FinTech and Commercial banks' performance in China: A leap forward or survival of the fittest?

Xihui Chen[1, 3], Xuyuan You[2] and Victor Chang[3]*

1. Governance and Finance Research Group, Teesside University Business School, Teesside University, Middlesbrough, UK
2. University of Leeds, Leeds, UK
3. Artificial Intelligence and Information Systems Research Group, School of Computing and Digital Technologies, Teesside University, Middlesbrough, UK

Emails: Xihui.chen@tees.ac.uk; 2994121543@qq.com; ic.victor.chang@gmail.com* and V.Chang@tees.ac.uk*
*: Corresponding author

Abstract

As the impacts of the COVID-19 pandemic play out globally, the banking industry has been affected in both positive and negative ways, with the crisis creating both opportunities and threats for the collaborations between FinTech and banks. The aim of this study is to investigate the impact of FinTech products (FTPs) on commercial bank's performance in China. Required data are collected with a quantitative approach and two self-designed questionnaires were distributed to customers and employees of commercial banks in China. The gathered data were examined using the structural equation modeling technique. The results of this study reveal that the perceived usefulness (PU) of FTPs has positive and significant impacts on customer satisfaction, low expectation of bank employee assistance, bank's service quality and employee work efficiency. Additionally, the perceived difficulty of use (PD) of FTPs has negative and significant impacts on customer satisfaction and low expectation of assistance. Interestingly, there is a positive and significant relationship between PD and banks' service quality and work efficiency, meaning that the service quality and work efficiency can reduce some shortcomings of using FTPs. This study recognizes the need to enhance the understanding of FTPs on non-financial firm performance. This is the first study that helps commercial banks in China understand the perception of FTPs from both customer and employee perspectives.

Keywords: FinTech, commercial banks, customer satisfaction, customer expectation, service quality, work efficiency, firm performance

1. Introduction

There is an ever-increasing use of financial technology (FinTech) products to attain greater profits. Especially, Following the Financial Stability Board (FSB, 2017), this study defines FinTech as an array of financial technology providers that enables seamless and better financial services (e.g., new applications, products, business models and processes) for businesses to even individual users. Ky et al. (2019) found that the successful implementation of FinTech products (hereafter, FTPs) in banks increases bank profitability and efficiency and enhances customer interactions and develops new customer segments. This is particularly important as a collaboration between banks and FTPs is the key to provide solutions in the "new normal" business environment that the COVID-19 pandemic has brought about. Wang et al. (2020) concluded that FTPs play a vital role in facilitating a bank's risk-taking behavior to achieve that bank's main corporate objectives, absorbing and maintaining customers by providing quality and timely service, as well as reducing customer costs and increasing bank profitability.

Apart from this bright side of FinTech, its implementation is time-consuming, and there are high costs in maintenance, upgrading and training for both customers and employees, and the possible risk of failures. Considering the imperative of engaging and building strong relationships to serve the customers best, obtaining a positive culture regarding technology among employees in the competitive environment, and considering the possible investment risks in FinTech, it is important that business activities related to FTPs be handled with care (Alt et al., 2018). Although COVID-19 is transforming how businesses use digital technology overnight, which will make an investment in FTPs more attractive (Wójcik and Ioannou, 2020), a holistic and integrated approach between the components of business processes, people and technology is required for maximizing investment return and successful corporate performance (Yang et al., 2009).

FTPs and their impact on bank performance have been the focus of many researchers (e.g., Odawa, 2016; Phan et al., 2020; Rega, 2017; Wang et al., 2020). A review of the literature has shown that many studies have empirically investigated the impacts of FTPs on organizational performance. For example, studies tested FTPs on internet banking and mobile banking (Ky et al., 2019; Okiro & Ndungu, 2013); self-service and machine learning (e.g., Odawa, 2016; Gomber et al., 2018; Noor et al., 2019), and cybersecurity (Chang et al., 2020; Meng et al., 2019; Ng & Kwok, 2017). Additionally, empirical studies measured bank performance differently, but ROA (return on assets, Ky et al., 2019), ROE (return on equity, Phan et al., 2020) and survey (Kianto et al., 2013) are the most commonly used methods. More studies have been published and called for an investigation of the impacts of COVID-19 on the relationship between FTPs and organizational performance (e.g., Wójcik and Ioannou, 2020; Akpan et al., 2020). This study use survey to measure banks' non-financial performance for two key reasons. First, it helps establish a connection between banks' strategies and daily tasks among the customers and employees. Second, there are non-controllable external risks (e.g., COVID-19) that would affect the revenue and expenses if a bank faces that. In such circumstances, looking at the financial measures might only give a dismal picture of a bank. Therefore, measuring banks' performance non-financially provides a more holistic view. For example, having a high customer satisfaction rate

and employees worked efficiently would mean that bank would be on track soon after the COVID-19 pandemic with the help of FTPs implementation.

Considering the perceived usefulness (PU) and the perceived difficulty of use (PD) of FTPs (David, 1989) and their effects on firm performance (from both customer and employee perspectives), to the best knowledge of the authors, no study has as yet focused on the perceptions of both the customers and employees, especially in the context of commercial banks in China. This study addresses the gap using David's (1989) technology acceptance model to understand the PU and PE of FinTech and their impact on bank performance via banking and FinTech cooperation literature review. Moreover, this study seeks to build an FTPs-Performance conceptual framework (Figure 1) with the ability to measure the FTPs and performance factors and test the framework empirically.

This study used several non-financial performance measures to gauze banks' performance in non-monetary terms, such as customer satisfaction, the expectation of employee assistance, bank's service quality and employee work efficiency. Two questionnaires were self-designed, one for customers and the other for bank employees. There were 307 customers who participated in the customer questionnaire and 94 bank employees who participated in the employee questionnaire. The structural equation modeling method was used to test the conceptual framework. The customer questionnaire results revealed that high levels of perceived usefulness of FTPs are associated with high customer satisfaction and low expectation of bank employee assistance. The results also showed that the difficulty of using FTPs causes low customer satisfaction and requires more assistance from bank employees. In the employee questionnaire, we found that the perceived usefulness of FTPs has positive and significant impacts on banks' service quality and employee work efficiency. Interestingly, a positive and significant relationship showed the difficulty of FTPs' use and service quality and work efficiency, meaning that service quality and work efficiency can overcome the difficulty of using FTPs.

This study extends the current literature on banking and FinTech and makes several contributions. First, most empirical studies tackling FinTech focus mainly on its impacts on society, customers, organizational risk behaviors and cybersecurity (Alt et al., 2018; Noor et al., 2019; Wang et al., 2020). To our knowledge, this is the first study to examine and conduct an analysis of FTPs implemented in commercial banks in China. Specifically, we intend to examine the PU and PE of FTPs from the perspectives of both the customers and bank employees. Second, this study adds to the literature examining the FTPs and bank performance relationship. Following Kianto et al. (2013) and Odawa (2016), instead of using the proxies (e.g., ROA, ROE, and net interest margin) traditionally considered in the empirical studies on banking literature, this study used a survey and measured bank performance from a non-financial perspective to investigate the impact of FTPs on customers (satisfaction and expectation) and employees (service quality and work efficiency). Third, this study complements the banking and FinTech literature that explores the determinant of bank performance using non-financial measures in Chinese commercial banks with a possible impact of the COVID-19 pandemic.

This study is structured as follows. Section 2 presents the FinTech revolution and its application in the financial industry. Section 3 discusses the literature review on

FinTech, bank performance and conceptual framework specification. Section 4 provides the research method and data. Research results and practical implications are discussed in Section 5 and Section 6 concludes the paper.

2 FinTech revolution and its application in the financial industry

FinTech has always been associated with the terms “advanced” and “competitive” in the financial industry (Acar & Çıtak, 2019; Gai et al., 2018; Wójcik and Ioannou, 2020). Gai et al. (2018) stated that the purpose of FinTech is to enhance service quality and work efficiency of financial services by using information technology applications. Fintech can also be used in P2P (peer-to-peer) lending, distributed ledger technology and third-party payments (Acar & Çıtak, 2019). The Financial Stability Board (FSB) (2019) defined FinTech as new frontier technologies, including AI (artificial intelligence), blockchain and big data that promote emerging business models, new technology applications and advanced product services. Following this definition, FinTech products (FTPs) are one form of FinTech leading the financial sector towards digital banking and suppressing the traditional banks. It is certain that the agnostic to COVID-19’s severity will change the face of the banking sector globally (Wójcik and Ioannou, 2020). This section will introduce the FinTech revolution and its applications in the financial industry and the Chinese banking sector.

