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Research Article

Integrating SEM and Artificial Neural Networks in Bridging Adoption Intention for Central Bank Digital Currency Payments

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ABSTRACT

China has emerged as a global leader in mobile payment systems and pioneered the establishment of central bank digital currency payments by employing more secure technologies to supplant third-party mobile payment methods. At this juncture, it is imperative to evaluate the factors prompting the acceptance of central bank digital currency payment among Chinese users. This study aims to determine the positive roles of perceived security, user interface attractiveness, monetary value, alternative attractiveness and national identity in affecting user adoption of central bank digital currency payments. The data was gathered from 302 Chinese mobile payment users through a self-administered online questionnaire. The data was analysed utilising a combination of the partial least squares structural equation modelling and artificial neural networks. The findings indicate that alternative attractiveness and monetary value have a significant effect on switching intention. The data enables central bank digital currency managers to recognize key parameters that affect the utilization of central bank digital currency payments.

Keywords: Central bank digital currency payment; Mobile payment; Switching intention

INTRODUCTION

As mobile communication technologies continue to create momentous advances, mobile payments are rapidly expanding their reach globally as an emerging means of payment (Loh et al., 2020). The payment method conveys a modern alternative to conventional payment methods by enabling a contactless transaction mode with portable devices. Mobile payments have not only intensely transformed consumer payment habits, but have also contributed remarkably to the development of digital economy and spawned a range of emerging payment methods such as QR code payments, near field communication payments, and central bank digital currency (CBDC) payments (Xia et al., 2023). In light of the raging COVID-19 crisis, the importance of mobile payments has become more protuberant, rendering them an indispensable means of payment. Especially in China, mobile payments have become a common payment method (Li et al., 2024). Innovations in mobile payments include contactless payments, mobile wallets, and

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fast transfers. While these technologies improve payment convenience, they also face challenges such as privacy and security (Samonte et al., 2024).

Central bank digital currency (CBDC) is the latest development in the field of digital currency, which aims to improve the reliability of the financial system by providing direct interaction between payment system participants (Lamberty et al., 2024). The launch of CBDC is an inevitable trend in the deepening of digital finance, and central banks in many countries are exploring its feasibility and necessity (Zhang, 2024). China's central bank digital currency payment (e-CNY) is a typical example of CBDC, and government support played a key role in its initial implementation (Wu et al., 2024). In the Chinese market, the mobile payment space is primarily dominated by third-party payment services such as Alipay and WeChat Pay. Nevertheless, the market landscape is gradually shifting with the piloting and rollout of central bank digital currency payments (Xia et al., 2023). Though, it takes time for CBDC payments to fully dominate the Chinese market. Simultaneously, many central banks around the world are actively promoting the research and development process of central bank digital currencies, among which the People's Bank of China (PBOC) has shown an active and steady stance in CBDC development (Xia et al., 2023). The promotion and application of CBDC payment is anticipated to have a far-reaching effect on financial regulation, policy implementation and the internationalisation process of RMB.

The importance of studying central bank digital currencies is reflected in many aspects. First, CBDCs contribute to financial inclusion and stricter monetary policy implementation (Samonte et al., 2024). Second, CBDCs can play a role in international payments, promoting economic growth and the integration of the financial system (Sood & Singh, 2024). In addition, CBDC research also involves ways to ensure the enforcement of regulations such as anti-money laundering and counter-terrorist financing while protecting payment privacy (Lamberty et al., 2024). Finally, the introduction of CBDCs may have a profound impact on the banking system and payment ecosystem, so its design and implementation strategies need to be studied in depth (Kvedaraviciute & Sapkauskiene, 2024). However, the reality is that the user usage rate of e-CNY payment is much lower than that of Alipay and WeChat Pay. In this context, it is very meaningful to evaluate the user acceptance behaviour of central bank digital currency payments. The main research question of this study is what factors affect the user's switching intention to e-CNY payment. This paper uses a two-stage innovative data analysis method of PLS-SEM-ANN to test the impact of perceived security, user interface attractiveness, alternative attractiveness, monetary value, and national identity on user switching intention to use central bank digital currency payments.

Currently, there is limited research on e-CNY payment, especially on users' switching intention from third-party mobile payment to e-CNY payment. Most studies only focus on the macro impact of e-CNY on the Chinese economy (Li et al., 2023), while this study focuses on the micro perspective of users' switching intention to e-CNY payment. This study explores the impact of CBDC payment characteristics including monetary value, alternative attractiveness, and national identity on users' switching intention, aiming to fill this research gap. Therefore, the results of this study will make a theoretical contribution and enrich the relevant theoretical research on user adoption in the field of CBDC

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payment. At the same time, the results of this study will make a practical contribution and provide targeted guidance for the relevant policies and promotion of CBDC payment.

This paper will be developed according to the following structure. The first section, introduction, explains the research background and research questions of the paper. The second section, literature review, reviews the relevant research on the central bank digital currencies and main research variables and develops hypotheses of the paper. Section 3 enlightens that the research method which is a quantitative research method based on a self-filled questionnaire, and clarifies the sampling method and questionnaire design. Section 4 conducts data analysis, utilising the PLS-SEM-ANN two-stage analysis method. Section 5 discusses the research results and puts forward policy recommendations. The last section concludes the study.

2. LITERATURE REVIEW

2.1 Central Bank Digital Currency

In recent years, as a major innovation in the field of financial technologies, central bank digital currency has triggered extensive research in academia. This part aims to systematically sort out the development status, optimization design, macroeconomic effect and financial market feedback of CBDC by reviewing relevant literature and points out the shortcomings of current research, providing direction for subsequent research. An important development direction for CBDC is to combine blockchain technology to enhance monetary supervision and transaction transparency. Through the immutable ledger of blockchain, CBDC systems can support secure and transparent digital transactions, and promote trust and accountability (Tunzina et al., 2024). This combination can also promote financial inclusion through diversified transaction methods, especially in areas with limited Internet access (Tunzina et al., 2024). Agur et al. (2022) revealed the selection mechanism of cash, CBDC and traditional savings tools based on the differentiated needs of economic entities for privacy protection and risk control, and pointed out that the popularity of payment media is significantly related to network externalities. The study underlined that the design of CBDC system needs to balance the anonymity of simulated cash and the interest-bearing function of deposit accounts, for avoiding excessive substitution of commercial bank deposits and weakening the credit creation ability, or completely reproducing the properties of cash and instigating physical currencies to withdraw from the circulations. When the network externality reaches the critical threshold, interest-bearing CBDC significantly reduce the central bank's currency circulation operation costs. Zhang and Huang (2022) further analysed the functional and non-functional requirements of CBDC, and pointed out through literature review that permissioned blockchains have more benefits in CBDC applications, but still face performance, scalability and cross-chain interoperability issues. Moreover, Barrdear and Kumhof (2022) used a dynamic stochastic general equilibrium model to assess that CBDC, as an interest-bearing central bank liability, competes with traditional bank deposits. Compared to a situation where government bonds account for 30% of GDP, the issuance of CBDC may permanently increase GDP by 3%, attributed to lower real interest rates, reduced tax distortions and lower transaction costs. The study also shows that CBDC can

