

Can citizen Internet banking in China become a champion in the digital transformation era?

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Abstract. *This study aims to make theoretical and practical contributions by addressing stagnation in the context of digital transformation (DX) and proposing specific measures. Focusing on the banking industry's skilled response to rapid changes to maintain and improve competitiveness, this study employs quantitative methods to investigate the expectations and assessments of Chinese financial service users regarding Internet banking. With a clear objective, this study seeks to contribute theoretically and practically by addressing stagnation in DX. Specifically, it focuses on the banking industry's response to rapid changes, employing quantitative methods to assess and understand Chinese financial service users' expectations of Internet banking. The results reveal that the prevalent use of payment services through mobile applications has significantly expanded the scope of financial services among citizens. Key factors driving innovation in the financial industry through fintech include close communication with consumers, service enhancement and sophistication and ensuring reliability. Privacy and the ethical use of personal information have been found to function as an indirect pathway that plays a vital role in socio-economic activities, acting as a critical element for the future development of the financial industry. These findings provide actionable insights for fostering innovation and development in the financial sector. The uniqueness of this study lies in its primary quantitative data analysis, which compares the prospects of financial services in China's advanced DX market. It shows the path the banking industry should take, emphasising the simplicity of mobile applications and the high frequency with which vital components are used. Going beyond theoretical insights, this research is a practical guide for implementing specific actions in a real business environment. It provides valuable insights into the Chinese market and offers guidelines for the broader financial industry currently navigating the intense waves of DX, ultimately aiming for sustainable and effective DX.*

Keywords: digital transformation, fintech, Internet banking, mobile application, China.

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Introduction

Background of the study

App-based services have continued to flourish while posing a challenge to Internet banking in China's financial industry. This change is rapid, and one of the key drivers is the proliferation of smartphones and the development of digital payment platforms in China. China's digital payment market is led by major players, such as Alipay and WeChat Pay, which offer convenient and fast payments through smartphone apps. Mobile payment apps are widely used for all kinds of payments, including daily payments, online shopping, restaurant payments and purchasing public transportation tickets (Ye et al., 2023). Furthermore, QR code payments are becoming widely accepted, and the use of cash is declining.

Behind this transformation is the Chinese government's active support for the digital economy and technological innovation by the private sector (Kshetri, 2023). The impact of the COVID-19 pandemic has also made contactless digital payment methods increasingly important. However, rapid digitisation also poses some challenges. The privacy of personal information and cybersecurity issues have emerged, requiring tighter regulations to address them (Chong et al., 2023). In addition, it is imperative to adopt an inclusive approach towards the elderly and segments of the population who face digital barriers.

In summary, the study suggests that China's digital payment market is growing rapidly and is expected to continue to expand. However, it is also an important area where challenges must be overcome. For what reason has Internet banking been slow to grow in China, in contrast to the growth of apps such as Alipay and WeChat Pay? In this way, it will probably function as an infrastructure for citizens' daily lives. One of the main objectives of this study is to obtain tips for revitalising Internet banking in China, which is still insufficient compared to its great potential.

Purpose of the study

This study seeks to investigate and propose strategic measures to overcome stagnation in the realm of DX, specifically focusing on the banking industry's response to rapid changes to sustain and elevate competitiveness. Using quantitative methods, this research aims to comprehensively explore the expectations and evaluations of Chinese financial service users regarding Internet banking. The objective is to provide theoretical insights and practical guidelines for fostering innovation and development within the financial sector in the dynamic landscape of DX.

Significance of the study

Several factors are considered responsible for the lack of growth in online banking in China compared to app-based payment services, such as Alipay and WeChat Pay.

Convenience and comprehensiveness: Alipay and WeChat Pay not only provide a means of payment but also offer a variety of value-added services. These apps allow users to perform many activities on one platform, such as receiving and sending information, using social media, engaging in online shopping and booking tickets. On the other hand, Internet banking focuses primarily on banking services and makes limited comprehensive service offerings (Eng & Tih, 2023).

User experience: App-based payment services offer an intuitive and easy user experience. Alipay and WeChat Pay offer very convenient payment methods, such as QR code payments. In contrast, navigating online banking websites can be more complex and less convenient than using mobile apps (Taylor, 2023).

Penetration and brand awareness: Alipay and WeChat Pay have built strong brand awareness through advertising and marketing. Many retailers, stores and tourist destinations accept these apps, and users are familiar with them. Internet banking is often less known and less popular with the average consumer, limiting its appeal as an option compared to app-based payment services (Ali et al., 2023).

Government regulation: The Chinese government closely monitors and regulates the digital payment market. Although Alipay and WeChat Pay are subject to regulation, online banking faces strict regulations that can make it difficult to introduce or expand new services (Hua & Huang, 2021).

These factors give app-based payment services, such as Alipay and WeChat Pay, an advantage in China's digital payment market. Although online banking has a strong presence, it may need to offer more value-added and user-friendly features to function as an infrastructure for citizens' lives.

In line with this awareness of the problem, this study aims to identify in an exploratory manner the factors that cannot be overlooked to revitalise the use of online banking and users' views and, in turn, to propose important guidelines for the development of online banking strategies through suggestions that can be obtained from the analysis of primary data. We will also propose important guidelines for banks in planning their online banking strategies by deriving suggestions from primary data analysis.

Since limited empirical analysis has been conducted on the prospects of DX in China's financial services, on the paths to demonstrate the functions of service use in citizens' lives, and on users' decision-making, this study conducted an exploratory analysis based on primary data to obtain answers to this issue. This is the greatest significance and contribution of this study.