2.1 FinTech revolution

It has become very important to understand how the traditional banking system (e.g., deposit loans and physical branches) has been disrupted and given rise to a new era of alternative finance (e.g., mobile gadgets, telecom and data services) (Gomber et al., 2018; Noor et al., 2019). Specifically, there are three phases of the FinTech revolution. FinTech 1.0 was from 1866 to 1967, during which period, the financial industry was somewhat connected with technology but was an analog industry (Arner et al., 2015). In FinTech 2.0 (1967 to 2008), communication and processing of transactions started to transform from an analog industry to a digital one (Arner et al., 2015). Society started to use electronic payments more frequently and FTPs were introduced to the market to support financial services. ATMs (automated teller machines) are one example of FTPs. Online banking was introduced later in 1980 in America but was mainly used among the developed countries (Arner et al., 2015). After 2008, a new era, FinTech 3.0, has emerged in both the developed and developing economies. Many internet financial service companies have been established, and traditional banks have begun to take on more of a FinTech form, offering digital products (Ky et al., 2019). For example, the BAT (Baidu, Alibaba and Tencent) are the three horsemen behind the explosive growth of FinTech in China. Companies that are reluctant to adapt FTPs have lost their competitive advantages (Wang et al., 2020). For example, China UnionPay beat out Visa and MasterCard to become the largest payment card scheme in the world. When Rega (2017) sees FinTech as one of the most promising industries, COVID-19 proves digital banking is no longer an option but an imperative. FTPs are the mainstream when COVID-19 hits.

2.2 The worldwide application of FinTech

FinTech makes the world more inclusive (Gupta & Mandy, 2018). Regardless of whether transactions are C2C (customer-to-customer) or B2B (business-to-business), FinTech innovation has made international money transfers easier than ever (Par, 2015). Thus, FinTech companies attract enormous venture capital investment worldwide to develop and create new FTPs. According to Accenture (2016), in the first

quarter of 2016, the global investment in FinTech rose to $5.3 billion, which is a 62% increase from the same period in 2015. Moreover, based on the 2017 statistics report on BCG FinTech Regulatory Tower, $130 billion was invested in 12,000 FinTech companies globally in equity financing, more than the GDP of Angola, according to the World Bank.

Studies (e.g., Gupta & Mandy, 2018; Ng & Kwok, 2017) recognized that FinTech provides companies with cutting-edge technology and helps them thrive in the fast-changing competitive business environment. Richard Lumb, the Accenture Group's chief executive, commented that companies across the world are chasing the tide of industry 4.0, as inventions and new service models merge FinTech into the traditional financial service industry (Accenture, 2016). Akpan et al. (2020) commented that such digital transformation is considered a vehicle for exceeding customer demands – a competitive advantage most companies require to survive the COVID-19. It also changes the way companies interact with their customers. For example, in the wake of the COVID-19, customers of all ages quickly learned to use online banking services when the bank branches closed with short notice. Many customers are digitally savvy, especially the millennials and Generation Z. Customers have increased their expectations – they prefer greater convenience, lower costs, rapidity and reliability when choosing financial services. Indeed, many FinTech products have made an incredible impact on people's daily life activities, such as low-cost and real-time remittance, real-time payment and loan approval, and remote account opening. In more detail, the use of video and face recognition technology in the remote account opening function allows customers to open bank accounts on mobile devices without visiting a branch (Gupta & Mandy, 2018). The experience with COVID-19 teaches the world that digital banking is the way forward.

2.3 The use of FinTech in the financial industry

2.3.1 Transaction processing

Transaction processing practice focuses on helping companies find, develop and maintain best-in-class service by using FinTech products. With the help of FinTech, transaction processing becomes swifter and more cost-effective (Gupta & Mandy, 2018). Banks can also continue their services during the COVID-19 crisis. For example, the blockchain cuts down on the need for trusted third-party banks to verify transactions and, therefore, lower or avoid the banks' charge fees in a transaction (Nguyen, 2016). Additionally, the invention of FTPs for digital payment methods (i.e., Alipay, WeChat and Apple Pay) has become the public domain trend. Perhaps unsurprisingly, such digital payment methods appealed to generations with cash flow and raised on cell phones. Not to mention how COVID-19 sped up the adoption of digital payments.

2.3.2 Investment and risk management

Regardless of the type of investment, there will always be some risk involved. Fintech can help banks improve risk management significantly through big data (Gai et al., 2018). Big data allows banks to collect and analyze data to identify customer behavioral patterns, thus allowing them to personalize responses, products and services through a tailored marketing experience. In responding to the COVID-19 challenge, the growth of remote working implies that an incredible amount of online data and information are being collected and shared across networks. Data analytics can be used to explore and analyze big data to mitigate risks and inform better

investment decisions with consistent returns for banks. Big data can also be used to enhance cybersecurity, detect fraud and prevent potential malicious actions (Gupta & Mandy, 2018). In principle, FTPs should provide further opportunities for banks while their services are in higher demand during COVID-19.

FinTech has had a huge impact not only on financial activities (e.g., transactions, investments, risk management, insurance, financing and budget applications) but also on regulations and compliance processes. The bigger the data, the higher the risk the companies will face (Noor et al., 2019). The COVID-19 is creating a need for banks to process personal data for a variety of specific purposes (e.g., managing and protecting their workforce, customers and the public) while accumulating user data. Data security regulations are, therefore, becoming more stringent. For example, the European Parliament approved and introduced the GDPR (general data protection regulation) to place certain restrictions on businesses worldwide that want to collect and apply users' data. Council of Europe issued a Data Protection Report (2020) to ensure greater respect of the rights to privacy and data protection in the use of digital contact tracing applications and monitoring tools during the fight of COVID-19. Additionally, in China, selling personal data can be punished by fines and up to seven years in prison, while personal information buyers can be sentenced to up to three years in jail and a fine (Dentons, 2020).

2.3.3 Compliance processes

The 2008 financial crisis impacted the financial industry by spawning new regulatory actions internationally to improve and strengthen the resilience of the financial system. The real-name financial transaction system is one of the tools that can effectively prevent money laundering because it allows the source of funds to be traced. Traditionally, all financial institutions manually verified the real name of an individual customer or legal entity. This system was subject to human error and bribery. However, with the emergence of FinTech, big data, AI and facial recognition make the verification process more reliable with less human error, thus boosting the bank's transaction volumes and saving time for both the bank and customers (Noor et al., 2019). More importantly, such a verification process helps banks maintain "business as usual" during COVID-19 even the branches have reduced hours or closures.

2.4 The three FTPs in the Chinese commercial banks

At present, we are seeing the enormous potential of at least three developing trends in FTPs being gradually unleashed in China. These are ATM, VTM and mobile banking. Banks should act rapidly and decisively in response, fortifying skills and capabilities to take advantage and adapt to the new market reality.

2.4.1 Automated teller machine (ATM)

ATM is a device that provides financial services (e.g., deposits, transfers of funds, withdrawals, digital wealth management tools and obtaining account information) without the prerequisite of referring to bank clerks. Customers use a bank card or a bankbook as a medium to authenticate their identity at the ATM and access their financial services. Customers can log in to an ATM using a password or fingerprints. The login process prevents hackers from breaking into the accounts or using the account without the owner's permission (Lee, 2018). In recent years, biometric technology (i.e., facial recognition) has been used at ATMs to reinforce security (Okokpujie et al., 2018).

ATM is the first FTP invented in the world and has become one of the most commonly used FTPs. The first ATM was deployed in China in 1985. There were one million ATMs in China as of 2019, with an 80 percent increase compared to 2009 (214,880 ATMs) (Chen, 2019). During the lockdown, access to cash in society is remaining essential around the world. Given this, the ATM is playing an even more critical role in ensuring that customers have access to cash and wider banking services when customers want to avoid face-to-face or in branch interactions during the COVID-19. That said, the ATM is still an essential self-service channel.

2.4.2 Virtual teller machine (VTM)

The design of the VTM is based on the ATM but goes beyond it. Apart from including all the functions that an ATM has, a VTM can also help customers open and close bank accounts, convert currencies, issue deposit certifications and more. Video conference systems are an innovation of VTMs too. The live video conferencing consultation function allows customers to receive immediate assistance from a banking representative and solve their problems (Yuan et al., 2016). In July 2013, banks (e.g., Bank of China, Everbright Bank and Minsheng Bank) had started to launch VTMs in small batches to reduce queuing lines in some of the busy branches, in turn, improving customer experience and satisfaction. With the breakthrough in FinTech, more than 30 banks in the Chinese market are deploying VTMs in 2019 (CNINFO, 2019). More VTMs are expected in the post-COVID-19 scenario.