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enhance economic stability as a countercyclical monetary policy tool. Davoodalhosseini (2022) studied the optimal monetary policy performance of CBDC, pointing out that if the cost of use is moderate, CBDC can improve resource allocation efficiency and approach optimal allocations, while the coexistence of cash and CBDC may lead to welfare losses. Moreover, Wang et al. (2022) constructed a CBDC uncertainty index and attention index, explaining that uncertainty index is more sensitive than attention index in the financial market's response to CBDC-related news. Li et al. (2022) showed through the CBDC signal index model that the intensity of the fintech industry's response to CBDC signals decreases over time. Allen et al. (2022) reviewed the research on the interaction between CBDC and financial technology, underscored the global impact of China's e-CNY pilot project, and pointed out that the regulatory frameworks and incentive mechanisms are crucial to the success of digital currency. Existing literature focuses on economic value and macro impact of CBDC, whereas micro-level user adoption research is relatively scarce. This paper aims to deepen the empirical analysis of the CBDC payment user behaviour to fill the current academic gap and provide more comprehensive theoretical support for policy making.

2.2 Rational Choice Theory

Rational choice theory provides a crucial for understanding the individual decision-making process. Especially in this study, it explains the association among variables such as user interface attractiveness, perceived safety and alternative attractiveness. According to rational choice theory, mobile payment users will conduct a detailed cost-benefit analysis when considering whether to switch to the central bank digital currency payments software (Becker, 1976). Research has found that rational choices can enhance individuals' sense of control over their behaviour and its outcomes. Choosing more reasonable options makes people feel more in control of the outcomes, and this perception is affected not only by the goal orientation of the choice, but also by the rationality of the choice (Yavuz et al., 2025). Specifically, the interface design and perceived security of the central bank digital currency payments can enhance users' convenience perception and security experience, thus prompting users to recognize its superiority over third-party payment and regard it as a better alternative option. When users perceive the potential benefits brought by central bank digital currency payment, they are more inclined to make switching decisions in order to maximize personal utility. As a basic theory in economics, this theory has been widely applied to fields such as higher education research (Sivatte & Gabaldon, 2025), information technology (Charki et al., 2017) and marketing (Chen et al., 2019). In European higher education research, rational choice theory was used to analyse the relationship between financial aid and academic performance. The study found that students who received financial grants performed better academically, indicating that financial grants motivate students to invest in their studies (Sivatte & Gabaldon, 2025). Empirical studies have revealed that consumers' positive perceptions of product quality and brand have a positive impact on their online shopping behaviour (Chen et al., 2022). Besides, when they face with negative electronic word-of-mouth, their attitude adjustment significantly affects purchase intention and brand switching behaviours, which further verifies the effectiveness of the rational choice theory in explaining the consumer behaviour patterns (Ardyan et al., 2021). In the context of emerging technology adoption, such as electric vehicles, consumers' decisions also follow the logic of rational choice that based on trade-off between perceived risks and

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benefits (Featherman et al., 2021). Although the theory has presented important values in various fields, its application in the field of central bank digital currency payments is still relatively limited. Therefore, this study aims to expand the scope of application of rational choice theory by incorporating it into the research model, and provides theoretical support and empirical analysis for research in the field of CBDC payments. This not only enriches the application scenarios of rational choice theory, but also provides a new perspective for understanding the decision-making mechanism of users in the process of CBDC payment adoption.

2.3 Perceived Security

Perceived security is defined as the subjective sense of security formed by users in the process of using technology (Loh et al., 2020). In the field of digital payments, this concept is specifically manifested as the difference in security perception when users compare different payment tools, such as the perceived security advantage of e-CNY as compared with other mobile payment methods. As a core variable of the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), the perceived security has been confirmed by the multi-field studies to have a significant positive impact on user behaviour. In the field of mobile payment, perceived security directly affects users' behavioural intention and satisfaction. Research shows that perceived security affects users' behavioural intentions through trust and attitude, and gender plays a moderating role in this process (Joshi & Chawla, 2024). This shows that improving users' trust and attitude towards mobile payment platforms is the key to promoting their use. Loh et al. (2020) tested the barriers to the popularization of mobile payments from the perspective of conversion intention and revealed that perceived security and privacy protection are the key determinants in driving user conversion plan, rather than trust. Mombeuil et al. (2021) further verified that the advantages of WeChat Pay in security and privacy protection significantly enhanced the continued use intention of foreign users. Lin et al. (2021)'s research during the COVID-19 epidemic showed that students' security perceptions of online learning platforms directly influence their intention to use. Jin et al. (2021) reached similar conclusions in their studies of Chinese college students, emphasizing that security perception is a vital driving force for the migration of traditional teaching models to online platforms. Singh and Srivastava (2020) confirmed that perceived security is a key predictor of customer adoption of mobile banking services. Besides, Aw et al. (2022) found in retail scenarios that the perceived security of digital voice assistants affects the smart shopping experience and hence strengthens consumers' willingness to continue use. As a legal digital currency application issued by the central bank, the operator of e-CNY has national credit endorsement and its technical architecture and risk control systems should theoretically be superior to commercial third-party payment tools. Based on the above cross-domain research conclusions, it can be reasonably inferred that in the choice of payment options, users' perceived security of e-CNY may constitute a crucial motivation for adoption. Precisely, the payment system endorsed by the central bank can strengthen users' sense of control and trust by reducing credit risk and transaction uncertainty, thus enhancing their willingness to use. Based on the above theoretical framework and empirical evidence, this paper proposes the hypothesis:

H1. Perceived security has a significantly positive relationship with alternative attractiveness.

