concerns and doubts of Fintech users about providers' abilities, replacing those fears with confidence. Given that the effect of service quality on both trust and perceived risk is greater than that of other two quality factors, service quality is the most important quality factor among the three dimensions for controlling uncertainty and encouraging continued use of Fintech.

Third, we discovered that each quality dimension plays a different role in Fintech continuance intentions. Previous IS studies have indicated that the three quality dimensions had indirect effects on technology adoption and use through trust or perceived risk [7,8,23,38]. However, we found that two out of the three quality dimensions (i.e., information and service qualities) directly and indirectly affect Fintech continuance intentions via trust and perceived risk, indicating the enhanced role of IT in Fintech. The results meant that the effects of IT on attracting and retaining Fintech users were extended. However, system quality had only an indirect effect on Fintech continuance intention via

perceived risk, indicating IT systems themselves have a limited ability to drive the behavioral intention of users. Overall, our findings confirmed the more extended role of IT in Fintech than that in other digital services, revealing the importance of IT for sustainable development of Fintech.

Finally, trust directly and indirectly improves Fintech continuance intentions, which is also consistent with previous studies. Trust is the strongest predictor of Fintech continuance intentions as well as the largest negative factor in perceived risk. Multiple studies have reported that Fintech is inherently risky and unpredictable, and users need the opportunity to acquire confidence before engaging in such financial transactions. This study also showed that trust reduces perceived risk, indicating that when Fintech users feel the risk reduced, the likelihood of using Fintech will increase. trust-building strategies and risk-mitigation strategies are required for Fintech providers to enhance continuous use of Fintech and meet sustainable development.

6.2. Managerial Implications

From a managerial perspective, this study presents several important implications. First, it provides useful insight into methods of effectively developing Fintech innovation strategies to realize the sustainable development of Fintech. Our study identified the causal relationship between IT, trust, perceived risk, and Fintech continuance intention. For example, we found that users develop trust and continue to use Fintech when they believe information provided by Fintech providers is of high quality and trustworthy because information quality is a strong facilitator of trust. Given that system and service quality can effectively reduce perceived risks, Fintech managers should recognize that user anxiety about the inherent and unpredictable risks of Fintech transactions can be alleviated when Fintech providers provide high-quality IT systems and service. Our findings can provide guidance to Fintech managers regarding innovation by combining IT development with trust-building and risk-mitigating strategies to meet a sustainable development of Fintech.

Second, Fintech managers should recognize the extended role of IT as an important antecedent of trust, perceived risk, and continuance intentions. Previous studies on digital services have identified an indirect effect of IT quality on behavioral use patterns and have regarded trust and perceived risk as full mediators. However, we found that information and service quality directly and indirectly affect Fintech continuance intention, whereas system quality only indirectly influences them. In other words, high-quality information and service can directly enhance trust, directly and indirectly mitigate perceived risk, and directly facilitate continuance intentions at the same time. Our findings imply that information and service quality in Fintech systems are major elements of user-retention strategies. Fintech managers should therefore focus on enhancing the IT quality of Fintech to attract and retain Fintech users, promoting Fintech innovation as beneficial in the long term.

Last, this study confirms that Fintech managers should establish trust to nurture continued Fintech use. Given uncertainty issues from the disruptive nature of Fintech, a trust-building strategy is essential to mitigating uncertainty and improving use behavioral patterns in Fintech. Our results show that high system and service quality can mitigate perceived risk, leading consequently to improved levels of trust. Information quality is the strongest and most direct trust facilitator and exerts the greatest impact on trust among the three quality dimensions. To gain a sustainable development of Fintech, Fintech providers should focus their Fintech innovation on how to build trust by adopting and utilizing new information technologies.

6.3. Limitations and Future Research Directions

Several limitations are associated with this study, some of which suggest directions for future research. First, although we measured unidimensional constructs of trust and perceived risks in a Fintech context, multifaceted, multidimensional trust and risk were not examined. As the effects of unidimensional trust and perceived risk can be biased, subsequent research should provide insights into multifaceted trust (e.g., competence, integrity, and benevolence) and perceived risk (e.g., financial, legal, security-related, privacy, performance, and time risks) to capture post-adoption phenomena

in a Fintech context. Second, although our research was based on a trust-oriented model integrated with an ISS model, there may be alternative models which can explain the different relationships among IT quality, trust, perceived risk, and Fintech continuance intentions. For example, trust can be regarded as a moderator between perceived risk and continuance intentions [32]. In this view, trust affects behavior intentions only when transactions are perceived as risky. From another perspective, the relationship between trust and perceived risk can be non-recursive [67]. Given the early stage of Fintech research, future studies should consider how these alternative models may complement explanations of Fintech-use phenomena and how these models can be integrated. Third, this study is a snapshot that focuses on post-adoption behavior of Fintech; it does not consider the changing and dynamic nature of Fintech-use phenomena. Ideally, longitudinal studies that track Fintech adoption behaviors over time are needed. This study suggests that future efforts can provide valuable insights into the dynamic features of Fintech adoption behavior over time by comparing pre-adoption and post-adoption behaviors. Finally, the cultural factors embedded in the empirical context of our study, i.e., Korea, limit our ability to generalize our conclusions to broader contexts, such as those of Singapore, Hong Kong, the UK, USA, and China. Future research that includes different cultural settings would enhance generalizability and external validity.

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Appendix A

Table A1. Structure of the survey instrument.

Constructs	ID	Questionnaire	Reference
Perceived risk (PR)	PR1	Using Fintech has many unexpected problems.	[16,30]
	PR2	Using Fintech has high uncertainty in respect of legal issues	
	PR3	Overall, there is a higher potential for loss in using Fintech than using traditional financial services.	
Trust (TR)	TR1	Fintech is secure in conducting its transaction.	[49,51]
	TR2	Fintech is reliable in conducting its transactions.	
	TR3	Overall, Fintech is trustworthy.	
System quality (STQ)	STQ 1	Fintech systems are easy to use.	[13,43]
	STQ 2	Fintech systems can be accessed immediately.	
	STQ 3	Fintech systems enable me to accomplish my financial transactions.	
	SYQ 4	Fintech systems provide helpful functions for my financial transactions.	
Information quality (IFQ)	IFQ 1	Information provided by Fintech systems is accurate.	[13,43]
	IFQ 2	Information provided by Fintech systems is up to date.	
	IFQ 3	Information provided by Fintech systems is easy to understand.	
	IFQ 4	Information provided by Fintech systems meets my needs.	
Service quality (SVQ)	SVQ 1	Fintech service quickly responds to my needs.	[13,43]
	SVQ 2	Fintech service has the knowledge to answer my questions.	
	SVQ 3	Fintech service understands my specific needs.	
	SVQ 4	Fintech service is always willing to help me.	
Continuance intention (CI)	CI1	I would positively consider Fintech in my choice set.	[48,51]
	CI2	I would prefer Fintech.	
	CI3	I would intend to continue to use Fintech.	
	CI4	I will use Fintech in the future.	

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sustainability

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Review

Fintech and Sustainability: Do They Affect Each Other?

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Abstract: Current concerns about environmental issues have led to many new trends in technology and financial management. Within this context of digital transformation and sustainable finance, Fintech has emerged as an alternative to traditional financial institutions. This paper, through a literature review and case study approach, analyzes the relationship between Fintech and sustainability, and the different areas of collaboration between Fintech and sustainable finance, from both a theoretical and descriptive perspective, while giving specific examples of current technological platforms. Additionally, in this paper, two Fintech initiatives (Clarity AI and Pensumo) are described, as well as several proposals to improve the detection of greenwashing and other deceptive behavior by firms. The results lead to the conclusion that sustainable finance and Fintech have many aspects in common, and that Fintech can make financial businesses more sustainable overall by promoting green finance. Furthermore, this paper highlights the importance of European and global regulation, mainly from the perspective of consumer protection.