2.4.3 Mobile banking

Mobile banking is the most mature FTP in internet finance, but its demand and growth for financial services among Chinese customers are far from slowing. Customer interaction and affinity are expanding, and online-to-offline mobile banking functions through smartphones have become another combat zone where banks are competing fiercely for market shares, including traditional financial institutions. In 2019, mobile banking sites averaged 326 million visits per month in China (CIW Team, 2019) – a 10.9 percent increase compared to 2018. There was a 200 percent jump in new mobile banking registrations. In comparison, mobile banking traffic rose 85 percent when the government-imposed lockdown in April 2020 due to COVID-19, according to Fidelity National Information Services (FIS). Laukkanen (2017) commented that mobile banking allows customers to access various financial services via smartphones. For example, in the Bank of China mobile app overseas version, apart from the common services (e.g., branch finder, balances, transfer and remittance and accounts overview), the app also provides lifestyle services (e.g., prime student service, financial consultation, mortgage information and tips to avoid coronavirus scams) and wealth management (e.g., global accounts and currency converters). These services provide opportunities for customers to understand their financial position and tips for managing their funds and hunting for higher investment returns internationally (Yao et al., 2018). Moreover, customers can interact with their banks via mobile banking, regardless of time and location. Customers can also access details of their accounts whenever and wherever necessary. Mobile banking is rapidly becoming the preferred digital channel. Both Giovanis et al. (2019) and Ky et al. (2019) see that mobile banking will replace traditional banking – it is just a matter of time. Furthermore, the way to log in on mobile banking is fairly secure – a password, a one-time e-token password and verification code are required to log in.

In fact, there are more banking services available on phone apps in the Chinese market. In the same Bank of China mobile banking app, aside from the banking services available in the overseas version, other daily life services are also available in the Chinese version. For example, a customer can use live chat, manage utility bills, select and top-up social media memberships, call a taxi, check medical insurance, do differentiated product matching, purchase restaurant vouchers and more.

Although FinTech has steadily evolved to become a part of our everyday life, customer expectations are changing, and the financial services industry is not immune to these new demands. Moser (2015) found that people's expectation for mobile banking is higher than their penetration rate. Moser (2015) stated that mobile banking is still at the developmental stage in its life cycle. The COVID-19 shock has certainly put an increased emphasis on mobile banking.

3. Literature review

3.1 FTPs and bank performance

Digital innovation and FTPs (e.g., ATM, VTM, and mobile banking) that promote inclusive financial services provide a new impetus to the banking sector to improve its performance in several ways. For example, to improve the relationship with customers' satisfaction and expectation, staff service quality and work efficiency, and profitability. Performance is important to all companies, and there are two directions to measure organizational performance: one is financial performance and the other one is non-financial performance. Studies (Ky et al., 2019; Singh et al., 2016) have examined the implications for banks in the use of FTPs and how it affects their profitability using a wide range of financial variables traditionally considered in the banking literature (e.g., operational performance, risk profile, and leverage, net interest margin, ROE and ROA). Non-financial performance is related to corporate social responsibility, customer satisfaction and expectation, service quality, and work efficiency (Richard et al., 2009). Odawa (2013) found the self-service technologies can improve service efficiency, increasing customer satisfaction, market shares and the customer base among commercial banks in Nairobi.

According to Yang et al. (2009), FinTech is one of the important elements and tools in shaping and evolving financial innovation. Financial innovation has some risk, but its value is evident in both theoretical and empirical literature (Gomber et al., 2018; Ng & Kwok, 2017; Wang et al., 2020; Wójcik and Ioannou, 2020). In other words, customers should be satisfied if the FinTech products are useful and easy to use. Meanwhile, a successful FinTech implementation in a bank should make employees' work serving customers easier and maintain the services while working remotely during COVID-19.

David (1989) built a technology acceptance model (TAM) to test the potential users' motivation to use the information system. Ha and Stoel (2009) used the TAM to explain the relationship between the causes of users' attitudes, beliefs, intentions and behaviors. They found that the capability of a technology to be used advantageously and to create freedom from difficulty or great efforts affected users' attitudes towards accepting a new technology (David, 1989). In turn, these attitudes will affect intention and behavior accordingly (Lee and Lehto, 2013). Using both TAM and perceived risk theory, Kansal (2016) found the financial risk is negatively associated with both the users' satisfaction and expectations of self-service banking service, and the increased performance risks reduced the customers' intention to use and trust technology.

Additionally, Kim and Woo (2016) investigated consumers' expectations and acceptance of QR (quick response) codes in food traceability systems. Their results showed that the ease of use of QR codes encouraged customers' purchases. In this context, we assume that the effects of FTPs implementation on banks' performance may depend on the usefulness and usage difficulties of FTPs among the users (e.g., customers and employees).

3.2 The perceived usefulness (PU) of FTPs

3.2.1 Processes automation

Automation is the focus of intense interest in the global banking sector. Banks are prone to offer partially or totally automated machine services and move away from the labor-intensive business operational models. This improves the convenience and accessibility of bank services. The emergence of FTPs enables customers to access the services 24 hours a day and seven days a week (Mazana et al., 2016). Many financial professionals gave high ratings to FTPs – Paul Volcker (2009) is one of the former chairpersons in charge of the US Federal Reserve (1979-1987).

Volcker commented that ATMs are the most important financial innovation that he has ever seen in the past 20 years because ATMs enable customers to handle the most routine, in-branch transactions. This advantage offers customers who prefer not to visit a local bank branch or interact directly with bank staff, particularly when this is the only option during COVID-19. Furthermore, ATMs reduce the human resource costs of bank staff and branch establishment costs because customers can self-complete services (e.g., deposit or withdrawal, and opening and closing bank accounts), which traditionally were done with the help of staff.

3.2.2 Customer satisfaction

FTPs help banks attract more customers. There were 2.5 billion adults who did not have bank accounts in 2010. This was either because they had no network signal at their remote location or because the geographical environment did not meet the construction standard for bank branches (Mazana et al., 2016). However, this group of people can still be considered as potential customers for banks.

There are fewer costs in solving information asymmetry issues. Information is much more accessible for people in general, especially for customers who have always been with disadvantages in this regard (Gupta & Mandy, 2018). FinTech products enable customers to handle banking business with a self-service function, thus enhancing their participation and experience. Transparency of information decreases the perceived risks and improves customer trust (Kaushik et al., 2020).

FTPs are cost-effective, too. For example, unlike in the traditional banking process, in which customers in China pay for the cost of opening a new account, with the help of FTPs, customers can complete the account opening process for free. The exemption of these expenses in the transaction process reduces the costs to customers and should increase customers' preference for using FTPs to make banks more competitive during the COVID-19 challenges.

3.2.3 Competitive advantages

After 2010, FinTech start-ups developed rapidly – consider, for example, Alibaba with its innovative financial product, Alipay. These third-party payment platforms threaten the monopoly of traditional commercial banks by providing customers with lower costs

and higher efficiency (Temelkov, 2018). According to the financial statistics report from the People's Bank of China, RMB deposits in January 2014 decreased by 940.2 billion yuan. Most of the people admitted that they feel safe and prefer to save money on a third payment platform, such as WeChat and Alipay (Yan, 2015).

However, FTPs help commercial banks regain competitive advantages and boost market shares by increasing the number of customers and providing additional services. Sannes (2008) found that in America, one in every three banks reported increased numbers of customers who started registering in their banks when they introduced FTPs. In China, commercial banks are launching mobile banking apps one after another and are constantly updating their systems to provide cutting-edge services to customers. For example, the mobile banking app of the China Merchants Bank has been upgraded to an eighth-generation version since 2010 (CMB, 2020). Its services cover basic banking business and meet the demands of most individual customers and corporate clients. Additionally, their mobile banking also cooperates with third-party customers, such as Didi Taxi and Starbucks, to provide value-added services to customers (Guo, 2019). China Merchants Bank is the second-largest bank in terms of the number of users on their own mobile banking app. By 2019, the number of users on the China Merchants Bank's mobile banking app has reached 114 billion, with a 19.1 percent market share. Although many phone apps are introduced to customers by online finance companies (e.g., Alipay), nearly all commercial banks in China have now introduced FTPs, which has diluted the market share. This phenomenon gives the banks a foundation for moving online and staying competitive to cope with COVID-19. Therefore, FTPs have become a useful tool for balancing traditional banks and online financial companies.

Hence, we propose the following hypotheses:
H1a – There is a positive relationship between the perceived usefulness (PU) of FTPS and customer satisfaction.
H2a – There is a positive relationship between PU of FTPS and customer expectations of employee assistance.
H3a – There is a positive relationship between PU of FTPS and service quality.
H4a – There is a positive relationship between PU of FTPS and work efficiency.

3.3 The perceived difficulty of use (PD) of FTPs

The emergency of FinTech has created both threats and opportunities in the banking sector. FTPs rely on intelligent data processing and deep learning to create value for financial services (Gai et al., 2018). However, this process involves issues, for example, those of data security and information privacy. Therefore, financial service institutions are constantly experiencing cyberattacks. The Cybersecurity report (SVB, 2015) highlighted that only 35 percent of companies think they can overcome the cyber threat and do better in business with FTPs implementation. Morgan (2015) predicted that global investment in cybersecurity would reach $170 billion by 2020. Following the attack of COVID-19, this predicted figure will only grow. Indeed, more companies are seeking to conduct data collection, processing and storage through the cloud (SVB, 2015). However, according to Ng et al. (2017), regulation on the cloud is still developing. When companies use public cloud data, it is difficult to find the physical location of the data. Also, the cross-cutting service modes in the network leave opportunities for improper use of information by hackers and criminals (Gai & Sun, 2018).