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2.4 User Interface Attractiveness

User interface attractiveness is defined as the degree of appeal of program interface design style to users' sensory and emotional level (Lee & Pan, 2022). In this paper, it specifically refers to the attractiveness of the electronic RMB (e-CNY) application interface design to users. As a key variable in technology acceptance model (TAM) and extended theory, interface attractiveness has been proven to have a significant impact on user technology adoption behaviour and continued use intention. Research has found that interface simplicity and content readability are generally welcomed by users, while navigation usability and personalized experience may trigger different reactions (Lun et al., 2024). Based on the stimulus-organism-response model, Lee and Pan (2022) documented that in contactless payment services, the attractiveness of the user interface and perceived security jointly improve users' performance expectations and emotional responses, thus enhancing continued use intention. Rahardja et al. (2023) further verified that the interface design attributes of the mobile payment applications indirectly affect continued use intention by affecting users' positive and negative emotional states. The extended expectation confirmation model by Gupta et al. (2020) documented that the perceived quality of the interface directly influences user satisfaction and subsequent use intentions. Tian et al. (2021) revealed that interface attractiveness, perceived usefulness, and price advantages jointly heighten user engagements and strengthen brand loyalty through mediation effects when learning the characteristics of mobile tourism applications. Furthermore, Zhou et al. (2021) pointed out in their study of mobile banking user loyalty that the interface design, system quality and service quality constitute a compound effect, among which interface attractiveness, as a direct driving factor, plays a key role in boosting user loyalty. Compared with commercial payment tools such as Alipay and WeChat Pay, the e-CNY application adopts a minimalist design concept, retaining only the core payment function, and the interface interaction logic is clear. This design strategy may form a significant alternative attractiveness by reducing the cognitive load and functional redundancy. Based on the above research results, the interface attractiveness affects technology adoption decisions by enhancing user experience fluency and emotional satisfaction. Thus, it can be inferred that in the payment tool selection scenario, e-CNY's simple interface design may boost its competitiveness relative to multi-functional payment platforms by enhancing user operation efficiency and positive emotion. Based on the theoretical framework and empirical evidence of interface attractiveness, this paper proposes the hypothesis:

H2. User interface attractiveness has a significantly positive relationship with alternative attractiveness.

2.5 Monetary Value

Monetary value is defined as the economic benefits that users gain from utilising technology (Loh et al., 2020). In the study of payment tool selection, this concept presents a special connotation as due to the high service fee rates such as account balance withdrawal fees of the third-party payment platforms like Alipay, monetary value in this scenario is specially manifested as the economic benefit loss suffered by users from using such tools. In contrast, the monetary value of the central bank digital currency (e-CNY) payment system is reflected in the economic advantage of zero marginal cost due to the exemption of service fees. Sankaran and Chakraborty (2022) found based on the UTAUT2 model that monetary value, emotional value, quality value and trust constitute significant predictors of

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Indian consumers' mobile banking adoption intention, indicating that in financial service scenarios, economic benefits directly affect behavioural decision. Zhang et al. (2015) confirmed through the expectation confirmation model that price advantage, a derivative dimension of monetary value, is the core contributing factor of user satisfaction on group buying websites, which in turn affects the willingness to continue using, emphasising the economic sensitivity in promotion scenarios. Liu et al. (2015) found that perceived value, including monetary value, and personal innovativeness positively influence Chinese consumers' acceptance of mobile coupons, and gender moderates the link between personal innovativeness and behavioural intention, showing the moderating impact of individual differences on value perceptions. From the view of switching intention, Loh et al. (2020) found that monetary value has no significant impact on the willingness to switch to mobile payments, while alternative attractiveness, trust and privacy perception played a leading role, indicating that non-economic factors may surpass monetary value in the competition of payment tools. Wu et al. (2022) confirmed that monetary value, as a sub-dimension of perceived value, affects the willingness to utilise digital currencies through the mediating impact of financial knowledge, while functional value and openness play a synergistic role, showing the multidimensionality of value perception in the adoption of emerging technologies. Third-party payment tools, such as Alipay, form negative monetary value through withdrawal fees, while e-CNY's zero-fee design creates positive economic values. Based on the finding by Loh et al. (2020) on the attractiveness of substitution, when users perceive that e-CNY can avoid economic loss and increase monetary value, switching intention may be triggered. Thus, this paper proposes the hypothesis:

H3. Monetary value has a significantly positive relationship with switching intention.

2.6 Alternative Attractiveness

Alternative attractiveness is defined as the degree of competitive superiority of the viable alternatives in the market perceived by consumers (Jones et al., 2000). In the context of payment tool switching, this study focuses on the attractiveness of the e-CNY as an alternative to traditional third-party payments such as Alipay. When users perceive that e-CNY surpasses existing solutions in terms of efficiency, cost, security, among others, it will trigger a tendency to switch behaviour. For instance, the study by Monoarfa et al. (2024) showed that alternative attractiveness significantly affects users' switching intention to Islamic banking. Loh et al. (2020) found in their study on mobile payment switching that alternative attractiveness is the major condition that prompts users to switch from traditional payment methods to mobile payments. This study provides theoretical support for competition in payment market and emphasizes the structural impact of alternative characteristics on user decisions. Moreover, Liao et al. (2021) found that alternative attractiveness, as a pull force, significantly and positively affects users' willingness to switch brands. In the highly competitive smartphone markets, the technological innovation and user experience of alternatives are key switching incentives. Sajjad et al. (2020) utilised the PPM model to confirm that the environmental attributes, alternative attractiveness, of alternatives significantly enhanced users' intention to switch from traditional motor vehicles to green transportation in the perspective of haze control, highlighting the decision-making weight of alternative characteristics in environmental crises. Tsai et al. (2022) found that the willingness of

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users of free over-the-top platforms to switch to paid platforms is driven by the attractiveness of alternatives, showing that content quality and experience advantages play a leading role in switching decisions in the digital service market. In addition, Foroughi et al. (2023) pointed out that the attractiveness of alternatives has a negative effect on the continued use intention of travel applications, which may be due to user's trade-off between the functional dependence and switching costs, reflecting the complexity of psychological contracts in specific settings. Compared with the third-party payment tools, such as Alipay and WeChat Pay, e-CNY relies on the credit endorsement of the central bank and has formed structural advantages in security and zero fees. Its simple interface design further reduces the cognitive load and constitutes the multi-dimensional attractiveness. This study hypothesizes:

H4. Alternative attractiveness has a significantly positive relationship with switching intention.