Keywords: Fintech; sustainability; green investment; socially responsible investing (SRI); green finance; greenwashing; digitization

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1. Introduction

Currently, more and more new issues are emerging that affect financial management. These are the consequence of increasing customer concerns for sustainability and respect for the environment in the goods and services they purchase and consume, as well as with growing digitization.

Important examples of these issues are corporate social responsibility (CSR) and environmental, social, and governance (ESG) factors. Similarly, the 2030 Agenda for Sustainable Development Goals (SDGs) promoted by the United Nations plays an important role in combating climate change.

The growing awareness of global warming and its negative impact on the planet means that customers are increasingly demanding ecological or environmentally friendly products for a more sustainable lifestyle. Customers, investors, and public administrations are exerting increasing pressure on organizations to obtain more transparent information on the environmental impact of their activities. For example, Nielsen Media Research reports that "66% of global consumers" (and 73% of millennials) [1] "are willing to pay more for environmentally friendly products. Thus, when these customers perceive firms to be socially responsible, they may be more willing to buy the products of these firms, and at a higher price" [2].

Hence, firms strive to differentiate their products and their brands from their competitors, setting up "green marketing" campaigns and modernizing their technologies. In addition, they compete for consumers' approval by advertising their products as environmentally friendly. These green marketing initiatives "are helpful to consumers by letting them know which products possess said green properties, but only if the claims in advertisements and product descriptions are honest and accurate" [3].

On the one hand, the innovations of green technologies provide additional financial resources, because green investment is an alternative option for financing such modernization. On the other hand, the existing competition for obtaining green-oriented investors and consumers leads to the use of "greenwashing" by companies as an unfair marketing instrument [4].

Greenwashing is a set of deceptive behaviors or practices that deliberately mislead consumers about the ecological activities of an organization or the environmental benefits of a given product, which appear to be sustainable but are not. Such practices are conducted using ambiguous words and images in the description of the environmental features of a product or via vague, unprovable, and even false ecological claims, exaggerating the ecological features of the product by omitting or masking important information, or by presenting data in a misleading way.

In other words, "greenwashing" is an attempt by a company to make its products appear environmentally friendly when, in reality, they are not. The concept was created by Jay Westerveld in 1986 and can be defined as "the intersection of two firm behaviors: poor environmental performance and positive communication about environmental performance" [5].

Certain factors, such as CO2-neutral certification, contribute to this phenomenon, as they allow a highly polluting company to appear ecologically sound by attaching a green label with this kind of certification for its products. However, such labels are not always meaningful, and it is important to distinguish reliable companies and those providing independent verification with standardized protocols from those that are not.

Greenwashing practices undermine the credibility of any corporate social responsibility (CSR) endeavor, since they threaten to negate the effects of communicating a company's efforts to act in an environmentally and socially responsible manner. At the same time, they threaten to erode customer confidence. "Whereas reporting about corporate social responsibility (CSR) initiatives is a reasonable and even often economically sound thing to do, greenwashing threatens to dilute the entire CSR movement, thereby reducing the pressure on companies to act economically and socially responsibly". Moreover, we must consider that "greenwashing is hard to detect with reasonable effort, so it goes unnoticed most of the time", and "even if greenwashing is detected, it is not perceived as very negative" [6].

As a result, "consumers increasingly mistrust statements regarding CSR, as they suspect they are being lied to, or important information is being withheld". Moreover, because greenwashing is not often detected, it "thereby does not have any negative consequences for the respective manufacturer or vendor" [3].

In addition, concern for the environment and sustainability not only affects consumers but also investors, who increasingly consider certain non-financial attributes in their investments, such as environmental, social, and governance (ESG) criteria. Related to this is socially responsible investment (SRI), which "appeals to investors who wish to go beyond the financial utility of their investments and derive non-financial utility by investing in companies that reflect their social values" [7].

It must also be considered that "investors are increasingly willing to incorporate into their investment decisions not only financial criteria (returns and risk), but also the non-financial attributes of SRI" [8] and that "country-specific factors tend to affect the relationship between corporate social and financial performance" of a company. Another issue to bear in mind is that "there is some evidence that the label "socially responsible" might be more a marketing strategy, thus not assuring investors that an SRI fund is really socially responsible" [8].

Related to the above are "green bonds", a type of fixed-income instrument applied exclusively to the partial or full financing or refinancing of eligible green projects, whether new and/or existing, which are in line with the four core components of Green Bond Principles (GBP) [9]. There are different kinds of green bonds on the market, and in 2019, $257.7 billion in green bonds were issued, a 51% increase on the 2018 figure and constituted a new world record [9].

Furthermore, as the supply and demand for sustainable financing have evolved, several providers of (new) products and services have emerged over recent years. These providers offer solutions for the (new) needs or demands set out in the new sustainability paradigm. These new products and services have emerged in support of the ecological transition process to promote the link between sustainability and economic and financial activities. Their various objectives include increasingly available information on climate; support for the design of more sustainable products and services; and the improvement of public transparency and information. For example, in Spain, the Fundación Ecología y Desarrollo, or ECODES (Ecology and Development Foundation), offers a climate-change risk assessment model that enables the financial sector to assess the predisposition to risks and opportunities of its credit and investment portfolios. This service was designed to be used by the banking sector, but is also useful for other financial sector entities, such as fund managers, investment advisers, insurance companies, and public sector entities in charge of socio-economic planning and development [10]. On a global level, the organization that conducts this kind of activity is the Intergovernmental Panel on Climate Change (IPPC), the United Nations body for assessing the science related to climate change [11].

Notwithstanding the above, digitization, internationalization, and risk analysis must not be forgotten. These are some of the most widespread business practices in the current era and are being increasingly used in the financial field, in general, and financial management, in particular.

Within the digital and technological context, the special importance of so-called "Fintech" must be highlighted. Fintech refers to the latest technologies used in innovative financial products and services. This is one of the most important new markets in recent times, and this cutting-edge business model has great potential for the collaboration of different types of institutions, both public and private.

Fintech [12] comprises digital innovation and modern technology to improve, develop, and automate financial services and is used to assist and support firms, investors, and customers in managing their financial activities using specialized applications and software [13]. Fintech generally attracts customers with more user-friendly, efficient, transparent, and automated products and services [14].

More specifically, Fintech includes new applications, processes, products, and business models in the area of financial services, consisting of one or more financial services, mostly or entirely provided over the internet, "simultaneously by various independent service providers, typically including at least one licensed bank or insurance company" [15]. Some of the financial services provided may include investment advice (robo-advising), credit decisions, asset trading, digital currencies, automatic transactions, payment settling, crowdfunding, person-to-person transactions (P2P), and smartphone wallets [15].

The current era in the evolution of Fintech is called "Fintech 3.0", which began in 2008, and whose first years were dominated by the global crisis and financial turmoil, when there was a loss in trust in the banking system. Then, technological firms began to operate using peer-to-peer networks outside the regulatory framework (in fact, 2000 of these platforms were developed in China) [16] and to apply new technologies in the financial markets, changing the way of doing business in all financial sectors [17]. This development is ongoing [17], and banks today are being displaced by technological firms and start-ups at a rapid pace [16]. According to Moro-Visconti, Cruz Rambaud, and López Pascual, some of the reasons for this rapid evolution of Fintech are the sharing and circular economy, favorable regulation, and information technology [14].