Literature review

The growth of app use in the Chinese financial market

A case study showing the rise of Alipay

Popularisation of mobile payments: Alipay is one of the leaders in popularising mobile payments in China. Using the Alipay app, users can make various payments using their smartphones. This includes online shopping, paying at restaurants, purchasing public transportation tickets and paying government fees. Alipay has been widely accepted in China for its ease and convenience in mobile payments (Xu et al., 2023).

Global expansion

Alipay is flourishing not only in China but also in international markets. It offers foreign exchange services to tourists and allows them to make payments abroad using Alipay wallets. Alipay is also accepted by international retailers and restaurants for providing benefits to visitors and foreign users. This example shows that Alipay plays a pioneering role in the field of digital payments in China and abroad. Alipay provides a user-friendly payment platform, and its growth is becoming a new standard for mobile payments (Xu et al., 2023).

In Japan, Alipay is not that common. It is relatively rare for the average Japanese retailer or service provider to accept Alipay. Some tourist attractions, luxury brand stores and major airports accept Alipay for Chinese visitors to Japan. However, in general, everyday payments, credit cards and cash are the primary payment methods used in Japan (de Seta, 2023).

Alipay is used in some tourist attractions and luxury brand stores as an effective payment method to support the buying behaviour of Chinese visitors to Japan. In contrast, it is still not commonly accepted in most retail stores and restaurants. For consumers in Japan, cash, credit cards, debit cards and electronic money (e.g. Suica, Pismo and Rakuten Edy) are the most commonly used payment methods (Fujiki, 2023).

However, in the Japanese market, where inbound is currently one of the main policies, there is a noticeable trend to introduce Alipay as a service specifically for Chinese visitors to Japan to increase its influence in that market. Some Japanese companies have introduced Alipay to attend to the growing number of Chinese tourists. In the future, it is likely that the use of Alipay for Chinese visitors to Japan will increase and continue to do so for some time to come (Huang et al., 2023). Next, we discuss the growth of WeChat Pay.

Penetration in China

WeChat Pay is widely popular in China and can be used in many places, such as retail stores, restaurants, public transportation and government offices. Users can scan QR codes within the WeChat app to make payments easily. This has reduced the use of cash, and contactless payments are becoming more common.

Online and offline integration: WeChat Pay integrates online and offline payments, allowing users to manage various payments using the app, from web shopping to restaurant payments. This provides benefits and improved convenience for users (Wang et al., 2023). WeChat Pay is gaining acceptance outside of China and is available to international visitors to China. It is increasingly accepted at international airports, major tourist attractions and luxury brand stores, especially for tourists from China (Zhu & Xu, 2023).

Offering various services: WeChat Pay offers users more options than just making payments. These uses include purchasing public transportation tickets, recharging cell phones, booking plane tickets and making hotel reservations. Users can access these services through the WeChat app, allowing them to perform many daily activities on one platform (Wang et al., 2023).

Digital marketing

WeChat Pay also provides a platform for advertisers and retailers to run targeted advertisements and campaigns, making it a digital marketing vehicle. WeChat Pay and Alipay employ robust digital marketing strategies to engage users effectively. Leveraging their extensive user bases, these platforms use targeted advertising, personalised promotions and integration with popular services to enhance user experiences. They employ data-driven insights to tailor advertisements, ensuring relevance to individual preferences (Daoud et al., 2023). Furthermore, both platforms leverage social features, such as group-based promotions and referrals, to foster a sense of community. The seamless integration of financial services, e-commerce and social functionalities contributes to the success of their digital marketing endeavours, creating a comprehensive and user-friendly ecosystem.

These examples illustrate the utility of WeChat Pay and its wide usage. WeChat Pay has been accepted by many users in China and abroad and is playing a significant role in the digital payment market (Tinmaz & Doan, 2023).

Increased diversity and convenience of services

The proliferation of cashless services within mobile applications contributes significantly to service diversity and improved convenience. This paradigm shift aligns with a consumer-centric approach that emphasises efficiency and accessibility. Integrating various services, such as payments, financial management and loyalty programmes, within these apps focuses on fostering a seamless user experience. The convenience of mobile transactions corresponds to evolving consumer preferences (Susiang et al., 2023). The transformative impact of cashless services within apps extends beyond streamlining financial interactions to nurturing a holistic and user-centric ecosystem that adapts to contemporary lifestyles (Larsson & Hatzigeorgiou, 2023).

Privacy and ethical use of personal information

Ensuring privacy and ethical use of personal information within financial services apps is paramount (Aldboush & Ferdous, 2023). Stringent regulatory frameworks require the implementation of robust data protection measures to effectively safeguard sensitive user details. Ethical considerations involve transparent communication regarding data usage, obtaining informed consent and providing users with control over their information. Striking a balance between data use for personalised financial services and respecting individual privacy rights is essential. Responsible handling of personal information fosters trust and integrity. It is the ethical responsibility of financial service apps to maintain user confidence and uphold ethical standards in the rapidly evolving digital landscape (Zostant & Chataut, 2023).

Security and trustworthiness of financial app services

Ensuring the security and trustworthiness of financial app services is paramount in fostering user confidence (Hildt & Laas, 2022). Healthy cybersecurity measures, including encryption protocols and multi-factor authentication, are imperative to protect sensitive financial data from unauthorised access and cyber threats. Regular security audits and updates further strengthen the resilience of these apps. Transparent communication about security features, compliance with industry standards and adherence to regulatory frameworks contribute to user trust.

The establishment of secure channels for transactions and a commitment to promptly address any security incidents underscore the app's commitment to user safety. In the dynamic landscape of financial technology, prioritising the safety of user information and transactions is crucial for sustaining trust and ensuring the reliability of financial app services (Krishna et al., 2023).