Data breaches, cyber ransomware and system intrusion, are the three commonly seen cybersecurity issues (Ng and Kwok, 2017). For example, Capital One is the seventh-largest bank in America and the fifth-largest credit card issuer in the world. In 2019, Capital One informed the public that its database was hacked, and about 106 million bank card users and applicants' information was stolen (Sohu, 2020). Additionally, in 2017, many sectors – and particularly the financial sector – were affected by the Armada Collective cybercriminals. Companies received malicious emails and were asked to pay ransoms of 10 bitcoins (the market value of around $30,000) as protection fees. In the same year, a hacking gang abused the SWIFT (Society for Worldwide Interbank Financial Telecommunications) banking network. Consequently, $60 million worth of funds were stolen from the Far Eastern International Bank in Taiwan (Sohu, 2020). There is also evidence that remote working increases the risk of a successful ransomware attack significantly due to the effect of lockdown on the spread of COVID-19 (Ferbrache, 2020).

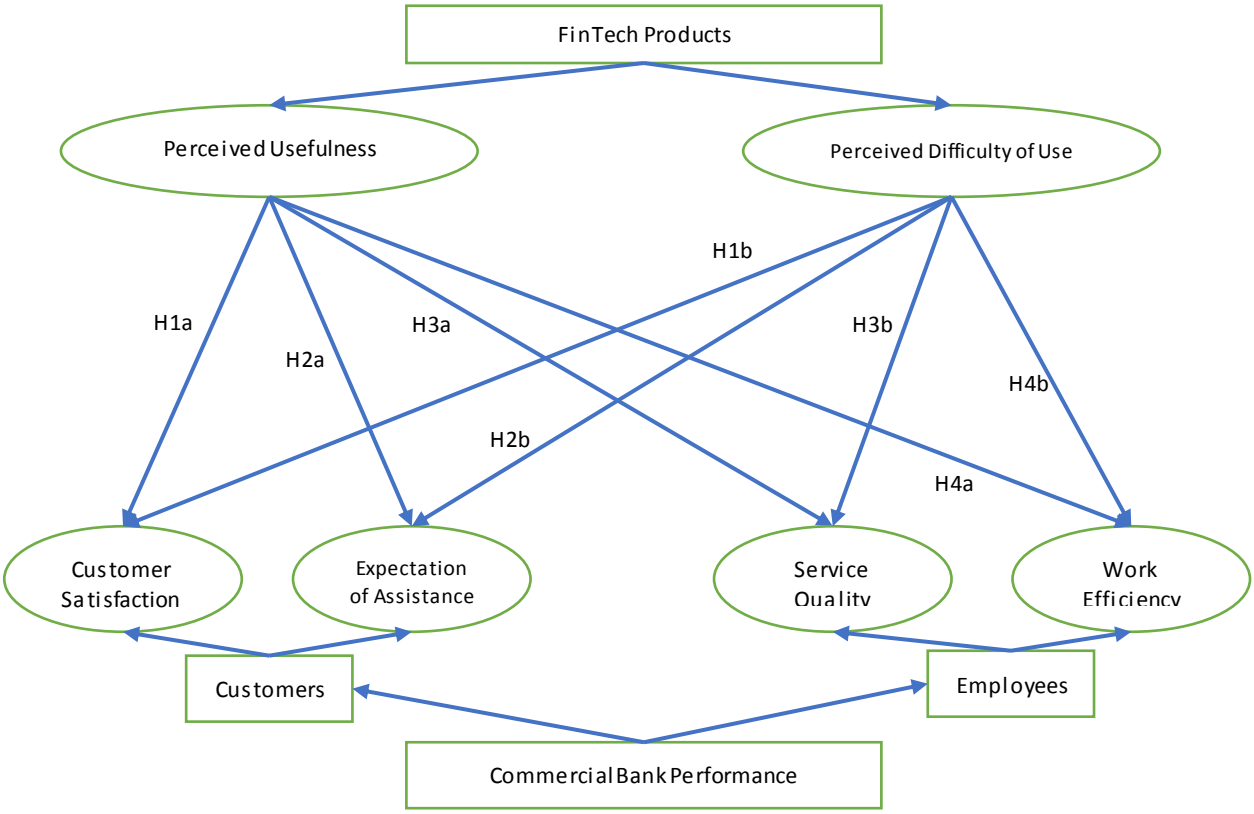
Customers have less information and expertise in financial technology than banks, and this can lead to their uneasiness about using FTPs. According to the perceived risk theory perspective (David, 1989), customers will reduce purchasing when they cannot predict the consequences or value of the purchasing behavior. Factors such as security, performance and time may affect customers' satisfaction and expectations of the product or business service (Lee, 2009). Phan et al. (2020) stated that FTPs provide new transaction methods and uncertainties to both the businesses and the users. These uncertainties can be hacker attacks, identity disclosures and internet fraud. These uncertainties can easily threaten the safety of customers' information and property and bring usage risk to banks. Financial e-fraud is an emerging problem to be tackled in the FinTech industry (Meng et al., 2019) and the COVID-19 sparks an upward trend in cybercrime (Akpan et al., 2020; Ferbrache, 2020). Therefore, customers will consider the safety, individual information privacy and performance efficacy of FTPs before using them. In turn, affected customers will expect more help and assistance from the bank.

Hence, based on our analysis and literature review, we propose the following hypotheses:

H1b – There is a negative relationship between the perceived difficulty of use (PD) of FTPS and customer satisfaction.
H2b – There is a positive relationship between PD of FTPS and customer expectations of employee assistance.
H3b – There is a negative relationship between PD of FTPS and service quality.
H4b – There is a negative relationship between PD of FTPS and work efficiency.

Figure 1 presents the conceptual framework based on the proposed hypotheses.

Figure 1. Conceptual framework



4. Research method

4.1 Questionnaire and sampling

We self-designed two questionnaires, one for bank employees and the other for bank customers. Both questionnaires were composed based on the five-point Likert scale, strongly disagree (one point) to the strongly agree (five points) continuum.

For the customer questionnaire, there were 26 questions divided into three sections.

- *Section A:* Fifteen items related to the FinTech products characteristics, including eight items for PU and eight items for PD of FTPs.
- *Section B:* Four items related to bank performance, including two items for customer satisfaction and two items for customer expectations of employee assistance.
- *Section C:* Four items related to the demography of the respondents. Demographic information includes the customer's age, gender, the number of years holding a bank account, and the knowledge of the respondents about FTPs in the bank.

For the employee questionnaire, there were 23 questions divided into three sections.

- *Section A: Eleven items* related to the FinTech product characteristics, including seven items for PU and four items for PD of FTPs.
- *Section B:* Eight items related to bank performance, including five service quality items and three work efficiency items.
- *Section C:* Four items related to the demography of the respondents. Demographic information includes the employee's age, gender, the number of years working in the bank, and FTPs in use in the bank.

Both questionnaires were originally designed in English and then translated from English to Chinese by a native Chinese speaker, an undergraduate studying at an anonymous UK University and back-translated into English by a professional translator. The back-translated English version was compared with the original English version to ensure consistency of meaning and accuracy were maintained. The Chinese version was checked and proofread by a native Chinese speaker, an academic working at the same university. The Chinese version was used for data collection. A pilot test prior to proceeding with the final data collection was conducted to check the validity and assess the internal consistency of the questionnaires. The baseline results revealed that both questionnaires had high internal validity levels and consistency in testing the conceptual framework (Figure 1). After a few grammar corrections, the questionnaires were finalized. An online survey tool (i.e., WeChat) was used for survey distribution between July to September 2020. The customers and employees were accustomed to regular use and access to WeChat and the internet.

In total, 400 completed questionnaires (307 customers and 93 employees) were submitted and used for the statistical analysis of this study. Bollen (1989) recommended researchers using a multiplier of a minimum of five to determine the sample size (Rahi et al., 2019). That means a minimum of 95 respondents in each survey should be determined. We received a good sample size in both the customer and employee surveys. Although the employee survey was short for 2 respondents, the 100 percent completion rate helped the test to be statistically valid. First, we conducted descriptive statistics and tested the reliability and validity. Second, the structural equation modeling method was used to investigate the impacts of FinTech products on bank performance.