2.7 National Identity

National identity is an individual's emotional identification and sense of belonging to his or her country, is a central dimension for understanding consumer behaviour (Zhang et al., 2019). In many economic and social fields, national identity has been proven to be a key factor affecting the consumer decision-making. Jia et al. (2023) explored the effects of consumer ethnocentrism, social norms and national identity on willingness to purchase domestic products through cross-temporal survey data analysis. The results report that social norms and national identity play a significant role in predicting consumers' willingness to buy domestic products, while the impact of consumer ethnocentrism exhibit certain research differences. Besides, age group and product type also have a moderating effect on the impacts of these variables, specifically national identity exhibit a more significant effect in predicting young people's purchase of domestic products. Sun et al. (2021) explored the impact of the electronic word-of-mouth (e-WOM) on customer brand awareness in the Chinese market from the perspective of e-WOM. The study exhibits that both positive and negative e-WOM are influenced by the source of the brand, which in turn affects consumers' ethnocentrism, while consumers' ethnocentrism has a positive effect on the brand assets of domestic brands. Wu et al. (2022) conducted an in-depth study on the users' adoption of digital currency electronic payments (DCEP) launched by central bank. By extending the unified theory of acceptance and use of technology (UTAUT), they report the impact of perceived fairness, habits, social influence and national identity on the usage of DCEP. Among them, national identity is confirmed to be a key moderator of the relationship between multiple variables, but it does not have a direct moderating effect among social influence and usage rate. These studies provide a new perspective for understanding the user adoption behaviour of digital currency and emphasize the central role of national identity in this process. However, the research of Lan and Trung (2024) proves that national identity does not affect consumers' ethnocentrism and willingness to purchase foreign products. Based on the different views of scholars on national identity research, it will be very meaningful to explore the impact of national identity in the field of CBDC payment. Given that e-CNY payment, as a payment procedure for digital currency of the People's Bank of China, has significant national attributes and China has been promoting the development of e-CNY payment as a national strategy, this research proposes the following hypothesis:

H5. National identity has a significantly positive relationship with switching intention.

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Based on the above explanations, the research framework of this study is proposed as shown in Figure 1.

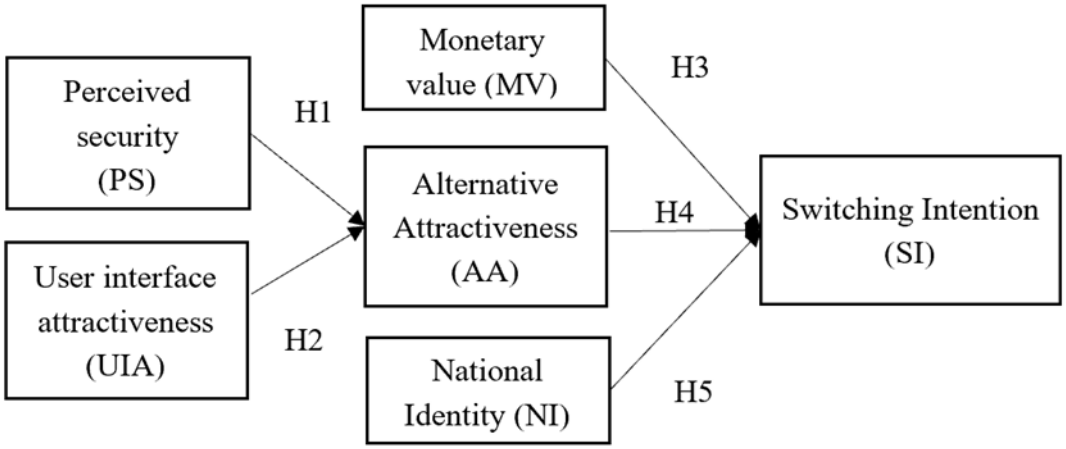

Figure 1. Research Framework

3. RESEARCH METHODOLOGY

In this paper, quantitative methods of analysis are applied, using a self-administered online questionnaire as the core measure (Zhou et al., 2022; Lo et al., 2024; Yuan et al., 2024). The questionnaire is carefully designed to cover thirty measurement items targeting six predefined latent constructs. The research model is shown in Figure 1, while the constructs and measurement items utilised in this paper are derived from previous research as shown in Table 1. The questionnaire is constructed on a seven-point Likert scale ranging from 1 'strongly disagree' to 7 'strongly agree'. The data is collected from Wenjuanxing, a well-known questionnaire platform in China (Li et al., 2020; Zheng & Zheng, 2014). Given the absence of a sample frame, this paper adopts a non-probability sampling strategy. This selection is based on the practical considerations, specifically to boost the accessibility of the sample and to effectively minimize the cost of study. A total of 302 completed responses is collected. The sample size is estimated utilising GPower software. A minimum sample size of 77 is determined with a statistical efficacy of 0.8, a marginal error of 0.05 and also an effect size of 0.15 using 3 predictor variables to evaluate the minimum sample size (Loh et al., 2020; Zhang et al., 2024). Besides, empirically, a sample size of between 30 and 500 are sufficient for most studies (Lo et al., 2024; Wong et al., 2024).

Responses are gathered from a total of 302 users, where 146 (48.34%) are female and 156 (51.65%) are male. Besides, the majority of respondents are aged 18 to 35 years (52.65 %). Meanwhile, most of the respondents have diploma and bachelor degrees (52.65%). The majority of the respondents have 7 to 10 years of experience in using mobile payments (62.25%), which is in line with the requirement of this study that the target respondents are experienced users of mobile payments. Besides, this study designs a screening question at the beginning of questionnaire to filter the target respondents, hence all respondents use Alipay and WeChat Pay as the main mobile payment methods. All respondents also use and know about China's central bank digital currency payments.