An artery role in socio-economic activities

Financial app services play a pivotal role in catalysing socio-economic activities by providing efficient and accessible financial tools. These apps empower users with convenient access to banking services, seamless fund transfers, bill payments and real-time financial management. Additionally, they facilitate investment opportunities, allowing users to participate in the capital market and wealth-building activities. The inclusive nature of these services improves financial inclusion by reaching underserved populations and fostering economic participation

(Kandpal et al., 2023).

Furthermore, financial apps contribute to a cashless economy, reducing reliance on physical currency and enhancing transactional efficiency. The ability to monitor expenses, set budgets and receive personalised financial insights promotes responsible financial behaviour. Beyond individual benefits, the aggregate impact of widespread financial app usage includes the potential for macroeconomic stability through improved financial literacy, increased investment and enhanced consumer spending (Kandpal et al., 2023). In essence, these apps serve as catalysts for economic growth, fostering financial well-being, accessibility and literacy at both individual and societal levels.

Hypothesis building and analytical model

Based on the academic discussions above, the hypotheses are created and summarised in Table 1. We have chosen two steps of the analytical approach, which are shown in Figures 1 and 2.

Table 1. Hypotheses of the study

H-number	Hypotheses
H1	'Increased diversity and convenience of services' has a significant impact on 'An artery role in socio-economic activities'.
H2	'Security and trustworthiness of financial app services' has a significant impact on 'An artery role in socio-economic activities'.
H3	'Increased diversity and convenience of services' has a significant impact on 'Privacy and ethical use of personal information'.
H4	'Security and trustworthiness of financial app services' have a significant impact on 'Privacy and ethical use of personal information'.
H5	'Privacy and ethical use of personal information' has a significant impact on 'An artery role in socio-economic activities'.
H6	'Increased diversity and convenience of services' have a significant indirect effect on 'An artery role in socio-economic activities' through 'Privacy and ethical use of personal information'.
H7	'Security and trustworthiness of financial app services' have a significant indirect effect on 'An artery role in socio-economic activities' through 'Privacy and the ethical use of personal information'.

The basic analytical model for the study is indicated in Figure 1.

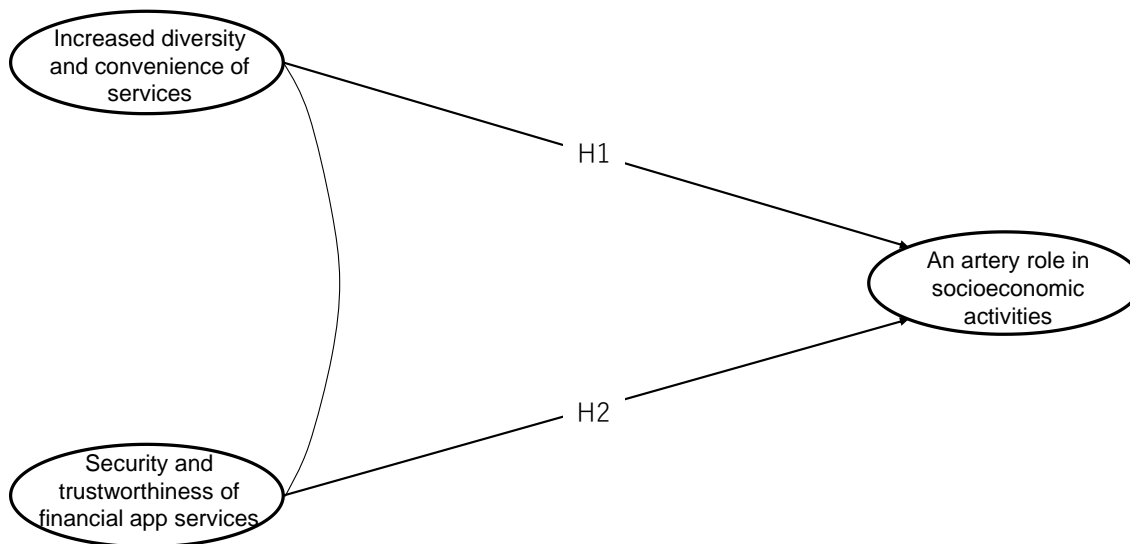


Figure 1. Conceptual framework of the direct model (authors' arrangement)

Source: compiled by the authors.

Figure 2 shows our final analytical model with a mediating role, which exhibits the privacy and the ethical use of personal information.

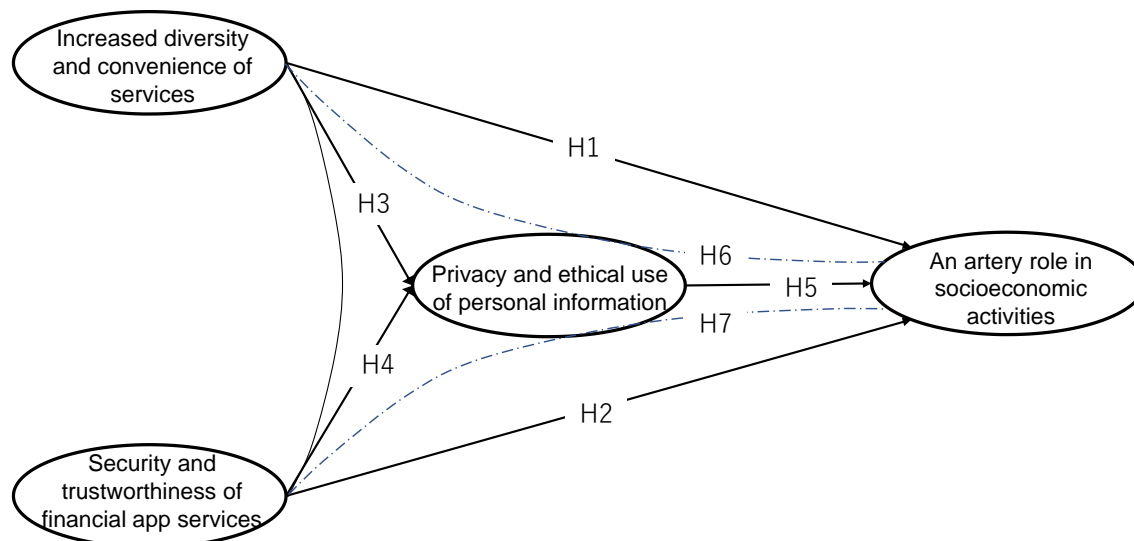


Figure 2. Conceptual framework with a mediating effect model (authors' arrangement)

Source: compiled by the authors.