4.2 Reliability and validity

We used Cronbach's alpha to test the reliability coefficient of the questionnaires (Hair et al., 2017). As Tables 1 and 2 showed, the total alpha coefficients of the FinTech products' characteristics (0.895 and 0.913 for the customer and employee questionnaires, respectively) and bank performance (0.702 and 0.942 for the customer and employee questionnaires, respectively), and individual items were greater than the 0.70 thresholds suggested by Hair et al. (2017). This result indicated that there was no reliability issue in the data. The internal consistency of items was tested by item-total correlations. The results indicated all correlations ranging from 0.578 to 0.847 and 0.582 to 0.824 of the customer and employee questionnaires, respectively. All results were above 0.4 levels (Loiacono et al., 2002), indicating that both questionnaires demonstrate a strong discrimination validity. An item in the disadvantages index showed an unusually low item correlation of 0.148 (less than 0.4). Although the alpha coefficient of this item was 0.942, its factor loading value was 0.033, significantly smaller than the suggested threshold of 0.4 (Hair et al., 2017). Therefore, this item was excluded from the data set, leaving a total of 25 questions in the customer questionnaire.

Additionally, we conducted an exploratory factor analysis. The rotated component matrix was inspected (see Tables 1 and 2), and all loaded values were greater than the 0.32 level suggested by Saxe and Weitz (1982). The result indicated that the distribution of values on questionnaires was adequate. The lowest eigenvalue for customer (2.26) and employee (2.84) questionnaires were significant at above 1.00.

Table 1. Customer questionnaire

Items	Item total Correlation	Mean	Standard Deviation	Cronbach's Alpha	Factor Loading	Eigenvalue	Variance (%)
FinTech Products' (FTPs) Characteristics α = 0.895							
Perceived Usefulness (PU) α = 0.946							
FTP saves the time in line.	0.819	3.94	1.023	0.938	0.750		
FTP reduces financial service time.	0.815	3.93	1.025	0.939	0.744		
FTP breaks the location limitation of financial services.	0.847	4.00	1.018	0.936	0.787		
FTP has complete functions, which meet your daily business needs.	0.780	4.03	1.099	0.941	0.693		
FTP reduces transaction costs, such as transfer expenses.	0.794	3.90	1.003	0.940	0.713	2.58	48.78
FTP can be connected with the third-party system to provide value-added services such as hotel booking and water payment.	0.819	4.10	1.075	0.938	0.747		
FTP enables you to have more autonomy to understand further the business handled by the bank.	0.774	3.89	0.971	0.941	0.684		
The accuracy of FTP avoids subjective human errors caused by morality and desire.	0.792	3.81	0.969	0.940	0.712		
Perceived Difficulty of Use (PD) α = 0.915							
Due to the lack of understanding of FTP, there will be operational errors, resulting in property losses.	0.792	3.02	1.250	0.897	0.718		
Before using FTP, it takes time to learn how to use it, which is a little annoying.	0.772	2.89	1.204	0.899	0.707		
Too fast an update results in an effort to adapt.	0.820	2.89	1.243	0.895	0.771		
Compared with counter service, the service of FTP has many limits, such as the limitation of each deposit and withdrawal amount.	0.824	3.09	0.248	0.895	0.775	2.26	58.71
FTP enables personal information to be transmitted in various payment systems, resulting in information disclosure risk.	0.816	3.12	1.268	0.895	0.759		
When using FTP, bank clerks' assistance is still necessary, and sometimes, it is more time-consuming.	0.782	2.86	1.222	0.898	0.730		
Sometimes, it is still inconvenient since some of the FTP are placed in a bank.	0.786	3.08	1.214	0.898	0.723		
Bank Performance (Customer perspective) α = 0.702							
Customer Satisfaction α = 0.733							
The service of FTP satisfied my demand.	0.578	3.89	0.964	0.718	0.789	21.08	3.05
I will be attracted by the comparably excellent service of FTP a bank, so as to become their loyal customer.	0.578	3.81	1.001	0.740	0.789		
Customer Expectation of Assistance α = 0.820							
The imperfection of FTP makes me more inclined to use counter service.	0.695	2.80	1.145	0.819	0.848	15.24	4.64
FTP reduces the interaction with bank clerks, which leads to a poor experience in banks.	0.695	2.59	1.194	0.821	0.848		

Table 2 Employee questionnaire

Items	Item total Correlation	Mean	Standard Deviation	Alpha	Factor Loading	Eigenvalue	Variance (%)
FinTech Products' (FTPs) Characteristic α = 0.913							
Perceived Usefulness (PU) α = 0.926							
FTP saves the time in line to maintain the order in the bank.	0.824	3.82	1.093	0.909	0.770		
FTP reduces the financial service time of each customer so that more customers can gain services in one day.	0.801	3.91	1.158	0.911	0.740		
FTP breaks the location limitation of financial services.	0.746	3.96	1.169	0.916	0.672		
FTP has complete functions (withdraw, deposit and transfer), which meet customers' daily business needs.	0.728	3.84	1.106	0.918	0.643	2.84	42.87
FTP reduces the operational costs; for example, paperless service reduces the cost.	0.779	3.92	1.172	0.913	0.711		
FTP can be connected with the third-party system to provide value-added services, such as hotel booking and water payment.	0.721	4.02	1.083	0.919	0.631		
The accuracy and preciseness of FTP can reduce mistakes in work.	0.759	3.84	1.086	0.915	0.682		
Perceived Difficulty of Use (PD) α = 0.783							
It's hard for customers to accept FTP.	0.582	3.27	1.190	0.736	0.587		
Connections with the third-party system can increase working pressure to maintain a good corporate relationship.	0.645	3.60	1.124	0.701	0.686	7.54	12.06
Customer complaints about the FTP, for example, ATM shallowed the debit card.	0.540	3.45	1.147	0.756	0.537		
When FTP is updated, it takes time to promote it to customers.	0.602	3.85	0.988	0.728	0.630		
Bank Performance (Employee Perspective) α = 0.942							
Service Quality α = 0.894							
FTP increases customers' satisfaction	0.755	3.73	1.012	0.868	0.728		
Customer base has increased.	0.746	3.77	1.114	0.870	0.704		
Customers' loyalty has been maintained.	0.685	3.69	1.093	0.883	0.629	3.36	20.65
FTP helps your bank gain competitive advantages.	0.762	3.78	1.041	0.866	0.737		
FTP improves the enterprise position of your bank in the industry.	0.758	3.76	1.155	0.867	0.724		
Service Efficiency of Assistance α = 0.867							
FTP increases employees' productivity (less service time per customer and more customers can be served per day).	0.770	3.75	1.039	0.794	0.813		
FTP optimizes the bank's operational costs through resource allocation	0.710	3.70	1.101	0.847	0.753	8.8	8.30
FTP facilitates the volume of bank sales.	0.762	3.80	1.099	0.799	0.808		

Table 3. Demographics of respondents

Customers		Employees	
Age	**Total population (%)**	**Age**	**Total population (%)**
18-24	32.00	<30	32.26
25-34	37.71	31-40	40.86
35-44	22.23	41-50	7.53
55-64	7.74	50-60	19.35
>65	0.00	>60	0.00
Gender		**Gender**	
Female	65.80	Female	48.39
Male	34.20	Male	51.61
Holding a commercial bank account		**Working for the Chinese commercial bank**	
1 year or less	5.54	5 years or less	27.96
1-4 years	34.53	6-10 years	33.33
5-10 years	43.65	10 years or longer	38.71
10 years or longer	16.29		

Table 4. Test of the hypothesized model

Hypotheses	Direction	Path coefficient	Standard error of estimate	t value	Results
H1a	PU to customer satisfaction	0.797	0.036	22.371***	Accepted
H1b	PD to customer satisfaction	-0.058	0.032	-1.787**	Accepted
H2a	PU to customer expectation of assistance	-2.93	0.051	-5.76***	Accepted
H2b	PD to customer expectation of assistance	0.791	0.046	17.083***	Accepted
H3a	PU Advantages to service quality	0.787	0.058	13.574***	Accepted
H3b	PD to service quality	0.129	0.062	2.069**	Rejected
H4a	PU to work efficiency	0.818	0.065	12.537***	Accepted
H4b	PD to work efficiency	0.131	0.070	1.860**	Rejected

Note: *p<0.10; **p<0.05; ***p<0.01

5. Results discussions and implications

5.1 Demographic profile

The demographic profile of the respondents can be found in Table 3. In the customer questionnaire, it shows that the majority of customers (65.8 percent) were female. Almost 60 percent of the customers were aged between 18 and 24 (32 percent) and 25 to 34 (37.71 percent). The result indicated that a high proportion of participated customers, especially millennials, prefer to interact with their banks through FTPs. This has forced banks to go digital. It is also observed that the majority of the customers have had a bank account between 1 to 4 years (34.53 percent) and 5 to 10 years (43.65 percent). This means the participating customers have held the bank account for a sufficient amount of time to notice the change of FTPs. Further analysis has been conducted to understand the customers' knowledge of FTPs. For example, while the majority of the customers use automatic teller machines (85.65 percent) and mobile banking (63.19 percent), only 9.45 percent of the customers who responded used the foreign currency exchange function (see Figure 2). Furthermore, 51.79 percent of the customers expressed that they use FTPs in most of the cases when they deal with the banking business. This result showed that, for the customers, conversations with the bank are online, and so are transactions. Most of the customers know about the FTPs from social media (e.g., WeChat and Weibo) (56.03 percent) and bank clerks (47.88 percent) (see Table 5). In general, banks have diversified methods to promote FTPs and approach current and potential customers.

