



# The effect of digital finance on Residents' happiness: the case of mobile payments in China

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## Abstract

With the popularization of digital finance in China, mobile payments have penetrated into all aspects of residents' daily life. However, few studies have examined the potential impact of mobile payments on people's happiness in China. Using the nationally representative data from the China Household Finance Survey (CHFS), this study adopts the ordered probit regression with endogenous treatment to adjust for possible endogeneity to assess the effect of mobile payments on residents' happiness. The results suggest an association between mobile payment usage and increases in happiness, which is supported by several robustness checks, such as using an alternative instrumental variable (IV), replacing the explained variable, and removing some extreme observations. In addition, we explore the mechanisms by which mobile payments affect residents' happiness from multiple perspectives. Positive mechanisms include promoting quality of life, reducing transaction costs, stimulating entrepreneurship, and increasing social interaction. However, as a non-cash payment method, mobile payments may also lead to over-consumption, which is detrimental to residents' happiness. Furthermore, the heterogeneous analysis shows inclusive attributes of mobile payments. We find mobile payments have a greater positive effect on happiness of some socially disadvantaged groups, such as elderly individuals, rural residents, the low-educated, and low-income households. These findings supplement the literature on online happiness and financial inclusion and refer to the possible negative impact of mobile payments. Therefore, it is necessary to actively promote mobile payments to benefit more socially vulnerable groups and prevent potential risks from over-consumption.

**Keywords** Digital finance · Mobile payments · Happiness · Ordered probit regression with endogenous treatment · China

**JEL Classification** I31 · G51 · D12

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## 1 Introduction

In recent years, with the increasingly close integration of information technology and financial services, China is moving into the digital financial era. China's digital financial system, consisting of mobile payments, online banking, financial service outsourcing, and online loans, has not only changed the financial formats but also people's daily life [38, 41]. Among them, mobile payment, as the payment tool closely connected with people's daily economic activities, has achieved great results in China [29, 73]. Mobile payment refers to the use of electronic devices such as smartphones by mobile clients to pay by electronic money [48, 58]. Mobile payment effectively unites the Internet, terminal devices and financial institutions to form a new type of payment system [11, 80]. Nowadays, China is the world's most developed and widespread country for mobile payments. A report showed that in 2017, more than 47% of consumers use mobile payments in China, ranking first in the world, and Alipay and WeChat Pay<sup>1</sup> have 810 million users.<sup>2</sup> The more convenient life brought by mobile payment is gradually turning China into a cashless society.

The success of mobile payments has inevitably attracted increasing discussion for related topics in the literature. However, most studies focused on the acceptances or drivers of mobile payments [1, 11, 39, 42, 48, 50, 55, 80] or impacts on household economic behaviors [29, 30, 35, 41, 73, 79]. Only a few analyses paid attention to household welfare-enhancing effects of mobile payments, such as household risk-sharing improvements and financial exclusion reductions [29, 72]. To date, to our best knowledge, few studies have explored how mobile payments affect residents' happiness. Given the inclusive financial attributes of digital finance [6, 21, 29, 56], as well as the convenience that mobile payments provide for family everyday life [41, 80], we supposed that Chinese residents, especially some socially vulnerable groups, are benefited by the popularity and development of mobile payments.

Specifically, as a portable and fast payment method, the convenience of mobile payments makes people no longer rely on traditional financial transaction tools in economic activities, which saves unnecessary transaction costs and improves transaction efficiency [1, 11]. In addition, mobile payments may improve household consumption structure and enhance people's quality of life [41, 51, 83]. Furthermore, mobile payment tools, such as WeChat Pay and Alipay, can also be used as online lending and online social platforms, lowering thresholds of access to funds, accelerating information transmission, and providing better conditions for starting businesses and increasing social interaction [29, 73]. Considering the strong link between factors such as lower transaction costs and improved quality of life and residents' happiness, mobile payments are likely to enhance people's welfare and happiness through multiple channels.

Based on a nationally representative sample from the China Household Finance Survey (CHFS) in 2017, we tried to identify the causal effect between mobile payment usage and the happiness. However, previous literature suggested that using

<sup>1</sup> Alipay and WeChat Pay are the most dominant mobile payment tools in China.