Methodology

Quantitative approach and conceptual model

The quantitative analysis in this study was conducted in two stages. First, quantitative analysis was conducted by setting 'variety and convenience of services' and 'safety and trust of services' as antecedents among the factors obtained, as pathways through which people perceive financial service applications to function as socio-economic arteries. Next, we assume 'personal information protection and ethical use of information' as an intermediary factor and examine the degree of people's perception of financial apps when mediated through this intermediary factor.

This method was used to measure the mediating effect of the 'personal information protection and ethical use of information' factor on the behaviour of Chinese financial service app users in their service use behaviour, and in turn, to examine the important factors that financial service app providers should keep in mind.

Data collection and analysis

In this research, a quantitative analysis was conducted to understand and analyse the outlook of Internet banking in China. The study specifically focused on app-based services, exploring the enhancement of banking services in the Chinese market and the diversification of options for users.

The choice to conduct a survey of Chinese financial service users stems from the specific focus of this research on the dynamics of the financial industry in China. China represents a significant and rapidly evolving market in the global financial landscape, with notable advancements in the DX. The survey was conducted with a sample size of 173 participants to ensure a comprehensive understanding of the perceptions and expectations of Chinese financial service users. The sample selection prioritised maintaining a balanced representation across gender and other demographic attributes to enhance the validity and reliability of the collected data. This approach aims to provide insights tailored specifically to the unique characteristics and preferences of the Chinese financial market.

Data collection adopted a web-based survey approach, gathering responses from Chinese Internet banking users. The study delved into the intricate details of app-based services, examining trends, preferences and expectations of users regarding banking services. The analysis aimed to provide a comprehensive understanding of the evolving landscape of Internet banking in China, offering insights into the potential advancements and diversification of options consumers. The selected analytical methods, including SPSS and AMOS, enabled a robust examination of the gathered data, contributing to a nuanced exploration of the path towards enriched banking services and expanded user options in the Chinese market.

Analytical approach

The data analysis for this study involved collecting primary data, as mentioned above, and verifying the hypotheses by applying statistical analytical methods to the original dataset. Statistical tools from SPSS v26 and AMOS v26

were employed for descriptive statistics, factor analysis, verification of multicollinearity using Cronbach's alpha and structural equation modelling (SEM) analysis based on the factors obtained.

Findings and analysis

Data profile

The data profile is succinctly described in Table 2. A meticulous consideration of the balance between attributes facilitated the collection of a targeted sample of 173. This achievement aligns with the intended goal outlined in the paper.

Table 2. Demographic profile (authors' arrangement)

Profile	Frequency	percentage	Cumulative percentage
Gender			
Male	82	47.4	47.4
Female	91	52.6	100.0
Total	173	100.0	
Age			
U18	1	0.6	0.6
18–25	50	28.9	29.5
26–30	51	29.5	59.0
31–40	52	30.1	89.0
41–50	14	8.1	97.1
51–60	4	2.3	99.4
Above 60	1	0.6	100.0
Total	173	100.0	
Education			
J High	6	3.5	3.5
High school	7	4.0	7.5
Career college	17	9.8	17.3
University	101	58.4	75.7
Grad school	42	24.3	100.0
Total	173	100.0	

Source: compiled by the authors.

Table 3 provides descriptive statistics on the subject evaluations on Internet banking obtained using the Likert scale among the collected data.

Table 3. Descriptive analysis (authors' arrangement)

	N	Min.	Max.	Mean	Dev.
11, Rate the convenience, service and other aspects of Int BNK app.	173	1	10	7.82	1.674
12, I trust the safety of Int BNK and other services.	173	1	5	4.10	0.876
13, The current real-name system in China makes Int BNK and services such as WeChat and Alipay more secure.	173	2	5	4.25	0.822
14, Int BNK does not have the problem of losing personal data.	173	1	5	3.66	1.070
15, Services such as Int BNK are worth using and reliable.	173	1	5	4.06	0.847
16, In China, banks that offer services such as Int BNK are doing a lot to protect their customers' information.	173	1	5	4.01	0.892
17, They trust functions such as Int BNK compared to money transfer functions of apps such as WeChat and Alipay.	173	1	5	3.94	0.944
18, Compared to money transfer functions such as WeChat and Alipay, I find functions such as Int BNK more convenient.	173	1	5	3.54	1.043
	N	Min.	Max.	Mean	Dev.
19, Now that WeChat's Zero Qian Tong and Alipay's Yu Zhu Bao offer higher interest rates than banks, would you deposit money in Zero Qian Tong or Yu Zhu Bao (yes or no)?	173	1	2	1.35	0.479
20, I will deposit money with WeChat and Alipay's Yuzhuhu Bao because I think they are safer than banks.	173	1	5	3.16	0.865
21, The advent of Int BNK has made a big difference in making life easier.	173	1	5	4.09	0.855
25, Int BNK services have become an integral part of life.	173	1	5	4.08	0.863

Table 3 (cont.). Descriptive analysis (authors' arrangement)

26, Int BNK services play an important role in today's cashless society.	173	1	5	4.20	0.821
27, The advent of Int BNK has facilitated the flow of money beyond the previous counter transactions.	173	1	5	4.13	0.818
28, The advent of Int BNK has improved customer service more than before with full counter transactions.	173	1	5	4.11	0.838

Note: Int BNK = Internet banking.