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Table 1. Measurement Items

Construct	Items	Sources
Perceived security (PS)	I think using e-CNY payment is financially secure.	Adapted from Loh et al. (2020)
	I am not worried about the transaction security of e-CNY payment.	
	I think e-CNY payment has the ability to protect my privacy.	
	I think using e-CNY payment does not put my privacy at risk.	
User interface attractiveness (UIA)	The user interface design (i.e. colours, boxes, menus, etc.) of the e-CNY application is attractive.	Adapted from Lee and Pan (2022); Shiau and Huang (2022)
	The user interface design of the e-CNY application looks professionally designed.	
	The user interface design of the e-CNY application is visually appealing.	
	The e-CNY application, such as the interface, is easy to use.	
Monetary value (MV)	Paying with Alipay and WeChat Pay does not save me more money compared to e-CNY payment due to withdrawal fees.	Adapted from Loh et al. (2020)
	Paying with Alipay and WeChat Pay does not provide better deals compared to e-CNY payment due to withdrawal fees.	
	Overall, I would not spend less with Alipay and WeChat Pay compared to e-CNY payment due to withdrawal fees.	
	Overall, by paying with Alipay and WeChat Pay, I would spend more than compared to e-CNY payment due to withdrawal fees.	
Alternative attractiveness (AA)	If I need to switch to paying with central bank digital currency, e-CNY payment is a good choice.	Adapted from Loh et al. (2020)
	e-CNY payment would benefit me more than Alipay and WeChat Pay.	
	I would probably be happy with the features and services of e-CNY payment.	
	Compared to Alipay and WeChat Pay, I would probably be more satisfied with e-CNY payment.	
National identity	I feel a strong sense of belonging to China.	
	I am proud of China in general.	

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(NI)	I am proud of China's history and culture. I am proud of China's economic development.	Adapted from Zhang et al. (2019)
Switching intention (SI)	I am considering switching from Alipay and WeChat Pay to e-CNY payment. I intend to switch from Alipay and WeChat Pay to e-CNY payment in the future The chance of my switching to e-CNY payment is high. I am determined to switch from Alipay and WeChat Pay to e-CNY payment.	Adapted from Balachandran et al. (2022); Loh et al. (2020)

Table 2. Demographic Characteristics

		Frequency	Percentage (%)
Gender	Male	156	51.65
	Female	146	48.34
Age	18-25	24	7.95
	26-30	45	14.90
	31-35	90	29.80
	>35	143	47.35
Education	Junior high school and below	48	15.89
	High school	57	18.87
	Diploma	86	28.48
	Bachelor	73	24.17
	Master and above	38	12.58
Mobile payment experience	1-2 years	9	2.98
	3-4 years	16	5.30
	5-6 years	34	11.26
	7-8 years	98	32.45
	9-10 years	90	29.80
	> 10 years	55	18.21
Alipay or WeChat Pay as main mobile payment method	Yes	302	100
	No	0	0
Used or know about e-CNY pay	Yes	302	100
	No	0	0

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4. DATA ANALYSIS

4.1 Common Method Bias

Due to the exploratory characteristics and small sample size, we use PLS-SEM as a suitable method for analysing the hypotheses and the research model. For data analysis, we use the SmartPLS 4 software. At the level of statistical techniques, we adopt the Harman's Single-Factor Test, which operates by including all variables in the factor analysis framework aimed at determining the proportion of total variance explained by a single factor (Howard, 2023) as shown in Table 3. The results of the analysis exhibits that the largest single factor explains only 31.681% of the total variance, a proportion well below the 50% threshold, from which it infers that there is no significant sign of change dominated by a single factor in the data of the study (Fuller et al., 2016). In addition, we further assess the potential impact of common method bias by calculating the Fornell-Lacker Criterion as shown in Table 4, which shows that the correlation coefficients between all the variables do not exceed 0.9 (Muntean et al., 2023), further validating that common method bias does not pose a significant threat in this study.

Table 3. Harman's Single-Factor Test

Total Variance Explained						
Component	Total	Initial Eigenvalues		Extraction Sums of Squared Loadings		
		% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.603	31.681	31.681	7.603	31.681	31.681
2	2.601	10.839	42.520			
3	2.283	9.514	52.034			
4	1.986	8.276	60.310			
5	1.327	5.529	65.839			
6	1.130	4.709	70.547			
7	0.680	2.832	73.379			
8	0.663	2.762	76.141			
9	0.584	2.435	78.575			
10	0.530	2.208	80.784			
11	0.510	2.124	82.908			
12	0.460	1.917	84.825			
13	0.427	1.777	86.602			
14	0.412	1.717	88.319			
15	0.388	1.615	89.934			

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16	0.343	1.427	91.361
17	0.333	1.389	92.750
18	0.304	1.269	94.019
19	0.284	1.182	95.201
20	0.268	1.115	96.316
21	0.249	1.036	97.352
22	0.248	1.032	98.384
23	0.211	0.879	99.262
24	0.177	0.738	100

Extraction Method: Principal Component Analysis.

Table 4. Fornell-Lacker Criterion

	AA	MV	NI	PS	SI	UIA
AA	0.838					
MV	0.403	0.826				
NI	0.209	0.180	0.830			
PS	0.510	0.310	0.168	0.852		
SI	0.467	0.522	0.155	0.324	0.789	
UIA	0.547	0.300	0.238	0.327	0.342	0.867

Note: Alternative attractiveness (AA); Monetary value (MV); National identity (NI); Perceived security (PS); User interface attractiveness (UIA); Switching intention (SI).

4.2 Outer Measurement Model

To validate the internal consistency of the external measurement model, Cronbach's alpha coefficient and composite reliability are adopted as assessment tools in this research (Yuan et al., 2024). Based on the data presented in Table 5, the Cronbach's alpha coefficient and composite reliability of all the measurement items exceed the generally accepted minimum threshold of 0.7, a result that significantly infers that the measurement tools adopted in this research exhibit a high degree of reliability (Hair et al., 2019). Besides, to assess the convergent validity (CV) of the data, we apply average variance extracted (AVE) as an analytical metric (Lo et al., 2024). From the data observation in Table 5, the AVE values of each construct exceed the critical value of 0.5, hence effectively validating the convergent validity of the data in this study (Lee et al., 2024). This research turns to the heterotrait-monotrait ratio (HTMT) as an assessment of discriminant validity (Aw et al., 2024), as revealed in Table 6. All HTMT ratio values are below the threshold of 0.9 recommended by Hair et al. (2019), a result that solidly supports a good level of differentiation among the constructs in the study model. In summary, there is a strong reason to trust that all constructs in the research model can be effectively differentiated at the empirical level.