<sup>2</sup> Data resource: <https://www.statista.com/statistics/744944/mobile-payment-platforms-users/>.

mobile payment is not random but selective for households, and the resulting endogeneity problems may lead to biased estimates [73, 79]. Therefore, we employed the ordered probit regression with endogenous treatment to address potential endogeneity issues [57, 82, 86]. In addition, this study has important practical implications as the inclusiveness of mobile payments benefits more socially vulnerable groups and make them happier. In recent years, the United Nations has been active in making people realize the importance of happiness in their lives, and advocated reducing inequality and improving mental health and well-being of all mankind [86]. The results of this research offer some insights for policymakers to further promote digital finance and mobile payments, enhance financial accessibility, and improve happiness of residents.

This paper contributes to the existing literature in three aspects. First, it is the first to employ nationally representative sampling survey data to evaluate the impact of mobile payments on residents' happiness. More importantly, using the ordered probit regression with endogenous treatment helps us to identify the causal relationship between mobile payment usage and people's happiness. Second, we analyzed and verified in detail the mechanisms by which mobile payments promote people's happiness in several ways. On the positive side, mobile payments can reduce transaction costs, improve quality of life, promote entrepreneurship, and enhance social interactions; on the negative side, given the close relationship between mobile payments and consumption [41, 51], mobile payments may lead to a decrease in happiness due to excessive household consumption. The findings supplement the literature on the potential adverse effects of mobile payments [34, 42]. Third, our heterogeneity focused on the inclusive financial attributes of digital finance and mobile payments in terms of age, urban and rural areas, education level, and household income. We find that mobile payment usage is more helpful to improve the happiness of some socially disadvantaged groups, such as elderly individuals, rural residents, the low-educated, and low-income households, which provides evidence for inclusive finance to promote residents' welfare from the perspective of happiness.

The rest of this paper is organized as follows. Section 2 provides a brief literature review and describes the institutional background. Section 3 outlines theoretical mechanisms of mobile payments on happiness. Section 4 explains our estimation strategy. Section 5 introduces the data and variables. Section 6 presents empirical results. Section 7 concludes this paper.

## 2 Literature review and institutional background

### 2.1 Literature review

There exist three strands of literature related to our study. First, some scholars explored the function of mobile payments and its impact on household economic behaviors. With the mobile Internet, mobile payment can fill the shortcomings of traditional financial payment methods and reduce the high transaction costs caused by backward infrastructure, which plays an important role in enhancing the welfare of households in developing countries [2, 29, 56, 87]. In particular,

[87] found that rural residents and women were rewarded with greater happiness through mobile payments. In addition, mobile payments eliminate the need for cash, bank cards, or checks in daily economic activities, which helps to save transaction time, reduce transaction friction, and improve convenience and security [30, 72, 83]. Moreover, the role of mobile payments in providing small loans and broadening social networks makes it effective in stimulating entrepreneurship [73, 79]. Also, more convenient financial services provided by mobile payments may smooth consumption risks and change savings behavior [29, 35, 41].

Second, one type of literature focused on people's online happiness, but reached two opposing views. Early research supported a hypothesis of social displacement, that people's happiness was weakened by the Internet use, as it reduces the offline communication and narrowed the social circle [28, 33, 53]. Subsequent studies provided more support for the idea that the Internet enhances people's happiness. On the one hand, the Internet increases the efficiency of information and knowledge dissemination and using Internet tools helps improve people's quality of life [9, 22, 81]. On the other hand, as a kind of social capital, it provides more opportunities and resources [64, 68], which can create more employment opportunities, enhance social status and psychological empowerment, and help create greater happiness [9, 88].

In recent years, with the popularity of online shopping and mobile Internet, more and more research discussed whether they would enhance people's happiness. Not surprisingly, these studies highlighted the positive role of online shopping and mobile Internet in enhancing residents' happiness [17, 34, 45, 57, 81, 86]. Online shopping improves shopping efficiency, saves time and enhances users' shopping experience with the advantages of the Internet platform [17, 34, 86]. Nevertheless, the potential downside is that online shopping may induce impulsive buying and conspicuous consumption [4, 24], or even damage consumer well-being by over-consumption [66].