Initially, the largest Fintech market was developed in the US, followed by the UK (the most important Fintech market in Europe) [18]. The European and American Fintech properties and background differ from the Asian Fintech, which specifically offers solutions for a lack of existing banking infrastructure [19].

Establishing Fintech is easier in well-developed economies, because the infrastructure and market regulations are there already. This infrastructure and affordable technology are critical to creating sustainable, unique financial innovation, although Fintech development

often occurs in economies where access to loans is more difficult [18]. In fact, "scalability plays a key role in new financial start-ups, and Fintech's profits remain quite small until a scalable number of customers has been convinced. This scalability of processes can be achieved by platform creation, which leads to economies of scale and, hence, reduced costs, and user networks being built" [17]. Additionally, "financial inclusion can positively affect the economy in terms of poverty reduction and economic growth, and innovations in digital finance can positively influence banks' performance and profitability" [17,20]. "Fintech's key advantages are greater control of customers' personal finance, rapid financial decision-making, and the ability to make and receive payments within seconds, although this results in a trade-off between efficiency and (data) security" [17,20]. Therefore, "from a regulatory perspective, the greatest challenges are then to ensure both consumer and investor protection and to guarantee financial stability" [17].

Fintech "allows performing business transactions from anywhere at any time, which gives flexibility to all actors" [13]. Companies that have developed Fintech have more innovative methods of extending banking services to customers and investors through cellphone apps, with increased flexibility and efficiency of financial services, and with the promise of saving time and costs through the use of digital technologies [13]. Furthermore, Fintech is a key driver "for financial development, inclusion, social stability, and integrity, and consequential sustainable development through building an infrastructure for an innovative digital financial ecosystem" [12]. It makes financial services more accessible, efficient, and affordable for customers and changes the ways of providing traditional services, representing the digitization of the financial industry [17].

"Fintech is also regarded as an engine for sustainable economic growth as a new industry having different characteristics from the traditional financial industry". With high expectations for growth, global Fintech investments have greatly increased. In fact, KPMG reported that "global investment in Fintech has doubled more than six times, from $18.9 billion to $111.8 billion between 2013 and 2018" [21].

Moro-Visconti, Cruz Rambaud, and López Pascual state that, "despite the young age of Fintech, many of these firms are experiencing significantly faster growth than their traditional financial services peers" [14]. In addition, since they belong to a growing industry and not a mature one, they are slightly more volatile than IT firms and much more volatile than traditional, established banks. This higher volatility was reflected in March 2020 in a much steeper fall than banks, followed by a more sustained recovery, "incorporating the digital resilience typical of most technological firms". "Whereas Fintech and technology stocks have fully recovered from the negative peak of 23 March 2020, banks (as of 30 June 2020) were still some 25% below their pre-COVID-19 prices" [14].

Experts claim that "Fintech has the potential to disrupt and transform the financial sector by making it more transparent, secure, and less expensive" [15], as financial products traditionally offered by licensed credit institutions (payment services and loans, among others) are now also offered by Fintech. It supports a greater diversity of products and providers, and offers improved risk management, with its ability to obtain instant customer feedback and use it to power real-time adjustments in the services offered [14].

However, for the last decade, large financial institutions have increased their interest, along with investments, in Fintech innovations, to the point that, in 2019, most competitive financial institutions considered Fintech to be their major investment [15]. Both operate in the same (financial) market and sometimes share customers [14]. In fact, it is expected that financial institutions will be able to reduce their costs and increase customer inclusion with the help of Fintech, leading to an increase in profits. Thus, Moro-Visconti, Cruz Rambaud, and López Pascual also believe that Fintech will "disrupt and reshape the financial industry by cutting costs, improving the quality of financial services, and creating a more diverse and more stable financial landscape" [14]. It will also lead to greater access to finance and investment, which offers great potential to transform not only finance but economies and societies, in general, through financial inclusion and sustainable, balanced development [14].

At present, new sector entrants aim to develop new, more customer-centric and digitally enabled services and, with key technology evolving "rapidly alongside changing consumer needs, industry leaders will be forced to compete with start-ups and tech companies for the new business models" [15]. Market leaders can benefit from this technological disruption, since "they have more financial resources and greater economies of scale for introducing new lines of business, compared to competitors", and the "amount of resources allocated to R&D&I can increase the agility of market leaders to mitigate damage from potential external disruptive innovations" [15].

"Fintech's technological advantage over traditional financial institutions is the key driver of success and competitive advantage. Fintech's technologies should have a value-added for the customer ("customer-centricity"), and mobile and data-based services can enhance efficiency. Another characteristic of Fintech is its ability to connect people or services through platforms" [17].

"Nowadays, customers choose the best service from a variety of companies, and traditional financial institutions increase their investments in external financial start-ups to stay competitive" [17]. This type of collaboration between Fintech and traditional institutions can take different forms, such as partnering, outsourcing, or investment as a venture capitalist [17].

Banks have changed their role in funding new financial technology entrepreneurs, since they now serve as a major provider of funding for young companies. Thanks to digital technology development, they have shifted from traditional money-lending activities to become stakeholders in Fintech and, therefore, equity investors [17]. Some authors [17] recommend "collaboration and trust-based relationships to mutually benefit Fintech and established banks", as Fintech "must be operated by experienced founders with a clear vision", because "investors expect founders to run the business successfully from Day 1" [17]. Moro-Visconti, Cruz Rambaud, and López Pascual state that all these ideas can be summarized by the word "co-opetition", according to which Fintech and banks are both able to compete and cooperate [14]. It is frequent practice for banks to internalize Fintech by buying it, so both "converge towards a common market, with co-opetition strategies that reduce conflicts of interest and other governance concerns. This strategic convergence is also catalyzed by the very fact that banks are digitizing their business models, thus reducing their atavistic differences" [14].

Fintech is the most cutting-edge technological innovation in the field of finance. Although most Fintech is specialized in one market segment, it can create value in every field of finance, using different business models, such as: payments, wealth management, crowdfunding, lending, and capital market business models [17]. They also use various tools, such as "cryptocurrencies and blockchain, new digital advisory and trading systems, artificial intelligence and machine learning, peer-to-peer lending (P2P), equity crowdfunding, and mobile payment systems" [22]. Currently, M-banking (mobile banking) and digital payments are the most popular Fintech solutions, with growing significance due to contactless pandemic prescriptions [14].

Fintech is quite disruptive because of its great innovations for the financial system and other infrastructure, which affect many other areas, such as the economy, society, and the energy sector [22]. Furthermore, Fintech has several effects on social, environmental, and ecological benefits in promoting the use of funds for energy and environmental projects, as well as the construction of renewable energy and environmental infrastructure, "leading to environmental and ecological development by providing cheap and adequate financing" [22].

To summarize, Fintech offers new ways of doing business in financial markets through the implementation of platforms, thanks to "technological implementation, related digital economy business models, and integrated services from different areas", providing "offerings beyond the traditional banking boundaries" [17]. Moreover, technology is creating value in financial services, as costs are being dramatically cut (for instance, branchless

customers do not need to spend time or energy going to the bank), revenues are increasing, because banking is available anytime and anywhere, and transactions are faster [14].