Figure 2. Knowledge of FTPs in commercial banks

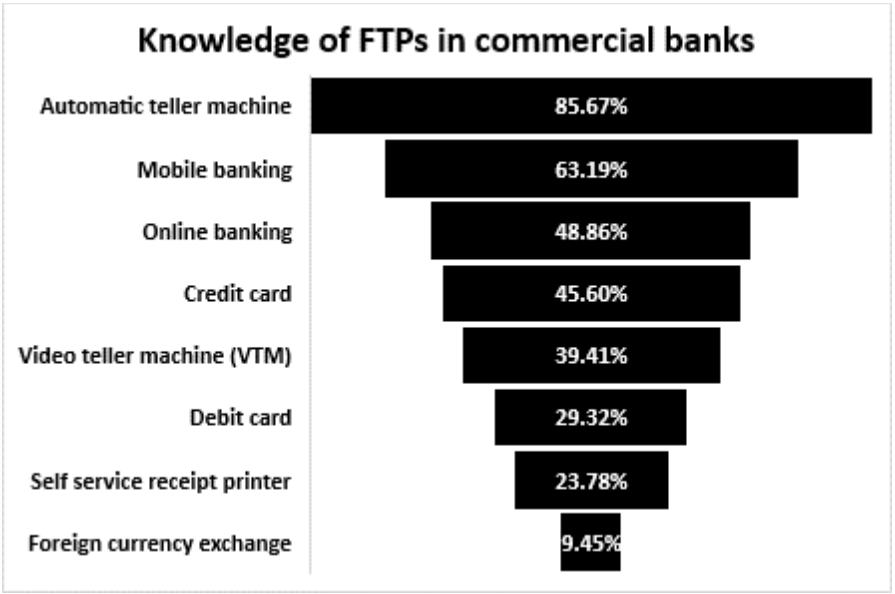
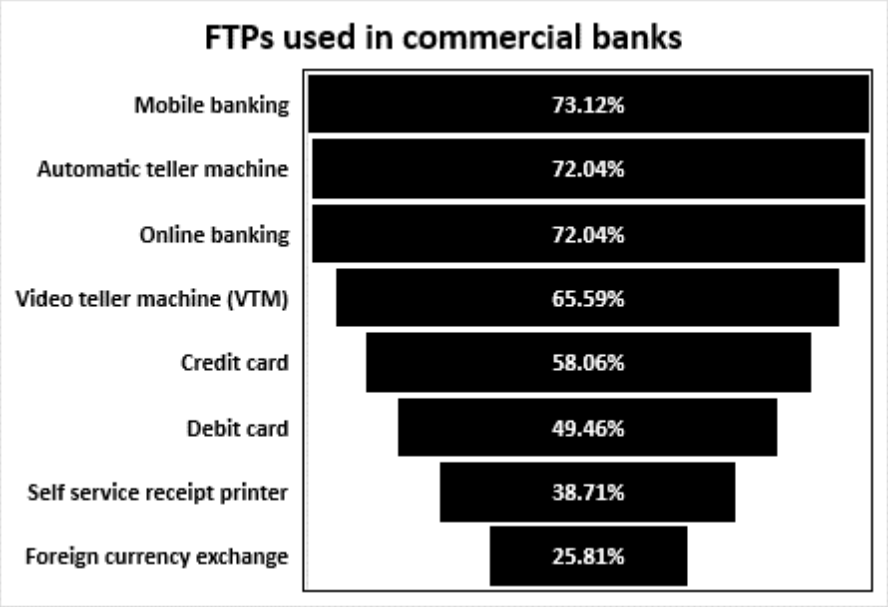


Table 5. Customer knowledge of FTPs

Frequency of using FTPs	Total population (%)
Every time I need to deal with the banking business	15.96%
In most of the cases when I deal with the banking business	51.79%
Sometimes	22.15%
Hardly ever, I prefer bank counter service	10.10%
How did you know about FTPs	
Bank clerk	47.88%
Social media (e.g., WeChat, Weibo)	56.03%
Word of mouth	30.94%
News, announcements, SMS	22.48%
Official publicity of the bank (e.g., Bank website, posters, bank Apps)	32.25%

Figure 3. FTPs used in commercial banks



The employee questionnaire shows that the gender split is equal between female (48.39 percent) and male (51.61 percent) employees in the bank. 32.26 percent of the employees are younger than 30 years old, and 40.86 percent are between 31 to 40 years old, indicating that most of the participating employees are in a younger age group. Further analysis demonstrates that 27.96 percent of the employees have worked for commercial banks in China between one and five years, 33.33 percent between six and ten years, and 38.71 percent have been with the bank for more than ten years, meaning that the participating employees have experienced changes in FTPs implementation. It is also observed among all the FTPs that mobile banking (73.12 percent), automatic teller machine (72.04 percent), online banking (72.04 percent), video teller machine (65.59 percent), and credit card (58.06 percent) are the most frequently used FTPs in commercial banks (see Figure 3). During the challenge of COVID-19, customers are looking to reduce contact with shared surfaces, and self-service has become a focal point for customers accessing financial services. Based on our result, with all the available FTPs, banks could potentially create a faster, safer and digital-first experience for their customers. For example, the tap and go and

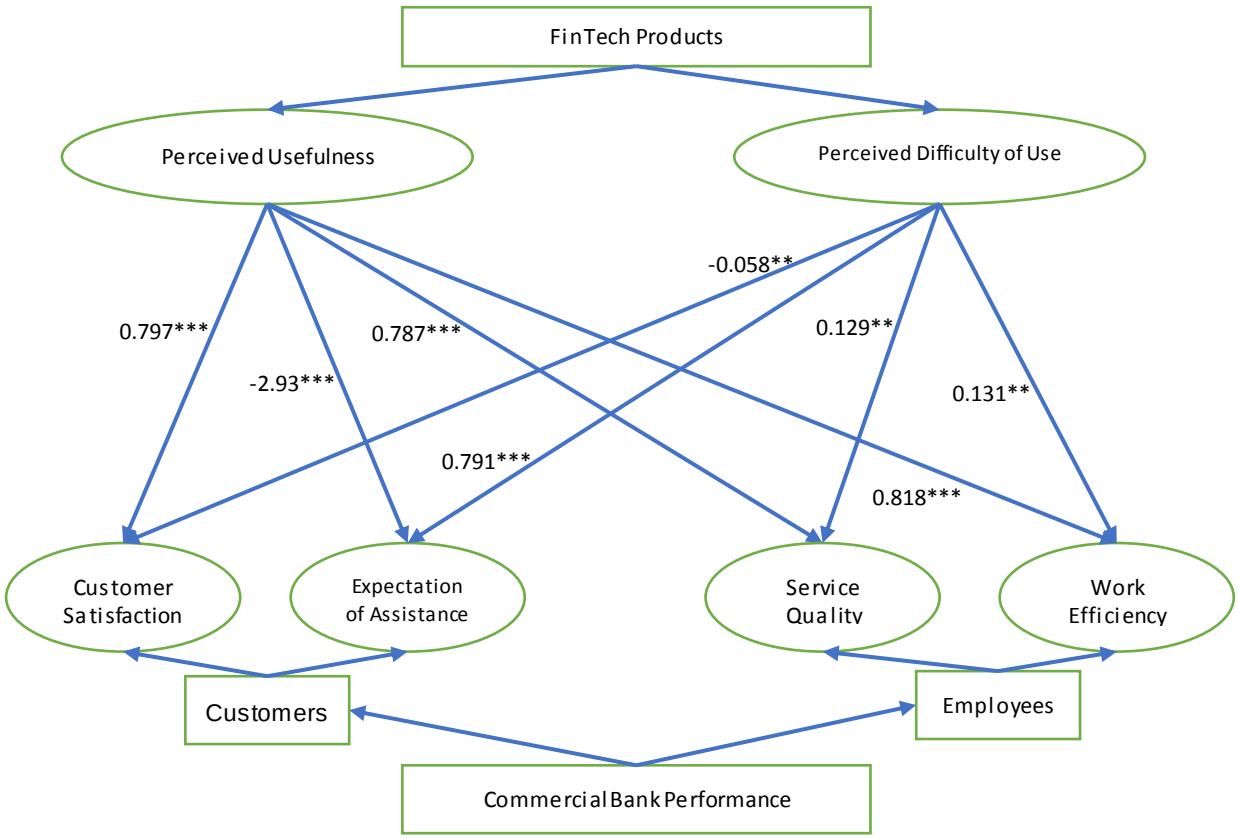
contactless payment methods can help protect and reassure customers during the COVID-19.