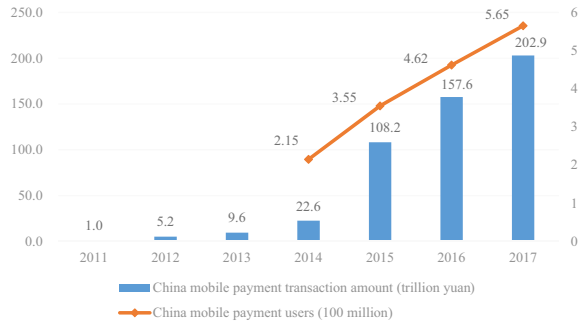
Similarly, mobile Internet enhances the convenience of Internet use for residents, strengthening online interaction and expanding social networks [45, 47, 57, 76]. However, [81] stressed the potential negative impact of mobile Internet from the perspective of privacy risk and task risk and argued that there is an inverted U-shaped relationship between mobile Internet and users' happiness. Furthermore, [34] found that although online shopping increased happiness, mobile Internet use and mobile shopping instead decreased users' happiness, due to potential privacy concerns. The above literature is summarized in Table 1.

Third, another type of literature relevant to our research is to analyze the effects of financial inclusion and financial accessibility on people's happiness. In terms of the economic, inclusive finance provides low-cost financial services that can effectively alleviate conflicts between household income and consumption, increase the risk-resistance capacity [21, 36], and maximize the household's utilities to enhance their happiness. At the psychological level, financial inclusion can alleviate poverty, financial exclusion, and income inequality [56, 61], promote social equity and improve residents' confidence in their future lives [6, 13], and ultimately enhance people's happiness.

**Table 1** Prior studies on online happiness

Topics	Authors	Findings
Internet use and happiness	Huang [28], Kraut et al. [33], Morgan & Cotten [53] Carter et al. [9]; Grieve et al. [22], Pénard & Poussing [64], Shapira et al. [68], Zhu et al. [88]	Happiness was weakened by the Internet use Internet use enhanced people's happiness
Mobile Internet and happiness	Lu & Kandilov [45], Nie et al. [57], Yang et al. [76] Zhan & Zhou [81]	Mobile Internet use was positively associated with happiness An inverted U-shaped relationship between mobile Internet use and happiness
Online shopping and happiness	Kwak et al. [34] Duan & Dholakia [17], Kwak et al. [34], Zheng & Ma [86] Boonchoo & Thourmrungrroje [4], He et al. [24], Rose & Dhandayudham [66]	Mobile Internet use damaged the happiness, due to privacy concerns Online shopping helped promote consumers' happiness Potential negative effects of online shopping on happiness
Mobile payment and happiness	Zheng & Ma [87]	Mobile payments promoted the happiness, especially rural residents and women

**Fig. 1** Transaction and users scale of China Mobile Payment. *Data source:* The People's Bank of China, the Payment & Clearing Association of China and iiMedia Research



## 2.2 Institutional background

As early as 1999, China Mobile, one of the three largest telecom operators in China, in cooperation with some financial institutions, started mobile payment pilots in some cities in Guangdong. However, due to the lagging financial technology and mobile Internet technology at that time, mobile payments were not promoted nationwide. Thanks to the popularity of smartphones, mobile Internet, and mobile e-commerce, things took a turn for the better in 2011 when users in some major cities began to use mobile payment tools. More importantly, the People's Bank of China issued third-party payment licenses to Alipay, Tenpay, UnionPay, UnionPay Commerce, and 99Bill in June 2011, which provided some mobile payment platforms with legal status and laid a solid foundation for the promotion of mobile payments in China.

In addition to the efforts of the Chinese government, telecom operators, financial institutions and third-party payment platforms, the use of QR codes has further accelerated the development of China's mobile payments since 2014. With QR codes, mobile payment processes become more convenient and secure, being used and promoted on a large scale in China. Benefit from this advancement, non-bank mobile payment tools such as Alipay and WeChat Pay are gradually becoming the mainstay of China's mobile payment market. Furthermore, mobile payment platforms were actively engaged in other financial services. For example, in 2013, Alipay accessed the Yu'E Bao money fund featuring easy operation, low threshold, zero fees, and anytime access [29, 40]. In addition to earning financial income, Yu'E Bao can also be used directly for shopping, money transfers, bill payments, and repayments, quickly becoming the largest money fund in the world [40]. What's more, WeChat Pay, based on China's largest social networking software, launched the WeChat red packet in 2014, which fits in with Chinese cultural traditions and is equally popular with the majority of users.