The main purpose of this paper is to research the relationship between Fintech and sustainability, analyzing the particular case of two different Fintech initiatives: "Clarity AI" [23], a technological platform aimed at aligning financial portfolios with ESG criteria, and "Pensumo" [24], which is linked to consumption and savings for pension plans. Specifically, the effect of greenwashing in Fintech companies and the possibility of using Fintech to promote sustainability will be analyzed, and how "Clarity AI" and "Pensumo" can contribute to this goal will be discussed. A set of recommendations and improvement measures will be proposed for apps related to sustainability, corporate social responsibility (CSR), and greenwashing, all via a literature review and case study approach.

This paper contributes to a global view of the subject by harmonizing theoretical literature about Fintech, the digital transformation context, and sustainability, as well as presenting several practical examples that consider sustainable and environmental concerns. Furthermore, the paper proposes a wide range of improvement measures and emphasizes the importance of consumer protection in the digitization and financial context.

The paper is organized as follows: first, the materials and methods used in the research will be explained; then, the Fintech and sustainability research results will be analyzed, paying particular attention to two Fintech platforms (Clarity AI and Pensumo). Proposals for improvement will then be discussed, and conclusions will be drawn.

2. Materials and Methods

This paper will analyze and study the relationship that exists between Fintech and sustainability via a fundamentally theoretical and descriptive methodology, with a review of the literature and several current Fintech examples.

To conduct the research, this paper builds upon a number of articles and reports, selected mainly from SSRN and the *Sustainability* journal, as is the case with Moro-Visconti, R.; Cruz Rambaud, S.; López Pascual, J., Sustainability in FinTechs: An Explanation through Business Model Scalability and Market Valuation. Sustainability 2020, 12, 10316. These authors firmly believe that Fintech plays a key role in the quest for sustainability.

These articles pose several issues related to greenwashing, sustainability, and Fintech from a general perspective, offering examples of currently sustainable Fintech, as seen in Table 1.

Two interesting reports from Afi and Spainsif have been used for further introductory information.

In addition to these academic resources, several Fintech websites were visited for actual examples, and the sites of Pensumo and Clarity AI were used to provide an in-depth description of Fintech. Other Fintech websites visited are listed in the References section. (The Pensumo Brochure was a useful tool in describing Fintech).

Table 1. Literature Review.

Section	Articles
Introduction	de Freitas Netto, S.V.; Sobral, M.F.F.; Ribeiro, A.R.B.; Soares, G.R.L. Concepts and forms of greenwashing: a systematic review. *Environmental Sciences Europe* **2020**, *32*(19). Gräuler, M.; Teuteberg, F. Greenwashing in Sustainability Communication—A Quantitative Investigation of Trust-Building Factors. **2014**. Pimonenko, T.; Bilan, Y., Horák, J.; Starchenko, L.; Gajda, W. Green Brand of Companies and Greenwashing under Sustainable Development Goals. *Sustainability* **2020**, *12*(4), 1679. Delmas, M.A.; Burbano, V.C. The Drivers of Greenwashing. *California Management Review* **2011**, *54*(1), 64–87. Gräuler, M.; Teuteberg, F. Greenwashing in Online Marketing—Investigating Trust-Building Factors Influencing Greenwashing Detection. **2014**. Badía, G.; Cortez, M.C.; Ferruz, L. Socially responsible investing worldwide: Do markets value corporate social responsibility? *Corporate Social Responsibility and Environmental Management* **2020**, *27*, 2751–2764. Badía, G.; Ferruz, L.; Cortez, M.C. The performance of socially responsible investing from retail investors' perspective: international evidence. *International Journal of Finance & Economics* **2020**.

Table 1. *Cont.*

Section	Articles
Results	Zhang-Zhang, Y.; Rohlfer, S.; Rajasekera, J. An Eco-Systematic View of Cross-Sector Fintech: The Case of Alibaba and Tencent. *Sustainability* **2020**, *12*, 8907.
	al Hammadi, T.; Nobanee, H. FinTech and Sustainability: A Mini-Review. *SSRN Electronic Journal* **2019**.
	Moro-Visconti, R.; Cruz Rambaud, S.; López Pascual, J. Sustainability in FinTechs: An Explanation through Business Model Scalability and Market Valuation. *Sustainability* **2020**, *12*, 10316.
	Kabulova, J.; Stankevičienė, J. Valuation of FinTech Innovation Based on Patent Applications. *Sustainability* **2020**, *12*, 10158.
	Fernandez-Vazquez, S.; Rosillo, R.; de La Fuente, D; Priore, P. Blockchain in FinTech: A Mapping Study. *Sustainability* **2019**, *11*, 6366.
	Hommel, K.; Bican, P.M. Digital Entrepreneurship in Finance: Fintechs and Funding Decision Criteria. *Sustainability* **2020**, *12*, 8035.
	Haddad, C.; Hornuf, L. The emergence of the global Fintech market: Economic and technological determinants. *Small Business Economics* **2019**, *53*, 81–105.
	Arner, D.W.; Barberis, J.; Buckley, R.P. The Evolution of Fintech: A New Post-Crisis Paradigm? *Georgetown Journal of International Law* **2016**, *47*, 1271–1319.
	Ozili, P.K. Impact of digital finance on financial inclusion and stability. *Borsa Istanbul* ***Review*** 2018, *18*, 329–340.
	Ryu, H.S.; Ko, K.S. Sustainable Development of Fintech: Focused on Uncertainty and Perceived Quality Issues. *Sustainability* **2020**, *12*, 7669.
	Deng, X.; Huang, Z.; Cheng, X. FinTech and Sustainable Development: Evidence from China Based on P2P Data. *Sustainability* **2019**, *11*, 6434.
	Alonso, A.; Marqués, J.M. Financial Innovation for a Sustainable Economy. *Banco de España Occasional Paper* **2019**, 1916.
	Macchiavello, E.; Siri, M. Sustainable Finance and Fintech: Can Technology Contribute to Achieving Environmental Goals? A Preliminary Assessment of 'Green FinTech'. *European Banking Institute Working Paper* **2020**, *71*
	Arner, D.W.; Buckley, R.P.; Zetzsche, D.A.; Veidt, R. Sustainability, FinTech and Financial Inclusion. *European Banking Institute Working Paper* **2019**, *41; University of Luxembourg Law Working Paper* **2019**, *006; UNSW Law Research Paper* **2019**, *63; University of Hong Kong Faculty of Law Research Paper* **2019**, *038; European Business and Organization Law Review (Forthcoming).*
	Anshari, M.; Almunawar, M.N.; Masri, M.; Hamdan, M. Digital marketplace and FinTech to support agriculture sustainability. *Energy Procedia* **2019**, 156, 234–238.
	Leong, C.; Tan, B.; Xiao, X.; Tan, F.T.C.; Sun, Y. Nurturing a FinTech ecosystem: The case of a youth microloan startup in China. *International Journal of Information Management* **2017**, *37*(2), 92–97.
	Caseiro, N.; Coelho, A. The influence of Business Intelligence capacity, network learning and innovativeness on startups performance. *Journal of Innovation & Knowledge* **2019**, *4*(3), 139–145.
	Crovetto, M. Proyectos Sociales—La Responsabilidad Social Corporativa. Final Degree Dissertation, Universidad de Barcelona, Barcelona (Spain), June **2017**.
Discussion	Macchiavello, E.; Siri, M. Sustainable Finance and Fintech: Can Technology Contribute to Achieving Environmental Goals? A Preliminary Assessment of 'Green FinTech'. *European Banking Institute Working Paper* **2020**, *71*.
	Moro-Visconti, R.; Cruz Rambaud, S.; López Pascual, J. Sustainability in FinTechs: An Explanation through Business Model Scalability and Market Valuation. *Sustainability* **2020**, *12*, 10316.