5.2 Testing hypotheses and results discussion

The hypothesized relationships were examined, and the results from path coefficients and t-value demonstrated that FTPs affect bank performance significantly. Consistent with Kansal (2016), our results (see Table 4 and Figure 4) show that a high level of usefulness of FTPs causes high customer satisfaction and low expectations of employee assistance on using FTPs; thus, H1a and H2a are supported. Additionally, the results also show that a high level of difficulty in using FTPs will lead to low customer satisfaction and high levels of demands requesting help from employees; therefore, H1b and H2b are supported. In the past, FinTech primarily referred to the support of bank end systems of banks, but the new developments in FinTech and the cooperation between FinTech and banks have changed how the financial services support its customers (Phan et al., 2020). In general, FTPs have seeped into individual users' everyday life. Whether it is mobile banking, reading and investing, wealth management, and overseas transactions, FinTech has steadily evolved to become a part of people's daily activities, and more areas are expected to be influenced. Due to the ease of managing and accessing banking without time and location restrictions, more customers are willing to accept FinTech and view it as a cost-effective way to interact with the bank. With the onset of the ongoing COVID-19 pandemic worldwide, there has been a huge change in how people run their businesses and how they live. FTPs enables bank customers to manage their accounts and funds and facilitate their payments through their smartphone or any other portable devices with less need to rely on brick and mortar services (Ky et al., 2019). Gone are the days when customers had to physically go to a bank branch to open an account or complete a transaction.

From the employee perspective, this study found a high level of usefulness of FTPs leads to high service quality and work efficiency; therefore, H3a and H4a are supported. We also found that although it might be hard to accept FTPs due to the difficulty of use and cybersecurity threats, employees are still confident in the service quality and their work efficiency. Therefore, H3b and H4b are rejected. This is in line with the findings of Wang et al. (2020) that most of the financial services processes are handled with the help of FinTech. Therefore, having a technology-supported organizational culture (i.e., employee perspective) will facilitate the FTPs' implementation. The involvement of employees in implementing financial innovation strategies will result in better organizational performance. Furthermore, banks usually have enormous customer bases. Not every bank or bank branch has enough workforce or the time to troubleshoot problems daily for every customer. However, this has changed with the help of FTPs. FTPs help banks leverage their big data to suggest relevant services, deals and products to their customers. The customization is a tool to engage the customers in direct and open conversations. It allows the bank employees to focus on strategic initiatives rather than poring over paperwork or other mundane work.

Figure 4. Conceptual framework results of path analysis



Note: *p<0.10; **p<0.05; ***p<0.01

5.3 Recommendations

Our findings presented novel insights into the convenience of FTPs for both customers and employees. More specifically, when customers and employees perceived the usefulness of the FTPs and ease of use at work and in their daily activities, they are more willing to accept FTPs. With the help of FTPs, banks can then collect large data and offer personalized products and services based on customers' financial behaviors and personal preferences, building trust in society and growing customer loyalty. Revenue will then automatically follow. These massive personalization tasks can be accomplished if banks are looking towards a third-party collaboration strategy, for example, by teaming up with FinTech and software companies to provide different types of technological capabilities that traditional banks do not possess. In the post-COVID-19 scenario, banks should continue their commitment to strengthening ties with the FinTech ecosystem, from which new opportunities for the financial and banking sector will keep emerging.

Nevertheless, our conceptual framework points out that service quality and work efficiency could potentially reduce FTPs' shortcomings. In other words, banks should continue considering the increased use of FinTech in their employees' work routine. In fact, because of the COVID-19 pandemic, when many activities have ground to a halt, innovation has been happening at a faster pace with technology to find solutions quickly (Akpan et al., 2020). Managers in banks should adjust the management measures to transform the bank from the traditional bank to the digital bank. For example, the bank should hire excellent talents with scientific and technological backgrounds to help improve the technical level of the banking system. Moreover,

given the perennial negative stimulus that regulations always lag behind innovation, hacking and identifying theft are unavoidable. R&D departments should monitor the occurrence of cyber-attacks in real-time and take reasonable measures to strengthen the cybersecurity system. Echoing Chang et al. (2020), this study recommends that the banks improve the system supervision to the financial technology with the reasons for fraud prevention and illegal data sharing avoidance due to one FinTech company serving multiple banks. For example, the banks should act promptly to stop long-term security stagnation and set up a separate department for cloud storage systems to make the data traceable and manage digital identities. Otherwise, cyber-attacks can open chinks (e.g., rogue and biases programs) in the armor of banks' cyber defense, thus compromising the reliability of FTPs.

Furthermore, society should develop more talented leaders who have tech fluency, drive innovation to transform technologies, and inspire change with a forward-looking and innovative vision. For example, the government or education authority should encourage and facilitate schools setting up FinTech-related courses, thus enabling people to understand and use FinTech at a younger age. This will also contribute to the future FinTech inventions. Currently, EU countries and America have more advanced experience in FinTech. Countries that are still in the developmental stages of FinTech should learn from them, perhaps by sending overseas students to study and exchange or encouraging domestic companies to work on foreign projects through investment.

5.4 Limitations and future work

One of the limitations of this study applies to the survey approach because it is difficult to generalize and expand the findings to a larger population. This study was conducted for the banking sector, aiming to investigate the impact of FinTech products on non-financial performance. In this case, the statistical results are valid based on commercial banks in China. Future studies are suggested to investigate different industries related to FTPs, such as hotels, hospitals, transport, or other industries with a different or larger sample. FinTech covers many aspects of these industries, for example, blockchain, bitcoin and P2P business operation modes. Future studies may consider exploring these technologies and their impacts on organizational performance. Additionally, due to the limited access to bank employees, only 93 employees participated in the data sample for this study. Researchers who have personal connections with the bank employees might have the advantage of access to a larger data sample size in future studies, and the results might be different when compared to this study.

6. Conclusion

The aim of this study was to examine the impact of perceived usefulness and difficulty of use of FinTech products on an organization's non-financial performance (customer satisfaction and expectation, service quality and work efficiency) among the Chinese commercial banks by proposing eight hypotheses. This study offered critical practical implications and contributions to the debate on using FTPs to galvanize the banking industry by enhancing non-financial performance. One of the contributions is the use of non-financial measures to boost banks' competitiveness by offering important additional knowledge that can indirectly reflect the PU and PE of FTPs in the banking sector. Different from other studies (Phan et al., 2020; Wang et al., 2020) that used financial performance measures, this study scrutinized the effects of PU and PE

effects on bank performance by capturing and analyzing the perception of FTPs among the key stakeholders (i.e., customers and employees) in the assessment of banks' non-financial performance. As the COVID-19 pandemic accelerates the front-end digitization, FTPs can further extend into products and services that fulfill customers' non-financial needs. Also, to combat the challenges brought by COVID-19, FTPs allow the bank to respond to a greater number of customer demands and vital operations being performed at an uncertain time. Therefore, four hypotheses were developed in our conceptual framework and each of them was identified and supported by the two perspectives (i.e., customers and employees). Thus, eight sub-hypotheses were tested. This approach has been effective after statistically tested on the eight sub-hypotheses and revealed a deeper structure of the relationship between FinTech and bank performance. In this paper, we can conclude that FTPs can be leap forward due to the acceptance by both customers and employees, and also survival the fittest because FTPs take a more significant role in the financial industry given the ongoing provision of digital services during the global COVID-19 crisis.

Acknowledgment

This work is partly supported by VC Research (VCR 0000108) for Professor Chang.

References:

Acar, O., & Çıtak, Y. E. (2019). Fintech Integration Process Suggestion for Banks. *Procedia Computer Science*, *158*92019), 971-978.

Accenture Study. (2016 April 13). Global Fintech Investment Growth Continues in 2016 Driven by Europe and Asia. *Newsroom.* https://newsroom.accenture.com/news/global-Fintech-investment-growth-continues-in-2016-driven-by-europe-and-asia-accenture-study-finds.htm

Akpan, I.J., Soopramanien, D. and Kwak, D.H., 2020. Cutting-edge technologies for small business and innovation in the era of COVID-19 global health pandemic. *Journal of Small Business & Entrepreneurship*, 1-11.

Alt, R., Beck, R., & Smits, M. T. (2018). FinTech and the transformation of the financial industry. *Electronic Markets*, 2018, 235-243.

Arner, D. W., Barberis, J., & Buckley, R. P. (2016). The evolution of Fintech: A new post-crisis paradigm? *Georgetown Journal of International Law*, *47*(4), 1271-1319.

Bollen, K. A. (1989). A new incremental fit index for general structural equation models. *Sociological Methods & Research,* 17(3), 303-316.

Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J. and Arami, M., 2020. How blockchain can impact financial services–The overview, challenges and recommendations from expert interviewees. Technological Forecasting and Social Change, *158*(2020), 120166.