Figure 1 shows the total number of mobile payment transactions from 2011 to 2017 and the number of mobile payment users from 2014 to 2017 in China. In 2013, the transaction value of mobile payments in China was only 9.6 trillion yuan, but it grew 135.42% in 2014 and saw an explosive growth in 2015, reaching 108.2 trillion yuan. In 2017, statistics from the People's Bank of China show that the number of mobile payment users in China has reached 565 million and the total transaction

value is more than 200 trillion is 90 times of the United States in the same period<sup>3</sup>. The number of mobile payment users exceeded 565 million, which means that more than one-third of Chinese people are using mobile payments.

With the further development of digital finance and mobile payment technology in China, fingerprint payment, unmanned supermarket, face scanning payment and iris payment are also gradually applied to mobile payment, which also makes mobile payment in China more convenient, efficient, and secure. Nowadays, the application scenarios of mobile payment are more diversified, including online and offline shopping, social networking, financial management, borrowing and lending, transportation, travel, entertainment, catering and takeaway, and so forth, which have penetrated into every aspect of life in China. The new payment revolution created by mobile payments is helping to improve the consumer experience, reduce transaction costs, and create greater digital financial benefits.

### 3 Theoretical analysis

We classified the possible mechanisms by which mobile payment usage affects residents' happiness into the following four categories: improving the quality of life, reducing transaction costs, stimulating entrepreneurship, and increasing social interaction.

#### 3.1 Improving the quality of life

Consumption is an important way to enhance personal utility and welfare, and consumption upgrade and promotion of household consumption structure are important ways to improve people's quality of life. However, China had the problems of high saving and low consumption for a long time [52, 74]. From the perspective of preventive savings, Chinese residents are used to reducing their consumption to cope with future uncertain events and risks [10, 75], which leads to a decline in quality of life. Besides, factors such as traditional culture, consumption habits, and insufficient supply of financial consumer tools attract the attention of scholars [14, 26]. As a multi-functional comprehensive financial instrument, the convenience and practicality of mobile payment may change consumption habits [42], improve the consumer experience [41], and promote household consumption upgrade [83].

First of all, mobile payment as a non-cash payment method can effectively reduce people's psychological account losses during consumption. Skipping the psychological process of cash payment helps to speed up consumption decision-making and stimulate the increase of household consumption [70, 83]. Next, mobile payment makes it easier for residents to get the required goods and services through their smartphones, which may change their consumption habits. Mobile payment usually cooperates with some shopping platforms to push promotional information for users,

<sup>3</sup> Data resource: [https://www.sohu.com/a/232624359\\_100157588](https://www.sohu.com/a/232624359_100157588).

which brings better consumer experience and make consumers more accustomed to using the mobile payment for shopping [42, 80]. Finally, mobile payment may also optimize the household consumption structure. For instance, mobile payment provides information to make people pay more attention to the high-level consumption field in the health, education, culture, and entertainment and electronic products, thereby optimizing household consumption structure and enhancing their utilities and happiness.

### 3.2 Reducing transaction costs

In China, due to the incompleteness of the financial system and credit system, traditional non-cash payment methods such as credit card or cheque payment have large transaction costs for common residents or households [60, 78]. Taking credit cards as an example, the penetration rate of credit cards in China is only 34.4%, while in developed countries in Europe and America, the ratio exceeds 85%<sup>4</sup>. Additionally, the non-popularity of credit cards makes them generally only available in high-end consumer places like upscale department stores and ritzy restaurants, which means many people are excluded from credit card payments, especially for socially disadvantaged groups. Furthermore, traditional payment methods limit economic activities across regions [65], and residents have to shop, transfer money, or pay utility bills offline or at bank branches, which incurs more additional transaction costs from wasting time, traffic, communication, and information acquisition.