3. Results

3.1. Fintech and Sustainability

In recent years, considerable progress has been made in the areas of both Fintech and sustainability [14]. The financial sector plays a key role in the challenge to mitigate climate change, one of the primary risks facing our society in the coming decades. In this context, according to Moro-Visconti, Cruz Rambaud, and López Pascual, "sustainability has grown from a niche preoccupation for business to a mainstream concern" [14], and the financial sector has the task of financing the investments needed to transform our economy into a more sustainable one [25]. There are various initiatives in the private financial sector aimed at introducing "sustainability" into its decision-making process to "achieve a balance sheet with a smaller carbon footprint and to develop a business strategy aligned with responsible investment principles and international standards" [25]. These new financial services

relating to sustainability are provided by both traditional suppliers and, above all, Fintech. It must be noted that the COVID-19 pandemic has demonstrated the existing link between sustainability, finance, and technology, since all countries have been urged to re-think the traditional models and to rely more heavily on technology and sustainability [26].

The development of new technologies has transformed the financial sector, and climate risk management is an important part of this transformation. Furthermore, sustainability criteria may play an important role in all these changes. Certain initiatives are being increasingly used, such as applications that employ artificial intelligence techniques to monitor the sustainability metrics cited in firms' annual reports and financial statements [25].

Although technology is not often associated with environmental goals, Fintech shows coherence and continuity with the ESG world, aimed at a "more inclusive, ESG-resilient, circular, and environment-friendly financial system supporting sustainable development". In fact, "the G-20 has included "Sustainable digital finance" as one of its 2030 work-streams, and the UN, since 2016, has been studying the link between Fintech and Sustainable development" [26].

Digital finance and Fintech both play a part in SDG achievement. One of the ways in which they do so is by enhancing the allocation of existing financial resources to support sustainable development, which occurs through "business models, incentives, policies, and regulations to redirect financial resources globally and in individual countries to provide SDG-related finance". Some examples of this process include ESG and socially responsible investment (SRI) and the significant growth of ESG-related financing in the EU, China, and Japan [27].

The authors of [14] state that Fintech "could help accelerate the development of green and inclusive financial markets and help realign finance to support sustainable development", as "it offers the prospect of quickening the integration of the financial system with the real economy, which will in turn enhance opportunities for greater decentralization and increased participation".

Moreover, the traditional barrier between developed economies and emerging markets is being lowered thanks to the rapid digitization and development of the Fintech industry. Thus, Moro-Visconti, Cruz Rambaud, and López Pascual state that Fintech has "the potential to mobilize green finance and, for instance, enable poorer people around the world to access innovative clean energy projects" [14]. In addition, these authors believe that Fintech "can unlock greater financial inclusion for new businesses that will deliver both impact and financial returns; mobilize domestic savings at scale by providing channels or platforms for retail investors to access impact investing opportunities; collect, analyze, and distribute information on both financial performance and impact performance for better economic decision-making, regulation, and risk management; and provide financial markets with the level playing-field and market integrity needed for long-term sustainable investment" [14].

One of the main fields of collaboration between Fintech and sustainable finance is crowdfunding, which involves either individuals or enterprises being provided with a large number of small amounts of money from other users via an online platform. Thus, green crowdfunding platforms and apps can help environmentally sustainable firms obtain finance and resources in a faster, cheaper, and more affordable way. In addition, these green crowdfunding platforms offer investors the chance to invest their money in sustainable initiatives [26].

Some examples of this are the following: "Abundance" [28] (UK), which allows investments in renewable energy projects and in generating and selling low-carbon electricity, having set up a marketplace where users can buy or sell financial instruments previously issued on the platform; "Ecomill" [29] (Italy), which promotes online equity investments to low-environmental impact projects and local renovation; and Lendosphere [30] (France), which provides loans from individuals for enterprises in the renewable energy sector [26].

In addition, blockchain technology has great potential in the sustainable finance sector. In fact, tokens are usually used to reward contributions to lower carbon emissions or

other green behaviors, thus creating incentives for the use of solar panels. For instance, Drop in the Ocean [31] (Switzerland) is a platform that brings together individuals and businesses and rewards responsible behavior with a virtual currency, which can be used to buy services or products from participating businesses. Climatrade [32] (Switzerland) has created a market in carbon credits represented by tokens, which can be used to offset carbon emissions by buying from mitigation projects. Similarly, SolarCoin [33] rewards solar energy producers with coins that can be exchanged, used in participating businesses, or traded in market exchanges; and Power Ledger [34] (Australia) has created a trading platform based on blockchain technology where residents can trade solar energy [26].

Then, artificial intelligence (AI) and big data analytics are used to collect and process information on companies and their environmental behavior. For instance, RepRisk [35] (based in Switzerland but with a global reach) uses both artificial intelligence and human analysis to translate big data (not only publicly disclosed information but also satellite data), in twenty languages, into research and metrics, evaluating the ESG risks of listed and non-listed companies [26]. Sustainalytics [36] (Netherlands) uses big data and AI for the cheaper incorporation of ESG considerations into investment decision-making [26]. Other initiatives are Your SRI [37], which uses traditional financial data, ESG data and carbon data to automatically determine a fund's ESG score and its carbon footprint [26], and APG (Netherlands), which [38] "has scanned more than 10,000 companies in twelve months for sustainability contributions, while Ecochain [39] software maps the entire life cycle of companies, including their environmental footprint, allowing the creation of carbon savings certificates digitally" [26].

All the tools and platforms mentioned above are summarized in Table 2.

Table 2. Green Fintech fields/tools and main platforms.

Fields/Tools	Platforms
Crowdfunding	Abundance (UK) Ecomill (Italy) Lendosphere (France)
Blockchain technology	Drop in the Ocean (Switzerland) Climatrade (Switzerland) SolarCoin (global reach) Power Ledger (Australia)
Artificial intelligence (AI) and big data analytics	RepRisk (based in Switzerland but with a global reach) Sustainalytics (Netherlands) Your SRI (available in 14 countries) APG (Netherlands) Ecochain (Netherlands, but available in more than 10 countries)

Prepared by the authors, based on [26].

In addition to these platforms, it is necessary to highlight the important role of Fintech in the process of transforming agriculture's business process into a more sustainable one. In this context, Fintech offers farmers different ways of obtaining funding, through crowdfunding and digital payment systems, as well as a digital marketplace that can connect "all actors (farmers, landowners, investors, and consumers) into a platform that can promote transparency, empowerment, resourcefulness, and public engagement in agriculture". This strategy contributes to increasing competition among suppliers and improves the sustainability of agricultural products, since customers are able to see prices, compare products, and be aware of their sustainable features, paying directly using Fintech [40].

Other Fintech, such as 007fenqi in China, gives young people greater access to financial products and services, as they are often excluded from most financial services. 007fenqi not only offers microloans to college students but is centered on their needs and offers services in four areas: spend, loan, earn, and invest. For instance, it offers them assistance in finding

part-time jobs or internship opportunities "so that they can earn an income and make their repayments on time", and "one of its main purposes is to educate Chinese youth about the importance of financial responsibility" [41].

To summarize, it is possible to verify that "sustainable Finance and Fintech sectors present many common aspects, and their linkage offers interesting synergies and great potential" [26]. In fact, Fintech can make the overall financial business more resilient and sustainable, as it promotes both sustainable development and green finance [14]. "Financial technology is also an excellent tool to build sustainable communities and lift poverty, as it promotes responsible consumption and production" [14]. In addition, "Fintech itself is environment-friendly, facilitating green finance, reducing asymmetric information for investors, promoting efficiency, valuing nature's assets, and backing sustainable lifestyles inspired by a sharing or circular economy" [14].