Source: compiled by the authors.

Multicollinearity test

Table 4 shows the absence of multicollinearity in the multivariate analysis. We examined the correlations between the candidate items assumed to be latent variables in the SEM analysis. Variables that showed an excessively high correlation were removed. As indicated in Table 3, all observed variables were reasonably related to each other without very high correlations. Therefore, the variables can be tested for further analysis.

Table 4. Correlation diagram (authors' arrangement)

		Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q25	Q26	Q27	Q28
Q11	Pearson Correlation	1														
	Sig. (2-tailed)															
Q12	Pearson Correlation	.425**	1													
	Sig. (2-tailed)	0.000														
Q13	Pearson Correlation	.359**	.553**	1												
	Sig. (2-tailed)	0.000	0.000													
Q14	Pearson Correlation	.302**	.429**	.381**	1											
	Sig. (2-tailed)	0.000	0.000	0.000												
Q15	Pearson Correlation	.442**	.673**	.614**	.509**	1										
	Sig. (2-tailed)	0.000	0.000	0.000	0.000											
Q16	Pearson Correlation	.343**	.505**	.473**	.568**	.453**	1									
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000										
Q17	Pearson Correlation	.383**	.450**	.370**	.481**	.455**	.414**	1								
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000									
Q18	Pearson Correlation	.307**	.435**	.359**	.410**	.498**	.396**	.439**	1							
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000								
Q19	Pearson Correlation	-0.107	-0.102	-0.135	-.252**	-0.136	-.182*	-0.135	-0.044	1						
	Sig. (2-tailed)	0.163	0.183	0.076	0.001	0.073	0.017	0.078	0.564							
Q20	Pearson Correlation	0.032	0.147	-0.055	.165*	0.067	0.127	.153*	.338**	-0.133	1					
	Sig. (2-tailed)	0.675	0.053	0.474	0.030	0.382	0.096	0.044	0.000	0.080						
Q21	Pearson Correlation	.422**	.539**	.457**	.369**	.563**	.418**	.474**	.378**	-0.146	0.076	1				
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.055	0.321					
Q25	Pearson Correlation	.448**	.543**	.473**	.337**	.567**	.377**	.541**	.485**	-0.149	0.101	.638**	1			
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.186	0.000				
Q26	Pearson Correlation	.387**	.472**	.511**	.231**	.460**	.348**	.383**	.246**	-0.035	-0.004	.546**	.496**	1		
	Sig. (2-tailed)	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.001	0.651	0.961	0.000	0.000			
Q27	Pearson Correlation	.234**	.427**	.376**	.196**	.476**	.397**	.325**	.240**	-0.100	0.087	.491**	.448**	.411**	1	
	Sig. (2-tailed)	0.002	0.000	0.000	0.010	0.000	0.000	0.000	0.001	0.190	0.256	0.000	0.000	0.000		
Q28	Pearson Correlation	.209**	.427**	.323**	.334**	.425**	.442**	.280**	.324**	-0.054	.209**	.506**	.431**	.517**	.378**	1
	Sig. (2-tailed)	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.484	0.006	0.000	0.000	0.000	0.000	
**. Correlation is significant at the 0.01 level (2-tailed).																
*. Correlation is significant at the 0.05 level (2-tailed).																

Source: compiled by the authors.

Factor analysis

Based on the dataset from which multicollinearity was eliminated, factor analysis was conducted, and SEM preparations were advanced. At the same time, Cronbach's alpha was also evaluated for each generated factor (Table 5). The 13 questions presented in Table 4 resulted in the generation of four factors. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.895, and the Rotation Sums of Squared Loadings were 67.6%.

The first factor, comprising four questions, is named 'An artery role in socio-economic activities'. The second factor, comprising three questions, is named 'Increased diversity and convenience of services'. The third factor, consisting of four questions, is named 'Security and trustworthiness of financial app services'. The final fourth factor, made up of two questions, is named 'Privacy and ethical use of personal information'. The reliability

coefficients (Alpha) for each factor are 0.784, 0.735, 0.737 and 0.717, respectively, all indicating reliability above 0.7, ensuring the reliability of the data (Bonett & Wright, 2015).

Table 5. Factor analysis (authors' arrangement)

	Components				Alpha
	F1	F2	F3	F4	
28, The advent of Int BNK has improved customer service more than before with full counter transactions.	0.763	0.194	-0.117	0.326	0.784
27, The advent of Int BNK has facilitated the flow of money beyond the previous counter transactions.	0.693	0.090	0.202	0.142	
26, Int BNK services play an important role in today's cashless society.	0.683	0.116	0.426	0.049	
21, The advent of Int BNK has made a big difference in making life easier.	0.628	0.435	0.310	0.114	
18, Compared to money transfer functions such as WeChat and Alipay, I find Int BNK functions more convenient.	0.123	0.705	0.086	0.356	0.735
17, They trust functions such as Int BNK compared to money transfer functions such as WeChat and Alipay.	0.182	0.704	0.242	0.243	
25, Int BNK services have become an integral part of life.	0.488	0.616	0.361	0.040	
11, I rate the convenience, service and other aspects of the Int BNK app.	0.056	0.372	0.731	0.043	0.737
13, The current real-name system in China makes Int BNK and services such as WeChat and Alipay more secure.	0.340	0.009	0.646	0.430	
15, Services such as Int BNK are worth using and reliable.	0.379	0.305	0.519	0.429	
12, I trust the safety of Int BNK and other services.	0.399	0.251	0.505	0.412	
14, Int BNK does not have the problem of losing personal data.	0.032	0.365	0.132	0.785	0.717
16, In China, banks that offer services such as Int BNK are doing a lot to protect their customers' information.	0.311	0.153	0.180	0.753	

Note: Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalisation. Rotation converged in 10 iterations.