As a more convenient and alternative tool for traditional financial payment methods, mobile payment may effectively lower the threshold of financial services and reduce the transaction costs of economic activities [56, 80]. First, compared with traditional financial institutions, mobile payment uses Internet technology to realize electronic money payment, simplifying the transaction process and improving payment efficiency [11, 23]. For consumers, these reduced costs include travel time and fees to and from banks, waiting time at bank counters, cash safekeeping costs, and the potential risk of receiving counterfeit currency. Second, mobile payment breaks through the physical limitations and geographical isolation of conventional payment ways, and realizes online remote payment, saving household transport and time costs [54, 77]. Third, mobile payment based on the internet platform also helps to improve people's ability to obtain information, alleviate information asymmetry in transactions [83], and help residents to obtain required goods and services at lower prices [49, 86]. In summary, mobile payment makes financial services more convenient and makes up for the deficiencies of traditional financial tools and brings a better trading experience feeling.

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<sup>4</sup> Data source: <https://www.quora.com/Why-aren%E2%80%99t-credit-cards-popular-in-China-the-worlds-second-largest-economy>.



### 3.3 Stimulating entrepreneurship

We considered the third possible mechanism of mobile payments affecting residents' happiness is stimulating entrepreneurship. Previous studies have found an inextricable relationship between mobile payment and Chinese households or individual entrepreneurship [29, 73, 79]. First, mobile payments, relying on the Internet and big data, effectively reduce the cost of financial services and broaden the access to funding for entrepreneurs [29, 30]. For example, with the credit points generated by mobile payment usage, entrepreneurs may obtain small loans from Ant Cash Now or Weilidai.<sup>5</sup> These microcredits are simpler and do not require collateral, saving entrepreneurs the cost of obtaining a bank loan, reducing financial constraints on families and providing incentives to start a business [79]. Second, mobile payments, provide an effective channel for information dissemination to explore and grasp more business opportunities through the Internet [39]. Third, mobile payments make online entrepreneurship more possible. Through mobile payments and e-commerce platforms, entrepreneurs may sell their goods or services to all over the world and have a wider source of customers [67, 69]. A cluster effect can be formed among Internet entrepreneurs to realize the optimal allocation of resources.

Given that the positive impact of entrepreneurship or self-employment on happiness has been widely recognized [63, 85], we regarded entrepreneurship would be one of the channels by which mobile payments promote residents' happiness.

### 3.4 Increasing social interaction

The last possible channel of mobile payments affecting Chinese residents' happiness is social interaction. First, mobile payments increase the frequency with which people participate in social networking. Relying on the Internet platform, mobile payment provides people with an effective means of communication and social contact. For example, WeChat Pay is developed by relying on WeChat, China's largest online social platform. By combining the custom of WeChat red packets with traditional Chinese characteristics, which greatly enhances residents' online social interaction experience [50].

Second, mobile payment provides more convenience for people to participate in online entertainment. At present, China has ushered in the era of online entertainment charges. Watching movies and TV dramas, listening to music, and playing online games on smartphones sometimes need to pay. There is no doubt that mobile payment helps people to have fun online easily.

Third, in addition to online activities, mobile payments also make it easier for offline social interaction [29, 48]. In terms of transportation, people can use mobile payments to take buses, subway, and shared bicycles, and there are discounts on highway payment. Concerning dining out and hotel accommodation, mobile payment can be used to make reservations. In the aspect of communication, mobile

<sup>5</sup> Ant Cash Now and Weilidai are microfinance businesses under Alipay and WeChat Pay.

payment can improve the service of quick inquiry and pay the phone and Internet bills.

Taken together, these conveniences provided by mobile payment create good external conditions for social interaction. Moreover, social interaction, as a social behavior that meets the needs of individual autonomy, promotes interpersonal relationships and increase residents' happiness, which has been verified by many previous studies (e.g., [3, 45, 59]).