Chen, Y. (2019 November 27) An analysis of the number and distribution of ATM machines worldwide and in China in 2019 shows that China has 7.89 ATM machines per 10,000 people. *Huaon*. https://www.huaon.com/story/488486

CIW Team. (2019) China Mobile Banking Overview 2019. *China Internet Watch.* https://www.chinainternetwatch.com/28776/shrinking-mobile-banking-p2p/

CMB China. (2020 September 15). The 8th Generation Mobile Banking Comes on Stage. *CMB Official.* http://www.cmbchina.com/mbankweb/

CNINFO. (2019, May 3) *Current Situation Investigation and Development Prospect Analysis Report of China's Remote Intelligent Teller Machine (vtm) Industry from 2017 to 2023.* http://www.cninfo360.com/yjbg/qthy/qt/20170321/547236.html

Data Protection Report (2020) Digital Solutions to Fight COVID-19. Council of Europe. https://rm.coe.int/prems-120820-gbr-2051-digital-solutions-to-fight-covid-19-text-a4-web-/16809fe49c

David, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340.

Dentons (2020) 2019 China Data Protection & Cybersecurity Annual Report. *Dentons. file:///C:/Users/U0033542/Downloads/2019%20China%20Data%20Protection%20Cybersecurity%20Annual%20Report.pdf*

Ferbrache, D. (2020) The rise of ransomware during COVID-19: How to adapt to the new threat environment. *KPMG. https://home.kpmg/xx/en/home/insights/2020/05/rise-of-ransomware-during-covid-19.html#:~:text=Ransomware%20isn't%20going%20anywhere&text=There's%20also%20evidence%20that%20remote,emails%20given%20levels%20of%20anxiety*

FSB. (2017). Financial Stability Implications from FinTech. *Financial Stability Board*. https://www.fsb.org/wp-content/uploads/R270617.pdf

FSB. (2019). Financial Stability Implications from Fintech. *Financial Stability Board.* https://www.fsb.org/wp-content/uploads/R270617.pdf

Gai, K., Qiu, M., & Sun, X. (2018). A survey on Fintech. *Journal of Network and Computer Applications*, *103*(2018), 262-273.

Giovanis, A., Athanasopoulou, P., Assimakopoulos, C., & Sarmaniotis, C. (2019). Adoption of mobile banking services. *International Journal of Bank Marketing, 37*(5), 1165-1189.

Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018). On the fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of Management Information Systems, 35*(1), 220-265.

Guo. Q. (2019, November 18). China Merchants Bank App8.0 Releases Open Ecology to Create New Wealth Life. *Tech Web.* http://www.techweb.com.cn/it/2019-11-18/2764590.shtm

Gupta, P. T., & Mandy, T. (2018). Fintech: The new DNA of financial services. *Journal of Services Marketing*, *20*(2), 125-135.

Ha, S., & Stoel, L. (2009). Consumer e-shopping acceptance: Antecedents in a technology acceptance model. *Journal of Business Research, 62*(5), 565-571.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., & Thiele, K. O. (2017). Mirror, mirror on the wall: A comparative evaluation of composite-based structural equation modeling methods. *Journal of the Academy of Marketing Science, 45*(5), 616-632.

Kansal, P. (2016). Perceived risk and technology acceptance model in self-service banking: A study on the nature of mediation. *South Asian Journal of Management, 23*(2), 51.

Kaushik, A. K., Kaushik, A. K., Mohan, G., & Kumar, V. (2020). Examining the antecedents and consequences of customers' trust toward mobile retail apps in India. *Journal of Internet Commerce, 19*(1), 1-31.

Kianto, A., Andreeva, T., & Pavlov, Y. (2013). The impact of intellectual capital management on company competitiveness and financial performance. *Knowledge Management Research & Practice, 11*(2), 112-122.

Kim, Y. G., & Woo, E. (2016). Consumer acceptance of a quick response (QR) code for the food traceability system: Application of an extended technology acceptance model (TAM). *Food Research International, 85*(2016), 266-272.

Ky, S., Rugemintwari, C., & Sauviat, A. (2019). Is Fintech good for bank performance? The case of mobile money in the East African Community. *The Case of Mobile Money in the East African Community*, June 5, 2019. Hal-02155077.

Lee, D. Y., & Lehto, M. R. (2013). User acceptance of YouTube for procedural learning: An extension of the Technology Acceptance Model. *Computers & Education, 61*(1), p193-208.

Lee, J. O. (2018). Automatic Teller Machine. US Patent No. 10,096,212. Washington, DC: US Patent and Trademark Office.

Loiacono, E. T., Watson, R. T., & Hoodhue, D. L. (2002). WEBQUAL: Measure of web site quality. *Marketing Educators Conference: Marketing Theory and Applications, 13*(3), 432–437.

Mazana, R., Rupere, T. & Kabanda, G. (2016). An assessment of the impact of self-service technology (SST) on firm performance: Case study of a bank in Zimbabwe (2009-13). *Journal of Payments Strategy & Systems*, *10*(1), 96-112.

Meng, W., Zhu, L., Li, W., Han, J., & Li, Y. (2019). Enhancing the security of FinTech applications with map-based graphical password authentication. *Future Generation Computer Systems, 101*(2019), 1018-1027.

Moser, F. (2015). Mobile Banking: A fashionable concept or an institutionalized channel in future retail banking? Analysing patterns in the practical and academic mobile banking literature. *International Journal of Bank Marketing, 33*(2), 162-177.

Ng, A. W., & Kwok, B. K. (2017). Emergence of Fintech and cybersecurity in a global financial centre. *Journal of Financial Regulation and Compliance*, *25*(4), 422-434

Nguyen, Q. K. (2016). *Blockchain-a financial technology for future sustainable development* [Paper presentation]. 3rd International Conference on Green Technology and Sustainable Development (GTSD), 2016.

Noor, U., Anwar, Z., Amjad, T., & Choo, K. K. R. (2019). A machine learning-based FinTech cyber threat attribution framework using high-level indicators of compromise. *Future Generation Computer Systems, 96*(2019), 227-242.

Okiro, K., & Ndungu, J. (2013). The impact of mobile and internet banking on performance of financial institutions in Kenya. *European Scientific Journal, 9*(13), 146-161.

Okokpujie, K., Noma-Osaghae, E., Okesola, O., Omoruyi, O., Okereke, C., John, S., & Okokpujie, I. P. (2018) *Integration of iris biometrics in automated teller machines for enhanced user authentication.* Singapore: Springer.

Par, D. D. (2015). Financial innovation and the state: Lessons for 21st century climate finance from the 19th century Railway Era. *CEPII FRANCE*. https://www.strategie.gouv.fr/english-articles/financial-innovation-and-state-lessons-21st-century-climate-finance-19th-centur

Phan, D. H. B., Narayan, P. K., Rahman, R. E., & Hutabarat, A. R. (2020). Do financial technology firms influence bank performance? *Pacific-Basin Finance Journal, 62*(2020), 101210.

Rahi, S., Alnaser, F.M. and Abd Ghani, M., 2019. Designing survey research: recommendation for questionnaire development, calculating sample size and selecting research paradigms. *Economic and Social Development: Book of Proceedings*, 1157-1169.

Rega, F. G. (2017). The bank of the future, the future of banking-An empirical analysis of European banks. Available at SSRN 3071742.

Richard, P. J., Devinney, T. M., Yip, G. S., & Johnson, G. (2009). Measuring organisational performance: Towards methodological best practice. *Journal of Management, 35*, 718– 804.

Sannes, R. (2008). Self-service banking: Value creation models and information research agenda. *Information Science,12*(2), 145-163.

Saxe, R., & Weitz, B. A. (1982). The SOCO scale: A measure of the customer orientation of salespeople. *Journal of Marketing Research, 19*(3), 343-351.

Sohu. (2020) Disclosure, blackmail, invasion ... How terrible is the security problem of financial technology? *Sohu.* https://www.sohu.com/a/366035046_99960938

SVB. (2015) As Technology Evolves, New Risks Drive Innovation in Cybersecurity. *SiliconValley Bank.* https://www.svb.com/cybersecurity-report

Temelkov, Z. (2018). Fintech firms opportunity or threat for banks? *International Journal of Information, Business and Management, 10*(1), 137-143.

Wang, R., Liu, J., & Luo, H. (2020). Fintech development and bank risk taking in China. *European Journal of Finance*, 2020(13), 1-22.

Wójcik, D. and Ioannou, S., 2020. COVID‐19 and Finance: Market Developments So Far and Potential Impacts on the Financial Sector and Centres. *Tijdschrift voor economische en sociale geografie*, 111(3), 387-400.

Yan, S. Y. (2015). Impact of internet finance on traditional banks and countermeasures. *People's Forum, 8*(1), 23.

Yang, J., Cheng, L., & Luo, X. (2009). A comparative study on e-banking services between China and the USA. *International Journal of Electronic Finance, 3*(3), 235-252.

Yuan, F., Liang, D., Zhang, G., Zhichao, L. V., Guangdong, S. H. I., Liu, S., & Chen, J. (2016). US "Virtual teller machine system." US Patent Application No. 14/894,091.