Source: compiled by the authors.

The convergent and discriminant validity test is performed here.

The CR is greater than 0.5, which indicates that there is no problem with the reliability of the data (Hair et al., 2011).

Table 6. Convergent and discriminant validity test (authors' arrangement)

	N	Mean	SD	Alpha	CR	AVE	F1	F2	F3	F4
Factor 1	173	3.852	0.770	0.784	0.787	0.481	0.693			
Factor 2	173	6.742	1.111	0.735	0.716	0.457	0.665**	0.676		
Factor 3	173	3.832	0.870	0.737	0.695	0.369	0.563**	0.576**	0.607	
Factor 4	173	4.132	0.649	0.717	0.566	0.592	0.606**	0.649**	0.489**	0.769

Note: N is the number of samples, Mean is the mean value of each factor, SD is standard deviation, Alpha is Cronbach's alpha, CR is Composite reliability, AVE is the average variance standard, and the values in bold on the main diagonal are the square root of AVE. **P<0.01.

Source: compiled by the authors.

SEM

Direct model

Figure 2 shows the results of the SEM calculations based on Figure 1 showing the conceptual framework of the direct model, where the values representing the validity of the SEM are chi-square/degrees of freedom of 1.169 (chi-square = 47.966, df = 41), GFI is 0.954 (>0.9), AGFI is 0.926 (>0.9), CFI is 0.991 (>0.9) and RMSEA is 0.031 (<0.08) within each limit. This means that the model is valid (Oe and Yamaoka, 2023).

Now, focusing on each latent factor, the path coefficient is 0.508 (P<0.01) on the path from increased diversity and convenience of services to an artery role in socio-economic activities. Next, the path from the security and trustworthiness of financial app services to an artery role in socio-economic activities has a path coefficient of 0.410 (P<0.05). The path connecting the covariance between increased diversity and convenience of services and security and trustworthiness of financial app services has a path coefficient of

0.850 (P<0.001), indicating a strong relationship. The path coefficient of 0.850 (P<0.001) indicates a strong relationship. Table 7 shows a summary of the path coefficient and probability for Figure 2.

As described above, the analysis in Step 1 confirms that the hypothesis is supported.

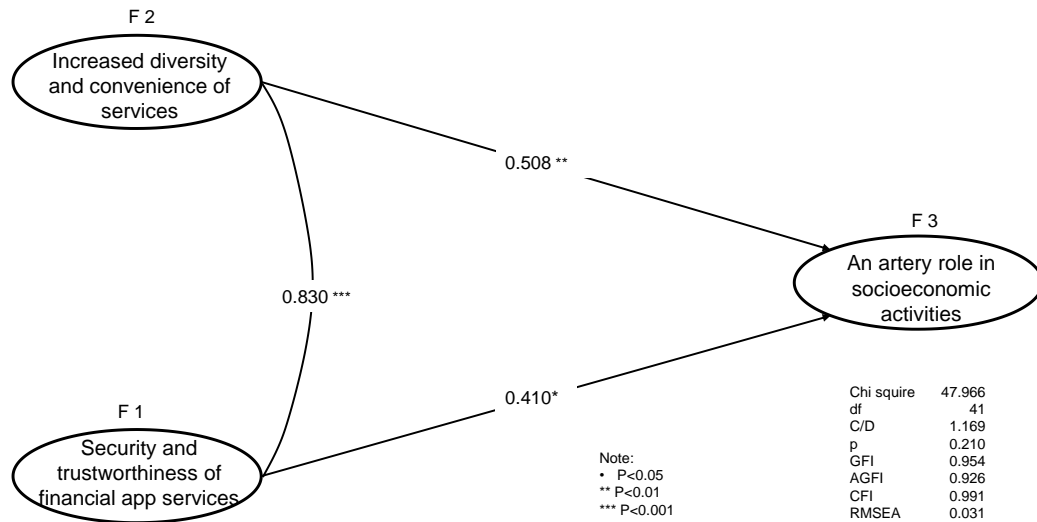


Figure 2. SEM result in Step 1 (authors' arrangement)

Source: compiled by the authors.

Table 7. Path coefficient for Step 1 (authors' arrangement)

To		From	Std. path coefficient	p
An artery role in socio-economic activities	←-	Security and trustworthiness of financial app services	0.410	*
An artery role in socio-economic activities	<---	Increased diversity and convenience of services	0.508	**
STF1	<---	Security and trustworthiness of financial app services	0.548	1 fix
STF2	<---	Security and trustworthiness of financial app services	0.705	***
STF3	<---	Security and trustworthiness of financial app services	0.841	***
STF4	<---	Security and trustworthiness of financial app services	0.794	***
IDC1	<---	Increased diversity and convenience of services	0.830	1 fix
IDC2	<---	Increased diversity and convenience of services	0.598	***
IDC3	<---	Increased diversity and convenience of services	0.659	***
ASA1	<---	An artery role in socio-economic activities	0.699	1 fix
ASA2	<---	An artery role in socio-economic activities	0.813	***
ASA3	<---	An artery role in socio-economic activities	0.628	***
ASA4	<---	An artery role in socio-economic activities	0.607	***
Increased diversity and convenience of services	<-->	Security and trustworthiness of financial app services	0.850	***

Source: compiled by the authors.