Two Fintech initiatives related to sustainability, socially responsible investment, and green behavior are described and examined below. The first is Clarity AI, a global Fintech, which operates in the artificial intelligence sector, and the second is Pensumo.

Among the reasons for the choice of Clarity AI are the great potential of the artificial intelligence sector, as well as the numerous awards that this Fintech has won in recent years. Moreover, it is worth noting its unique methodology, which can have a significant impact on the decision-making process of investors and could be extended to other areas.

As far as Pensumo is concerned, there are many reasons that justify the choice of this Fintech. Firstly, it is a financial services Fintech company that we know in depth because of professional reasons. Secondly, it has received many national, European, and international awards and has an excellent track record of growth. In addition to considering sustainability from a financial perspective, it seeks to promote responsible behavior and attitudes among consumers by rewarding certain actions and proposes an original method to complement the pensions system.

3.2. Clarity AI

Clarity AI [23] is a global Fintech company founded by Rebeca Minguela in 2017, with offices in the USA, UK, and Spain and clients all over the world.

Clarity AI is a "societal impact rating agency and tech company offering a software solution for investors to optimize the societal and environmental impact of their investment portfolios". It allows investors to manage the social impact of their portfolios through a technological platform using big data and machine learning to assess the sustainability and environmental impact of more than 30,000 firms in 198 countries, 187 local governments, more than 200,000 funds, and following 1000 indicators.

The main objective of Clarity AI is to measure the social and environmental impact of companies. Investors often find it difficult to assess the impact of their investments, as there are limited and unreliable data, so it is laborious and expensive for them to draw clear and simple conclusions. Clarity AI offers an easy solution to this problem through its technological platform. It "aggregates multiple data sources and selects the most reliable ones" and "offers the largest coverage of social and environmental impact data about publicly traded securities in the market, with the highest level of reliability and accuracy".

Clarity AI contributes to more socially and environmentally efficient capital allocation. To achieve this goal, it provides decision makers with "the most reliable and comprehensive tools to understand and optimize social and environmental impact, leveraging scientific research and the latest technologies" [23].

Fintech offers an "end-to-end technology solution based on scientific research, quantitative assessment, and global preferences that optimizes the societal impact of investment portfolios" [23]. To do this, Clarity AI enables investors to import or create a portfolio of securities and either select their social and environmental personal preferences or allow Clarity AI to apply the global standard. Then, it shows investors the social and environmental impact and the financial performance of the portfolio they have created. This portfolio can be rebalanced by considering Clarity AI's recommendations on how to opti-

mize social and environmental impact and financial performance. As a result, investors have a rebalanced portfolio based on their initial preferences, interests, and conscience, but by considering social and environmental issues and leveraging multiple sources of data and information.

It must be noted that Clarity AI has a unique and proprietary societal impact methodology, which measures and assesses not only how companies behave but also, and more importantly, the social impact of these companies. This Fintech company believes the traditional ways of financial markets to evaluate and measure the impact of companies on society, which consists of using ESG indicators, is limited, because it considers only how companies behave in the three dimensions of ESG (environmental, social, and governance), without considering the relevance to society of the products and services offered by these companies. With its methodology, Clarity AI expands the ESG framework to "clarify the real impact of the companies on society" [23].

An important part of the mission of Clarity AI is to communicate "the importance of understanding and optimizing societal impact, leveraging the latest technologies". In recent years, this revolutionary Fintech company has received wide recognition for its positive impact and innovative approach and was selected as a 2020 Technology Pioneer by the World Economic Forum. In addition, it was selected by the Harvard Innovation Lab "as one of the most innovative projects in the United States to participate in a one-year research project to develop the social impact measurement methodology". It has also gained funding from Horizon 2020 and the European Union Research and Innovation program and has been ranked among the top 14 start-ups with global impact from the more than 1900 candidates by Impact Growth.

This is an example of business intelligence (BI), since it uses technology to process information in order to improve decision making and to predict the behavior of portfolios and companies with a degree of certainty. Clarity AI converts data into useful knowledge and then makes better and faster decisions. In fact, this knowledge is a source of competitive advantage for Clarity AI, as there is a positive relation between business intelligence characteristics and innovation in startups [42].

3.3. Pensumo

The Fintech Pensumo (Pension by Consumption) was created by José Luis Orós. Its main objective is to make micro-contributions to a private pension plan through daily consumption, and its vocation is a collaborative and responsible economy to obtain social benefit.

It is registered in Spain and Europe under the corporate name "Plataforma de Fidelización PENSUMO S.L." and aims to introduce the so-called "Pension by Consumption" into Spain, a new (non-equity) savings model that links the daily actions of consumption, recycling, sports activities, and good practices as a citizen, for example, with the receipt by users of economic micro-contributions for a lifetime, in a savings plan that grows as these actions are carried out for as long as money accumulates in the plan [43].

Due to the aging of the European population, the decrease in the number of Social Security contributors, and the inability of the general population to save enough, the viability of the pension system is in danger. In this context, the European Union's White Paper on Pensions proposed improving private savings plans and developing plans to promote long-term saving by the public through the introduction of certain incentives. Along the lines of these European recommendations, Pensumo provides an innovative tool to supplement pension savings.

According to several market studies and the data obtained in the two pilot years with almost 2000 users and 100 stores, it was estimated that 6.5% of the Spanish population over the age of 18, that is, around 3 million people, will be Pensumo users. These users are mainly women between the ages of 35 and 40 who shop at service stations, hairdressers, and sports stores [43], who are concerned about their future but lack the ability to save on a regular basis.

Thus, Pensumo can be said to offer a unique savings system. The app and the CRM that controls the data must be downloaded and, from then on, customers go about their everyday activities (shopping, recycling, sports activities, cultural consumption, road safety, and volunteering, among others) and justify them via the app, so that these actions are measured and rewarded by businesses and partners. Thus, consumers can use their smartphone as an instrument to save from contributions given as an incentive and in return for sustainable, responsible, and ethical purchases made or activities performed. In short, it is a system of savings generated from a set of responsible actions measured via cellphones.

There are two ways of saving using Pensumo: either purchases in affiliated stores or by taking part in challenges, as the app promotes campaigns that motivate responsible and collaborative actions (e.g., recycling, road safety, and "I go by bike"), whose conditions are indicated in detail for each campaign. For purchases, each business has a different contribution percentage, whereas for challenges, contributions are fixed but can vary from one challenge to another.

To justify the purchases, all that is required (in the app) for physical commerce is a photo of the purchase receipt from the associated stores. Meanwhile, online purchases must be made through the app, and the user then sends a confirmation email [24]. In addition, contributions to the savings plan are variable and are limited by time and the number of activities, to ensure users do not consume too much in order to receive incentives.

Currently, many of the activities proposed by Pensumo are aimed at sustainability; that is, they contribute toward developments capable of meeting current needs, without jeopardizing the resources and possibilities of future generations. Examples of this are purchases made in local stores, using bicycles to move around the city, and recycling, as all these activities are considered sustainable.

Every day, small amounts of money (cents, most of the time) accumulate in the savings policy guaranteed for each consumer. As indicated above, the consequence of the widespread use of this system by most people would be the emergence of a new type of pension system. This would supplement that of the Social Security and would be unique insomuch as it is free and voluntary for the beneficiaries [44], as indicated above.