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Table 5. Construct Reliability and Validity

	Items	Loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AA	AA1	0.858	0.858	0.860	0.904	0.701
	AA2	0.839				
	AA3	0.856				
	AA4	0.797				
MV	MV1	0.817	0.845	0.853	0.896	0.683
	MV2	0.771				
	MV3	0.866				
	MV4	0.848				
NI	NI1	0.725	0.855	0.971	0.898	0.689
	NI2	0.907				
	NI3	0.928				
	NI4	0.740				
PS	PS1	0.840	0.875	0.883	0.914	0.726
	PS2	0.894				
	PS3	0.820				
	PS4	0.853				
SI	SI1	0.732	0.798	0.802	0.868	0.623
	SI2	0.832				
	SI3	0.790				
	SI4	0.800				
UIA	UIA1	0.876	0.890	0.893	0.924	0.752
	UIA2	0.853				
	UIA3	0.891				
	UIA4	0.848				

Note: Alternative attractiveness (AA); Monetary value (MV); National identity (NI); Perceived security (PS); User interface attractiveness (UIA); Switching intention (SI).

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Table 6. Heterotrait-Monotrait Ratio (HTMT Inference)

	AA	MV	NI	PS	SI	UIA
AA						
MV	0.472					
NI	0.229	0.205				
PS	0.584	0.359	0.186			
SI	0.561	0.630	0.167	0.383		
UIA	0.623	0.345	0.273	0.371	0.404	

Note: Alternative attractiveness (AA); Monetary value (MV); National identity (NI); Perceived security (PS); User interface attractiveness (UIA); Switching intention (SI).

4.3 Inner Structural Model

A bootstrapping technique with five thousand sub-samples is used in this study to conduct an in-depth analysis and validation of the structural model. Table 7 details the hypotheses that are tested and supported. It is notable that except for national identity (NI), all the hypothesized relationships report statistical significance, where the corresponding p-values are significantly less than the 0.05 level of significance, which strengthens the reliability of the results. Specifically, perceived security (PS) ($\beta = 0.370$, $p < 0.001$) and user interface attractiveness (UIA) ($\beta = 0.426$, $p < 0.001$) have a significant positive impact on alternative attractiveness (AA). Furthermore, monetary value (MV) ($\beta = 0.396$, $p < 0.001$) and alternative attractiveness (AA) ($\beta = 0.303$, $p < 0.001$) have a significant positive effect on switching intention (SI). Meanwhile, the relationship between national identity (NI) ($\beta = 0.021$, $p > 0.05$) and switching intention (SI) is not significant.

Table 7. Hypothesis Testing

		Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T-statistics (|O/STDEV|)	P-values	Decision
H1	PS -> AA	0.370	0.372	0.063	5.855	0.000	Supported
H2	UIA -> AA	0.426	0.426	0.060	7.150	0.000	Supported
H3	MV -> SI	0.396	0.396	0.057	6.978	0.000	Supported
H4	AA -> SI	0.303	0.301	0.065	4.668	0.000	Supported
H5	NI -> SI	0.021	0.036	0.051	0.406	0.342	Unsupported

Note: Alternative attractiveness (AA); Monetary value (MV); National identity (NI); Perceived security (PS); User interface attractiveness (UIA); Switching intention (SI).

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4.4 Predictive Relevance and Effect Size

To provide a comprehensive review of the quality of the structural model, Table 8 presents in detail the findings of the assessment of the coefficient of determination (R^2) and cross-validation redundancy (Q^2), which show that R^2 is greater than 0.19 in both cases, and that cross-validation redundancy findings are greater than zero, therefore implying that the model exhibits out-of-sample predictive relevance (Yuan et al., 2024; Lee et al., 2024). These metrics follow the normative criteria proposed by Hair et al. (2019). Turning to the analysis of relative impact (f^2), Table 9 reveals that except for national identity (NI), the f^2 values for all variables exceed the 0.02 threshold defined by Cohen (2013), showing moderate to large effect sizes.

Table 8. Determination Coefficient and Cross-Validated Redundancy Analysis

	R-square	R-square adjusted	Q^2 (=1-SSE/SSO)
AA	0.422	0.418	0.290
SI	0.351	0.345	0.213

Table 9. Effect Size (F2)

	f-square
AA -> SI	0.115
MV -> SI	0.200
NI -> SI	0.001
PS -> AA	0.212
UIA -> AA	0.280

4.5 Artificial Neural Network Analysis

Haykin (1999) proposed an artificial neural network (ANN) algorithm that aims to simulate the working mechanism of the human brain. Compared with the regression analysis, ANN shows unique advantages in processing non-compensatory decisions without making prior assumptions about the normal distribution of data (Lau et al., 2021). This study adopts the multi-layer perceptron (MLP) ANN model framework, which is built on the feedforward back propagation (FFBP) mechanism and includes an input layer, a hidden layer and an output layer (Leong et al., 2020). In the MLP model, the sigmoid activation function is employed to activate neurons, while the transmission and processing of information are achieved through weighted synaptic connections. To effectively alleviate the overfitting problem, this study employs a 10-fold cross-validation method, in which 10% of the dataset is designated to evaluate the generalization ability of the model, and the remaining 90% of the dataset is used to train the model. Figure 2 shows the typical calculation process in ANN analysis. The prediction effect of the model is gauged by the root mean square error (RMSE) indicator. The lower the RMSE value, the higher the prediction accuracy as shown in Table 10.