In Step 1, we created a very simple delta-shaped model that moves from the three latent factors, security and trustworthiness of financial app services (STF), increased diversity and convenience of services (IDC), to an artery role in socio-economic activities. In the real world of finance, privacy and ethical use of personal

information are important factors. Without strengthening ‘privacy and ethical use of personal information’, the development of finance cannot be expected. Therefore, in Step 2, we attempted to analyse a model that approximates the real world and includes the privacy and ethical use of personal information. Figure 3 shows the Step 2 model, which adds privacy and ethical use of personal information (hereinafter referred to as ‘PEP’) to the central part of the Step 1 model and finally moves towards an artery role in socio-economic activities (hereinafter referred to as ‘ASA’). The Step 2 model takes the central part of the model to PEP and finally to ASA. The tools used are IBM SPSS v26 and AMOS v26. Bootstrap was used 5,000 times. The respective values for the validity of the SEM are chi-square/degrees of freedom of 1.704 (chi-square = 100.517, df = 59), GFI is 0.924 (>0.9), AGFI is 0.903 (>0.9), CFI is 0.957 (>0.9) and RMSEA is 0.064 (<0.08), within each limit. This means that the model is valid (Hair et al., 2010; Hayes, 2015).

Looking at the new path from the same latent factor as in Step 1, IDC to ASA has a path coefficient of 0.514 (P<0.01), (Lower 0.008, Upper 1.405). Next, STF to ASA has a path coefficient of 0.423 (P<0.05), (Lower -0.514, Upper 1.044). The covariance path between IDC and STF has a path coefficient of 0.857 (P<0.001). So far, the results are almost the same as in the Step 1 figure. Now, considering the path over PEP, the most important issue in Step 2, the path coefficient for IDC to PEP is 0.163 (P>0.05), which is not significant. The path coefficient for STF to PEP is 0.635 (P<0.01), (Lower -0.224, Upper 1.305), which is significant. The path coefficient of PEP from STF is 0.635 (P<0.01), (Lower -0.224, Upper 1.305). Furthermore, the path coefficient for PEP is found to be 0.039 (P>0.05), (Lower -0.161, Upper 0.653), which is not significant. The results of this analysis present a serious problem for the real financial world.

Mediating role model

Therefore, we focused our analysis on the indirection effect that occurs when the two latent factors, IDC and STF, pass through the PEP on their way to ASA. The results are as follows:

The indirect effect of IDC on ASA was 0.553 (P<0.001), (Lower 0.343, Upper 0.788) and from STF to ASA was 0.432 (P<0.05), (Lower -0.514, Upper 1.044). This indicates that the path as an indirect effect is valid for the direct path, IDC, through PEP and what appeared to be a blocked path for ASA. The R2 of the latent factor for PEP is 0.607 and the R2 for ASA is 0.778, which is high, indicating that there is a large correlation in this model. Table 8 shows a summary of the path coefficient and probability for Figure 3.

Therefore, the model concretely and theoretically shows that strengthening PEP in the real financial world leads to strengthening the financial artery, called ASA.

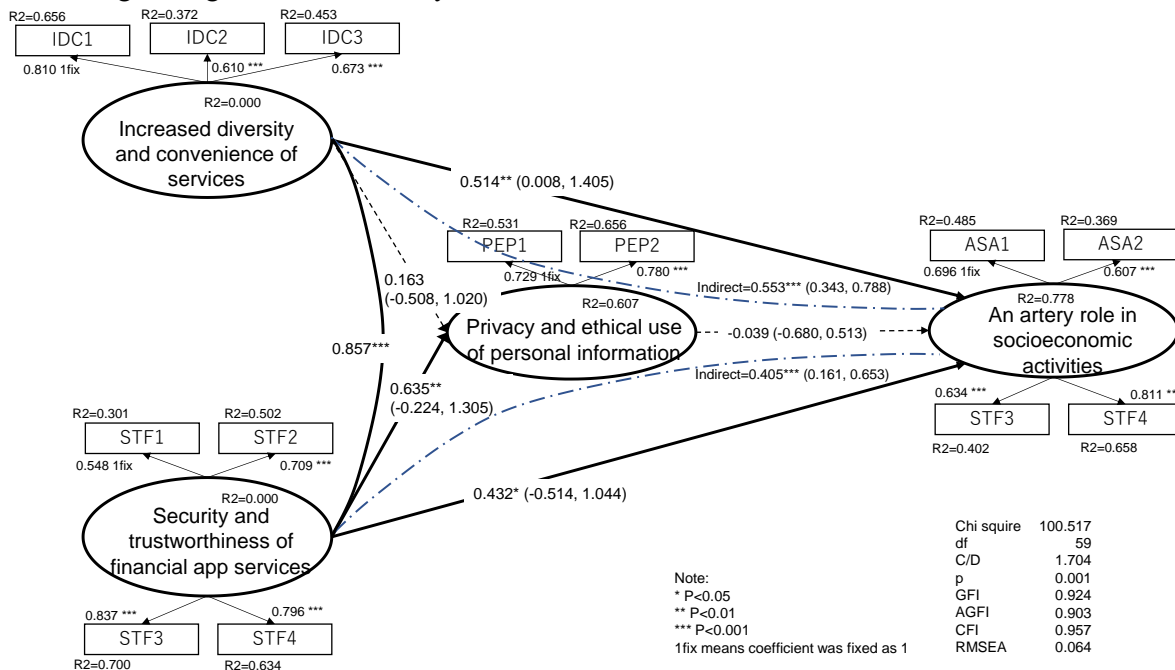


Figure 3. SEM result Step 2 (authors' arrangement)

Source: compiled by the authors.