Whenever a challenge is completed or a purchase made by consumers in an establishment associated with Pensumo (both online and physical), micro-contributions to their savings plan are made, which means they are saving for their future, as the cents accumulated generate the profitability determined in the final product they are invested in. Currently, this final product is a guaranteed savings plan with a 0.5% annual return [44]. In addition, more savings can be made by making extraordinary contributions added to the existing savings or by disseminating the app to new users (such as friends or family) and new businesses, as this also has its benefits. Moreover, Pensumo users can check their accumulated savings on the website and in the app.

The money accumulated is managed by the insurance company Allianz in an open collective insurance policy, with the sole requirements being to be of legal age and to have a confirmed registration. This policy has no maintenance costs and does not require the user's account number until the moment the money is redeemed [24].

Redeeming the money can be requested by the user through the website by downloading and completing a PDF request form stating the account number where the money is to be deposited. The Allianz product conditions specify that the money can be redeemed in 5-year liquidity windows, without penalty. The money can also be redeemed after the first year, although with a corresponding penalty [24]. In short, consumers cannot use or dispose of the money whenever they wish but must wait for the aforementioned 5-year liquidity windows or pay a penalty if they redeem it after the first year, which may be inconvenient for many users. In addition, it must be considered that this penalty implies a cost, whose amount should be known and compared with the savings in order to assess the actual profitability obtained by the consumer.

The main income for this Fintech company comes from a 1% commission on sales. Pensumo does not have fixed fees, but each business decides the percentage of each

purchase made by the user. This varies according to the type of business and its features, and the Fintech company receives 1% of that assigned percentage, allocating the rest to user savings plans. Thus, there is no other payment, as businesses pay no membership, maintenance, or withdrawal fees.

Pensumo also obtains income from the development of platforms for large companies and groups, through the creation of benefit systems for groups of workers and their families. Pensumo develops "ready-to-use" ICT platforms, adapted to the characteristics of each group and the expected objectives. This system "can be complementary to other existing incentives in the company that aim to guarantee the future well-being of the participants". Furthermore, "the maximum costs per employee are established by the company, which can decide the actions to be rewarded itself or can coordinate them with Pensumo" [44]. These actions may range from employee training or recycling to commuting by bicycle or participating in company activities. "The cost for the company is estimated at €20 to €30 per worker per month, and the accumulated cost of a personal employment savings plan can exceed €30,000 in 25 years" [44].

In short, for small businesses, Pensumo is a quick, simple, and different loyalty tool in which "the savings received by the client are real money, as opposed to gift cards and other discounts" [24]. It also represents a way of differentiating itself from the leading companies in the sector.

Considering all the above, this is a new business dimension that pays less attention to the short term and is also concerned with sustainability. Some examples of this are activities rewarded by Pensumo, as they involve local commerce, which eliminates unnecessary travel and reduces the use of vehicles, as well as activities aimed at taking care of the environment, such as recycling or cycling, thus avoiding the consumption of fuel and emission of pollutants. For example, through the "Reciclo y sumo" challenge ("I recycle and contribute"), contributions can be obtained by recycling: "through photos or QR codes, and by setting a limitation of visits to the container, an awareness action linked to savings is achieved" [44].

For many consumers, concepts such as ethical savings, socially responsible investment, recycling, the collaborative economy, and fair trade and local trade are becoming increasingly common. Thus, "Pensumo creates a community between companies and users, encourages the habit of saving, and also encourages values such as sustainability and the like. Pensumo is a clear example of a socially responsible company, and, moreover, it is the future of pensions" [43], as it is a free and voluntary savings system.

Perhaps due to all these considerations, Pensumo was selected in 2017 and 2019 as one of the Spanish projects for the Horizon 2020 Project, funded by the European Commission. It also received recognition as an Innovative Small and Medium-sized Enterprise (SME) by the Ministry of Industry and Competitiveness for the period 2018 to 2021. It has also received several awards and certifications of excellence since 2014. In 2018, it was awarded the Aragonese Prize for Social Entrepreneurship and was considered the Best Startup of 2018 in the "El Español" Digital Awards. In 2019, it received the Collaborative Economy Award "Lánzate" from E.O.I and Orange, and the EU-GIVE Award in Brussels, also in the context of the Collaborative Economy. Finally, in 2020, it was recognized by the Spanish "Red Española Pacto Mundial" and Rafael del Pino Foundation for its contribution toward the Sustainable Development Goals (SDG).

In conclusion, Pensumo aims to promote customer loyalty and corporate social responsibility (CSR) from a social and innovative perspective, by saving for the future.

Some of the main features of Clarity AI and Pensumo are summarized in Table 3.

Table 3. Main features of Clarity AI and Pensumo (summary).

Clarity AI	Pensumo
Global reach. It is a societal impact rating agency and tech company. It offers a software solution for investors to optimize the societal and environmental impact of their investment portfolios. It uses big data and machine learning to assess sustainability and environmental impact. It contributes to more socially and environmentally efficient capital allocation. It provides decision makers with the most reliable and comprehensive tools. Possibility of creating personalized portfolios. Unique and proprietary societal impact methodology.	Spanish Fintech company. It is a system for generating savings by carrying out a set of responsible actions measured via cellphones. Its main objective is to make micro-contributions to a private pension plan through daily consumption and sustainable behavior. It promotes several campaigns that encourage responsible and collaborative actions. The contributions to the savings plan are variable and are limited in time and the number of actions. The money accumulated by using Pensumo is managed by the insurance company "Allianz" in an open collective insurance policy, which has no maintenance costs. It is possible to redeem the money in 5-year liquidity windows without any penalty. Businesses pay no membership, maintenance, or withdrawal fees. It creates benefit systems for groups of workers and their families.

Personal research.

4. Discussion

Having examined the relationship between Fintech, sustainability, and environmental development and after analyzing two important examples of sustainable Fintech platforms, both general and specific proposals for improvement to make these Fintech initiatives even greener and more environmentally friendly will be discussed. These proposals must consider consumers, as it is essential for them to be informed and aware of the behavior of the businesses they deal with regularly, as well as for the bonds and stocks they invest in.

4.1. Proposals for Commercial Solutions

On the one hand, although Clarity AI already uses big data and machine learning to assess the sustainability and environmental impact of companies and investments, we believe it would be advisable to offer investors complete information on the behavior and impact of different companies. This is because it is important to show investors the social and environmental impact of their portfolios and recommend how they should optimize this impact and performance; it is also essential to explain the reasons why they should or should not invest in a specific fund or company.

This could be achieved by including a descriptive section in the platform on the behavior, relevant data, and analysis of the sustainability reports, and even news on the most important companies and funds. Considering this kind of information, users would be able to understand the reasons why they are being advised to invest, or not, in a certain firm, stock, or fund. In addition, it would be essential to keep investors informed of recent environmental and social scandals, perhaps by creating an "alarm" or notifications system that would provide them with more timely and accurate news.

On the other hand, even though Pensumo already takes into account issues such as sustainability, the environment, and recycling, and despite the fact that CSR is a basic and essential requirement for all companies wishing to be part of its network of collaborators, we believe it is difficult to verify whether company behavior is actually sustainable or whether the company is merely greenwashing.

Thus, we believe several improvements could be made to the app, so that it directs consumers towards even more responsible behavior, by taking a step further in respecting the environment and achieving a more sustainable society.

In addition to the behavior and values Pensumo rewards, such as local commerce, volunteering, recycling, and/or maintaining an active and healthy life, we believe this Fintech company could promote better information for users about the goods and services they purchase and the activities of the brands they normally consume. Thus, an aware, well-informed consumer who chooses companies and brands that respect society and the environment should be rewarded and not only in the field of local commerce but in all the areas of a consumer's life.