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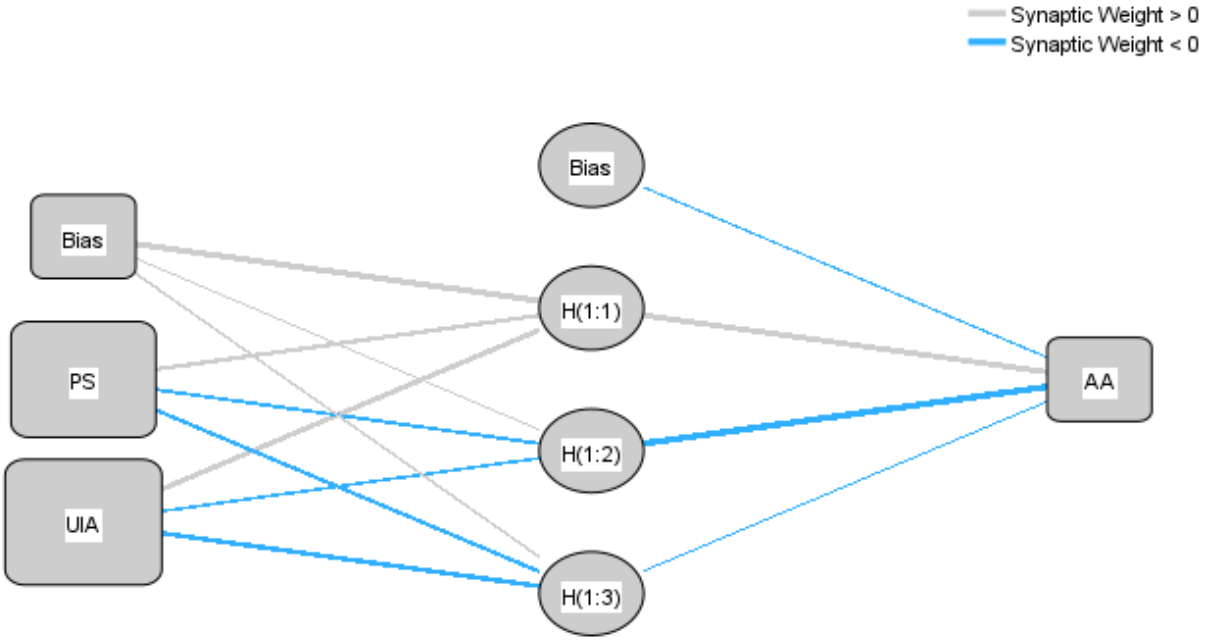
In addition, Table 11 lists in detail the contribution of each predictor variable in the ANN model to the overall prediction effect, which provides essential insights for in-depth analysis of behavioural characteristics of the model. The final research findings exhibit that the prediction results obtained by ANN analysis are consistent with those obtained by the partial least squares structural equation model (PLS-SEM) analysis.



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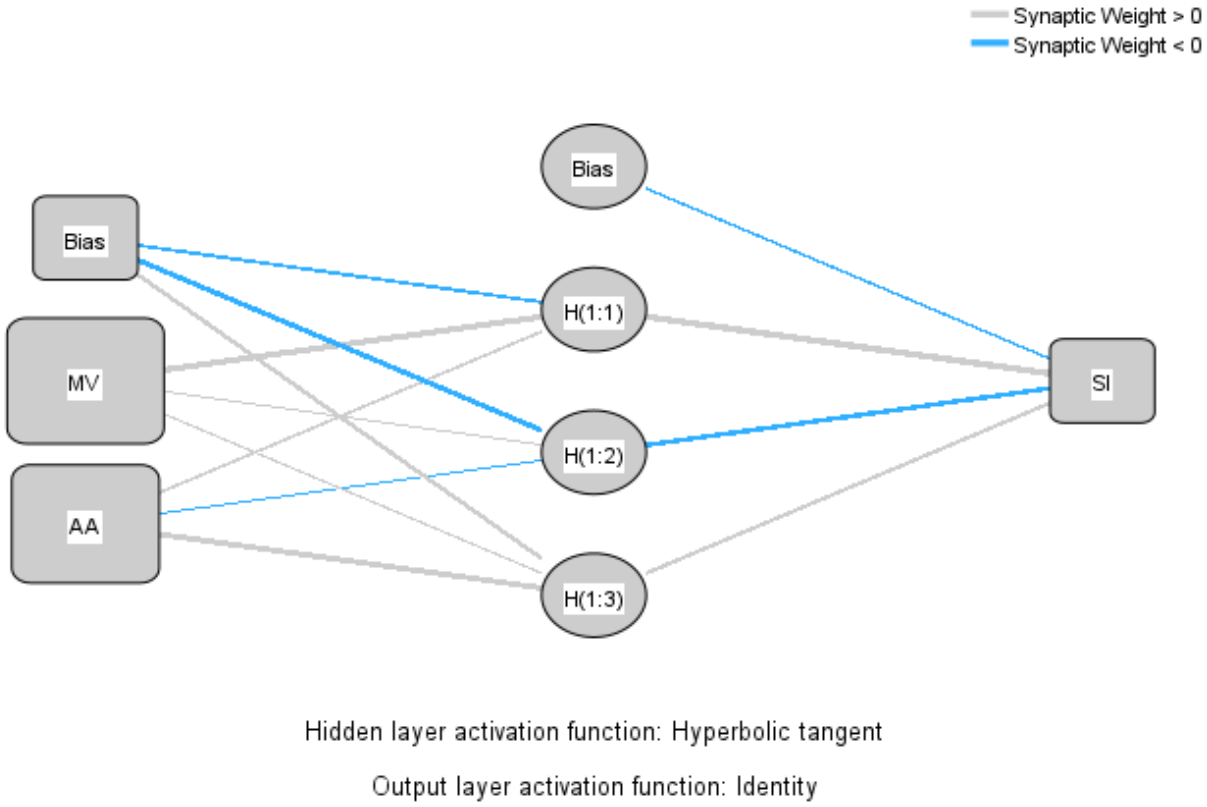

Figure 2. Artificial Neural Network Analysis

Table 10. RMSE Value of 10-Fold Artificial Neural Network Models

	Model A		Model B	
	Input: PS, UIA		Input: MV, AA	
	Output: AA		Output: SI	
	Training	Testing	Training	Testing
Neural network	RMSE	RMSE	RMSE	RMSE
ANN1	0.5534	0.5328	0.5836	0.5408
ANN2	0.5421	0.6366	0.5748	0.4657
ANN3	0.5669	0.5530	0.5806	0.4958
ANN4	0.5852	0.4759	0.5799	0.4926
ANN5	0.5408	0.5725	0.5665	0.5136
ANN6	0.5680	0.4604	0.5804	0.4923
ANN7	0.5677	0.4564	0.5758	0.5491
ANN8	0.5413	0.5836	0.5717	0.5160
ANN9	0.5306	0.6385	0.5947	0.7731
ANN10	0.5484	0.4578	0.6527	0.5594

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Mean	0.5544	0.5368	0.5861	0.5398
SD	0.0169	0.0717	0.0246	0.0870

Note: Alternative attractiveness (AA); Monetary value (MV); National identity (NI); Perceived security (PS); User interface attractiveness (UIA); Switching intention (SI).