Table 8. Path coefficient for Step 2 (authors' arrangement)

Direct path					95% PC	
To		From	Std. regression weights	P	Lower	Upper
PEP	<---	STF	0.635	**	0.224	1.305
PEP	<---	IDC	0.163	0.468	0.508	1.020
ASA	<---	PEP	0.039	0.778	0.680	0.513
ASA	<---	STF	0.432	*	0.514	1.044
ASA	<---	IDC	0.514	**	0.008	1.405
STF1	<---	STF	0.548	1fix	0.338	0.716
STF2	<---	STF	0.709	***	0.603	0.790
STF3	<---	STF	0.837	***	0.761	0.896
STF4	<---	STF	0.796	***	0.709	0.865
IDC1	<---	IDC	0.810	1fix	0.669	0.886
IDC2	<---	IDC	0.610	***	0.497	0.718
IDC3	<---	IDC	0.673	***	0.522	0.806
ASA1	<---	ASA	0.696	1fix	0.543	0.800
ASA2	<---	ASA	0.811	***	0.719	0.878
ASA3	<---	ASA	0.634	***	0.479	0.749
ASA4	<---	ASA	0.607	***	0.460	0.717
PEP1	<---	PEP	0.780	***	0.649	0.890
PEP2	<---	PEP	0.729	1fix	0.543	0.877
IDC	<-->	STF	0.857	***	0.260	0.892
Indirect path						
ASA	<---	IDC	0.553	***	0.343	0.778
ASA	<---	STF	0.405	***	0.161	0.653
Squared multiple correlations (R2)						
		PEP	0.607			
		ASA	0.778			
		STF4	0.634			
		STF1	0.301			
		STF2	0.502			
		STF3	0.700			
		IDC1	0.656			
		IDC2	0.372			
		IDC3	0.453			
		ASA1	0.485			
		ASA2	0.658			
		ASA3	0.402			
		ASA4	0.369			
		PEP1	0.609			
		PEP2	0.531			
Fitting indexes						
		Chi square	100.517			
		df	59			
		C/D	1.704			
		p	0.001			
		GFI	0.924			
		AGFI	0.903			
		CFI	0.957			
		RMSEA	0.064			

Note: * P<0.05, ** P<0.01, *** P<0.001

1 fix means the coefficient was fixed as 1.

Source: compiled by the authors.

Table 9 shows the results of the hypothesis test.

Table 9. Results of the hypothesis testing (authors' arrangement)

H-number	Hypotheses	Test result
H1	'Increased diversity and convenience of services' has a significant impact on 'An artery role in socio-economic activities'.	Adopted
H2	'Security and trustworthiness of financial app services' has a significant impact on 'An artery role in socio-economic activities'.	Adopted
H3	'Increased diversity and convenience of services' has a significant impact on 'Privacy and ethical use of personal information'.	Rejected
H4	'Security and trustworthiness of financial app services' has a significant impact on 'Privacy and ethical use of personal information'.	Adopted
H5	'Privacy and ethical use of personal information' has a significant impact on 'An artery role in socio-economic activities'.	Rejected
H6	'Increased diversity and convenience of services' has a significant indirect effect on 'An artery role in socio-economic activities' through 'Privacy and ethical use of personal information'.	Adopted
H7	'Security and trustworthiness of financial app services' has a significant indirect effect on 'An artery role in socio-economic activities' through 'Privacy and ethical use of personal information'.	Adopted

Source: compiled by the authors.

Conclusion

Theoretical contributions

The theoretical contribution of this study lies in proposing concrete measures to address the stagnation of transformation in the banking industry's DX, with a specific focus on the prospects of financial services in the Chinese market. By emphasising the frequency and simplicity of mobile app usage as criteria, the research sheds light on the path that the financial industry should take as the arterial system of socio-economic activities. This, in turn, provides a theoretical guideline for achieving sustainable and effective DX, offering insight into navigating the challenges posed by the intense waves of DX within the entire financial sector.

Practical contributions

The practical contribution of this research lies in its application-oriented recommendations for the banking industry, specifically designed to navigate the challenges of DX in the dynamic Chinese market. Using quantitative methods, the study provides actionable insights for financial institutions to enhance their competitiveness through the adoption of fintech and improved communication with consumers. The emphasis on mobile app-based payment services and their impact on the future of financial services not only offers practical guidance for the Chinese market but also serves as a blueprint for the broader financial industry to achieve sustained and effective digital innovation amid the ongoing wave of DX.

The potential for future use of the research results lies in providing guidance for professionals and executives in the financial sector, including banks, to improve the sustainability and development of Internet banking. The insights from this study also have the potential to serve as reference material for policymakers and experts involved in formulating policies and considering challenges and prospects in the broader landscape of industrial DX.

Limitations and further research opportunities

The limitations of this study include a primary focus on the Chinese market, potentially limiting the generalisability of the findings. Additionally, the research relies primarily on quantitative analysis, overlooking qualitative nuances that can provide deeper insights. Future research should consider a more extensive international scope and incorporate qualitative methodologies to capture the intricacies of user perceptions. Exploring the evolving regulatory landscape and its impact on the adoption of fintech in different regions could further enrich our understanding of the dynamics of the financial industry. Addressing these aspects would contribute to a more comprehensive and globally applicable framework for guiding DX in banking.

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resources: D.Yi. W.; data curation: D.Yi. W.; writing-original draft preparation: D.Yi W., Oe H.; writing-review and editing: Y. Y., Oe H.; visualization: Y. Y.; supervision: Oe H.; project administration: Oe H.

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