## 4 Empirical strategy

To identify the causal relationship between mobile payment usage and residents' happiness, we must rule out the endogenous problem. On the one hand, there may be a two-way causal relationship between mobile payment usage and residents' happiness. For example, higher happiness may indicate a higher level of education or financial literacy, which makes them more willing to try new digital payment methods. On the other hand, individuals' mobile payment behavior may be self-selected. Whether residents use mobile payments is confounded with a range of factors, such as perceptions, personality, habits, risk awareness, and thinking inertia. Although we reduce potential endogeneity from bidirectional causality and self-selection by controlling for individual characteristics, household characteristics, and city fixed effects, some confounders are not observable or measurable.

Undoubtedly, it is better to use the instrumental variable (IV) method to solve the endogenous problems caused by two-way causality and self-selection bias. Specifically, we utilize the mobile payment usage rate of the others within a community (village) as an IV. According to the theory of peer group effect [7, 18], the mobile payment use of individuals within a community (village) is influenced by others, due to the pervasive nature of mobile payment usage. When the more people within a community (village) choose to use mobile payments, individuals are more likely to follow them and adopt this payment method as well [57]. Therefore, our IV is consistent with the relevant hypothesis. Furthermore, since the IV only includes the mobile payment use of others within a community (village), the happiness of individual residents is unlikely to be influenced by such data aggregated through other channels [5, 27, 82]. In other words, the use of mobile payments by others only affects their own happiness, and it is difficult to make a connection with the individual's well-being.

Another concern is whether to use linear or nonlinear approaches for the estimation of happiness. Ferrer-i-carbonell & Frijters [19] concluded that estimates were relatively unaffected by the assumption that happiness was cardinal or ordinal. In subsequent studies, most of the literature was likely to use both linear and nonlinear estimates to guarantee the reliability of results e.g., [32, 37, 82]. Similar to these studies, in main specifications, we employed ordered probit models and performed robustness tests using linear estimations. In addition, given that our core explanatory variable is binary, we estimated the ordered probit regression with endogenous

treatment [57, 82, 86], including a ordered probit model for residents' happiness and a probit model for mobile payment. Models can be written as follows:

$$Happiness_{ic} = \alpha_0 + \alpha_1 MP_{ic} + \alpha_2 X_{ic} + \alpha_3 City_p + \mu_{ic} \tag{1}$$

$$Happiness_{ic} = \begin{cases} 1 & \text{if } Happiness_{ic}^* < \lambda_1; \\ k & \text{if } \lambda_{k-1} < Happiness_{ic}^* < \lambda_k, k = 2, 3, 4 \\ 5 & \text{if } Happiness_{ic}^* > \lambda_4; \end{cases} \tag{2}$$

$$MP_{ic}^* = \beta_0 + \beta_1 Z_c + \beta_2 X_{ic} + \beta_3 City_p + \epsilon_{ic} \tag{3}$$

$$MP_{ic} = \begin{cases} 1 & \text{if } MP_{ic}^* > 0; \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

where  $Happiness_{ic}$  denotes the happiness score of the householder  $i$  in the community (village)  $c$ .  $MP_{ic}^*$  is a latent variable representing householder  $i$ 's continuously varying propensity of using mobile payment.  $MP_{ic}$  is a dummy variable that takes the value of 1 if the household  $i$  in the community (village)  $c$  uses mobile payment, and 0 otherwise.  $Z_c$  refers to the IV measured by the mobile payment usage rate of the others within a community (village)  $c$ .  $X_{ic}$  denotes control variables, and  $City_p$  is a vector of city-level dummies, capturing the prefecture-level city fixed effects.  $\epsilon_{ic}$  and  $\mu_{ic}$  are error terms.

## 5 Data and variables

### 5.1 Data source

Our data comes from the CHFS in 2017, which covers 1417 communities (villages) of 326 cities in 29 provinces, with microdata for 40,013 households. The CHFS is conducted by the Southwestern University of Finance and Economics and it's nationally representative of Chinese households due to its stratified sample design. The CHFS collects detailed information on residents' demographic characteristics, household income and expenditure, assets and liabilities, employment and entrepreneurship, and so forth. Especially in this wave, the CHFS investigated whether households use mobile payment. In addition, in the subjective attitude part of the CHFS questionnaire, it recorded the information about residents' happiness. Therefore, the CHFS provides an accessible and reliable source of data for our research on mobile payment usage and residents' happiness.