Table 11. Sensitivity Analysis

PLS path	Original sample (o)/path coefficient	ANN results: normalized relative importance (%)	Ranking (PLS-SEM)[based on path coefficient]	Ranking (ANN)[based on normalized relative importance]	Remark
Model A					
PS->AA	0.370	93.461%	2	2	Match
UIA->AA	0.426	100.000%	1	1	Match
Model B					
MV->SI	0.396	100.000%	1	1	Match
AA->SI	0.303	84.298%	2	2	Match

Note: Alternative attractiveness (AA); Monetary value (MV); National identity (NI); Perceived security (PS); User interface attractiveness (UIA); Switching intention (SI).

5. DISCUSSION

This research employs empirical analysis to determine and confirm the significant enhancement effects of perceived security and user interface attractiveness on user alternative attractiveness. These results are consistent with the previous research of Loh et al. (2020), Aw et al. (2022), Lee and Pan (2022) and Rahardja et al. (2023), consolidating the consensus of academic community in this field. Compared with the databases relied on by third-party payment applications, the central bank digital currency (CBDC) payment database managed by the state exhibits higher security and offers a more solid assurance for the user personal information and privacy. Hence, CBDC payment performs better in terms of perceived security. The e-CNY payment application has a stronger appeal to users with its professional and simple interface design. As the two main advantages of CBDC payment, perceived security and user interface attractiveness jointly promote users' alternative attraction to the current payment methods. This study further introduces the second-stage artificial neural network (ANN) analysis, and the findings document that the effects of user interface attractiveness on user alternative attractiveness ranked the first, which is consistent with the findings from the partial least squares structural equation model (PLS-SEM) analysis utilised in the preliminary stage. To escalate the popularity of e-CNY payment, designers should take measures to optimize the interface design of e-CNY payment applications. That is, they can utilise design elements of modern aesthetic trends, such as simple

colour matching, intuitive icons, smooth animation effects, among others. Besides, they can pay attention to personalized customization functions to meet the diverse needs of users.

This research also confirms the significant positive driving effect of monetary value and alternative attractiveness on users' switching intention to use the central bank digital currency (CBDC) payments. This result is consistent with previous research findings by Wu et al. (2022), Tsai et al. (2022) and Foroughi et al. (2023), further consolidating the consensus of theoretical community in this field. CBDC payment services are exempt from various fees including cash withdrawal and handling fees during provision process, which brings more significant economic benefits to users compared with third-party payment methods, thus stimulating users' willingness to switch to CBDC payments. As the China's central bank digital currency payments, the e-CNY carries a strong national attribute, and China has always regarded the promotion of e-CNY payment as a national strategy. However, although users with a strong sense of national identity may be more likely to have a readiness to switch to e-CNY payment, this study finds that national identity does not have a significant impact on user switching intention. This may be because e-CNY payment is still in its early stages of development, the market penetration is not high, user education is not sufficient, the user base is relatively weak, and usage habits have not yet been formed. Despite active promotion at the national level, users' understanding of the e-CNY as a national digital financial innovation is not yet in-depth, and therefore national identity needs to be strengthened. At the same time, this conclusion is consistent with the research results of Lan and Trung (2024). To further explore, this study introduces the second-stage artificial neural network (ANN) analysis. The findings shows that the impact of monetary value on user conversion willingness ranked first, which is consistent with the findings of partial least squares structural equation model (PLS-SEM) analysis used in the preliminary stage. To increase the usage rate of e-CNY payment, designers can adopt reward mechanisms including points, cashback and coupons to encourage users to adopt e-CNY for payments, optimizing the monetary value of e-CNY payments.

6. CONCLUSION

This study has made an important theoretical contribution in the field of central bank digital currency payment. Given the increasing focus of academic circles on the multi-dimensional impact of this technology, it is worth noting that the discussion on users' conversion intention to CBDC payment is still lacking. This study effectively broadens the theoretical boundaries and depth of CBDC payment research. This study deeply integrates Perceived Security, User Interface Attractiveness, Monetary Value, Alternative Attractiveness, and National Identity, and constructs a targeted research framework to deeply analyse the internal mechanisms that affect users' switching intention to CBDC payment. The development of this model not only provides a new theoretical perspective for understanding user behaviour decisions, but also provides a good example for theoretical research in the emerging field of CBDC payment, which promotes the enrichment and improvement of the knowledge system in this field.

This study has made outstanding contributions at the methodological level. It breaks through the limitations of traditional linear models and creatively introduces a composite analysis method including two-stage PLS-SEM-ANN.

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This method not only inherits the advantages of the PLS model in linearity and compensatory characteristics, but also cleverly incorporates the nonlinear and non-compensatory characteristics unique to the ANN model. By adopting this innovative method, the study not only deepens the understanding of the characteristics of linear and nonlinear models, but also successfully constructs a more comprehensive and in-depth framework to capture and analyse the multidimensional factors and their interactions in complex decision-making processes, thus opening up new paths for future related research.

The conclusions of this study provide meaningful practical guidance for the promotion of e-CNY payment. First, the conclusions of this study prove the significant enhancement effect of perceived security and user interface attractiveness on user alternative attractiveness. In order to increase the usage rate of e-CNY payment, designers should take measures to optimize the interface design of e-CNY payment applications. At the same time, this study confirms the significant positive driving effect of monetary value and alternative attractiveness on users' switching intention (SI) to use central bank digital currency (CBDC) payment. In order to increase the usage rate of e-CNY payment, designers should adopt a reward mechanism to encourage users to use e-CNY for payment.

However, this research has limitations, mainly because its cross-sectional design only reflects the status of CBDC payments in China at one point in time and the highly dynamic nature of the field may cause changes in future results, making longitudinal tracking research essential to gain a deeper understanding. In addition, the data collection is limited to China, limiting the understanding of differences in CBDC payments across cultural contexts. Thus, future research should conduct cross-country comparisons and include samples from diverse cultural contexts to comprehensively explore the multifaceted influences on CBDC payments and their variability.

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