We believe that an improvement to the app would be to encourage the consumption of goods and services from brands and companies that are truly respectful towards the environment, and with each purchase made in these companies, the consumer using Pensumo would accumulate new savings in their pension plan. Thus, fully responsible and informed consumption would be promoted not only in local establishments or businesses but also in all companies with which the consumer interacts.

For example, consumers could try to inform themselves about the social and environmental behavior of their electricity supply company, their bank, their telephone company, their internet service provider, their home furniture manufacturers, the hotel chains where they spend their holidays, and the restaurants where they go for lunch or dinner.

However, it is difficult to know if a company is behaving responsibly and if its products and services are truly ecological or environmentally friendly. As explained in the Introduction, there are currently many companies involved in deceptive practices to make potential customers believe they respect the environment, when in fact this is not the case. Thus, corporate social responsibility (CSR) reports should include information about known greenwashing practices.

One possible improvement for Pensumo could be the introduction of a QR code reader in the current app. This could scan the company codes with which consumers interact, codes that would link to CSR or Sustainability Reports of specific companies. Then, after analyzing these reports, consumers will be able to determine whether the company they are about to carry out a transaction with is truly a responsible company. Reading the QR code could allow for company press releases to be traced, to ascertain whether they have been involved in any type of scandal. This would allow greenwashing factors to be known, and the potential investor would find out how sustainable the company actually is and how it meets CSR criteria. It might also be interesting for the app itself to suggest more ecological or sustainable alternatives to particular companies and products.

4.2. General Proposals for Sustainability in the Fintech Sector

In general, to promote a more environmentally informed society, more standardization would be required in both the format and metrics of ESG reporting and sustainability reports. Thus, ESG reporting, benchmarking, and rating could be improved with new technologies such as AI, big data analytics, and DLT. These tools could compile information from disparate sources (including articles), "processing of large amounts of data (even non-standardized and unstructured) about companies' social and environmental impacts, as well as translation in more standardized and comparable data, with positive effects on pricing accuracy and the level of reliability of ESG data" [26]. In fact, a large amount of data from "NGOs, specialized websites, and satellites (publicly available through the European Union's Copernicus network and the US Landsat network) might be combined and processed by AI to track air pollution and emissions by single power plants and, more generally, double-check information provided by companies" [26].

Another important point to consider is Fintech regulation, since, according to Moro-Visconti, Cruz Rambaud, and López Pascual, this will be the key to determining the kinds and number of Fintech companies entering the industry and who the dominant players are [14].

In 2018, the European Commission adopted the "Financing Sustainable Growth" Action Plan to redirect private capital towards more sustainable investments and the Fintech Action Plan, with the aim of creating a harmonized and dynamic European framework for Fintech. The Commission released a package of proposals to implement ESG considerations in the decision-making process of investors, including "a Regulation with criteria to determine the environmental sustainability of economic activities (Taxonomy Regulation) and therefore clarify for investors what activities can be considered to be "green" and used as a basis for standards and labels for sustainable financial products" [26]. The final text of this regulation was signed by the Parliament and Council on June 18, 2020, with the aim of reducing greenwashing and market and regulatory fragmentation among the Member States. "The Commission is also evaluating the opportunity of introducing, also for non-financial information, a European Single Electronic Format (ESEF), as for financial reporting, of issuers in regulated markets" [26].

In addition to all these measures and regulations, we believe it would be appropriate to continue improving European and Global regulation of Fintech companies and sustainability criteria to enable investors and consumers, in general, to "access adequate non-financial information from companies (limiting companies' discretion and wide variations in standards) while at the same time reducing the unnecessary burden on companies" [26] and aligning those legal documents with EU taxonomy.

It will be important in the near future to adapt company reporting and transparency, accounting standards and rules, sustainability research and ratings, labeling tools for financial assets and products, and corporate governance. Moreover, it will be necessary to increase "opportunities for citizens, financial institutions, and corporates to actively engage in the sustainable finance debate regarding green investments and investor protection, through varied actions such as the development of guidelines for financial advisers, programs to raise awareness and financial literacy about sustainability, green securitization, and the deployment of digital technologies in the sector" [26].

To conclude, there are still many regulatory issues related to customer and consumer protection to be resolved. More specifically, consumers need regulation regarding data protection, accessibility, portability and interoperability, wrongful assessments, opacity and discrimination, and financial exclusion [26]. Therefore, institutions all over the world must go ahead with their regulatory processes and frameworks to improve consumer protection and information. The challenge for regulators will be, ultimately, to "keep a level playing field that strikes the right balance between fostering innovation and preserving financial stability, and consumer protection" [14].

5. Conclusions

5.1. Theoretical Contributions and Implications

As has been discussed in this paper, the current concerns over global warming and environmental issues, as well as the importance of corporate social responsibility (CSR) and environmental, social, and governance (ESG) factors have led to the emergence of different kinds of behavior (e.g., greenwashing) and finance trends and tools (such as socially responsible investment and the use of sustainable Fintech initiatives) due to a willingness by investors to incorporate not only financial criteria but also non-financial attributes into their investment decisions.

In the current environment, the financial sector plays a key role in fighting climate change, as it has the task of financing the investments needed to transform our economy into a more sustainable one. The new financial services relating to sustainability are provided by both traditional suppliers and, above all, Fintech companies, aimed at improving, developing, and automating financial services.

Fintech companies are becoming increasingly popular, with great expectations for growth, and they are used to assist and support firms, investors, and customers in managing their financial activities, using specialized applications and software. Furthermore, the Fintech industry is a driving force for sustainable economic growth with several effects

on social, environmental, and ecological benefits. As far as environmental and ecological development is concerned, Fintech can promote the use of funds for energy and environmental projects, as well as the construction of renewable energy and environmental infrastructure.

Fintech shows consistency and continuity with ESG criteria through the use of tools such as crowdfunding, big data analytics, blockchain technology, and artificial intelligence. As indicated above, sustainable finance and Fintech have many shared aspects, and Fintech can make financial business overall more sustainable, as it promotes green finance.

Throughout this paper, the strategic perspective of Fintech has been described, and it has been possible to study the relationship between Fintech and sustainability by providing an extensive review of the literature. Furthermore, the theoretical scope has been applied to some examples of real, sustainable Fintech, which show ways to implement sustainable behaviors and to promote green investment.

The paper emphasizes the need for greater standardization in both the format and the metrics of ESG reporting and sustainability reports, as well as the implementation of different systems and technologies to detect and prevent greenwashing practices. This would direct consumers towards even more responsible behavior by taking a step further in respecting the environment and towards a more sustainable society.

5.2. Implications for Practice

Theoretical implications have been put into practice by analyzing and describing two cutting-edge Fintech companies: Clarity AI and Pensumo.

The analysis of these two important Fintech platforms leads to the conclusion that this kind of app and platform still needs improvements to keep consumers, users, and investors informed and aware of the behavior of the businesses they usually deal with, as well as of the bonds and stocks in which they invest. In this context, this paper gives some practical advice and recommends improvement measures in order to optimize the platforms' performance from the perspective of consumer information and protection.

5.3. Future Research Direction

Future research will focus on European and global regulation frameworks. They play an essential role, but it is still necessary to resolve many problems related primarily to customer and consumer protection. Thus, future research into the impact of user information and protection on sustainable Fintech companies is needed.

It will be necessary to study different examples of sustainable Fintech and seek out their weaknesses in order to propose new improvement measures. What is more, it will be essential to design a plan for each platform so as to put all these measures into practice and to modify their apps by taking into account all the considerations discussed throughout the paper.

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