## 5.2 Variable description

We assigned the explained variable *Happiness* based on the response of the CHFS questionnaire, "Overall, do you feel happy now?", which was widely used in previous studies (e.g., [19, 31, 32, 45, 85]). We assigned a value of 5 if their answer is "very happy", In turn, values 4 to 1 indicate "happy", "indifferent", "unhappy", and "very unhappy", respectively.

The householders were asked about the payment methods commonly used. The five options are cash payment, card payment (including bank card, credit card, etc.), computer payment (including online banking, computer Alipay, etc.), mobile terminal payment such as mobile phones, iPad (including Alipay, WeChat payment, mobile banking, Apple pay, etc.), and others. Based on responses to this question, we defined the explanatory variable *Mobile payment* equals to 1 if the householders used mobile terminal payment, and 0 otherwise.

As mentioned earlier, we utilized the mobile payment usage rate of the others within a community (village) as an IV. We use the household number provided by CHFS to match households living in the same community (village) and calculate the proportion of other householders who use mobile payments.

Additionally, we included two levels of control variables in this paper. First, at the householder level, considering the potential nonlinear effects, we chose *Age* and *Age squared* [57, 85]. The remaining demographic variables include *Gender*, *Urban*, *Party member*, *Education*, *Marriage Health*, which we considered the positive effects of the female householders, living in urban areas, political identity, good education, and self-rated health on residents' happiness in China [45, 46, 79, 82, 87]. Moreover, since insurances, social trust, and risk preferences may affect both individual mobile payment use and happiness [15, 43, 45], *Commercial insurance*, *Social trust*, and *Risk attitude* are also controlled for.

Second, in the household characteristics, we first controlled for two variables of household demographics, *Child dependency ratio*, *Elderly dependency ratio*, because of the influence of child and elderly dependency ratio on residents' happiness [85]. In addition, among the economic characteristics, we selected a series of variables [12, 15, 20, 37, 43, 57], such as *Household income*, *Fixed deposit*, *Current deposit*, *Household debt*, *Housing ownership*, *Shop ownership*, and *Car ownership*. Last, given the effects of social security on individual happiness [62], *Pension insurance* and *Medical insurance* were further included.

## 5.3 Descriptive statistics

Variable definitions and descriptive statistics are represented in Table 2, and all continuous variables (e.g., *Child dependency ratio*) are winsorized by replacing samples among the top 1% and the bottom 1% to avoid the influence of extreme values on the estimates. In addition, 18 observations that use mobile payments but not smartphones were removed. To confirm that householders' responses were acceptable and reliable, 27 householders under the age of 18 were also excluded. After excluding missing values for the above variables, our final observation was 36,998. We find

**Table 2** Variable definitions and descriptive statistics (N = 36,998)

Variables	Definition	Mean	SD
Happiness	Householder happiness. An ordinal variable with values of 1, 2, 3, 4, and 5, with higher values indicating greater happiness	3.8628	0.8301
Mobile payment	Use = 1; nonuse = 0	0.2667	0.4422
Mobile payment usage rate	Mobile payment usage rate within a community (village)	0.2739	0.2013
Age	Householder age	55.385	14.064
Gender	Householder gender. Female = 1; male = 0	0.2073	0.4054
<i>Hukou</i>	Urban = 1; rural = 0	0.6816	0.4659
Party member	Householder politics status. Member of Communist Party of China = 1; others = 0	0.1254	0.3312
Education	Householder education status. 1 = unschooled, 2 = primary school, 3 = junior middle school, 4 = vocational high school, 5 = senior high school, 6 = junior college, 7 = bachelor degree, 8 = master's degree, PhD degree = 9	3.4324	1.6733
Marriage	Householder marital status. Married = 1; others = 0	0.8528	0.3543
Health	Householder self-rated health. An ordinal variable with values of 1, 2, 3, 4, and 5, with higher values being healthier	3.3824	1.0149
Commercial insurance	Owned = 1; not owned = 0	0.0881	0.2834
Social trust	An ordinal variable with values of 1, 2, 3, 4, and 5, with higher values indicating higher trust in strangers	3.9779	0.9100
Risk attitude	An orderly variable with values of 1, 2, 3, 4, and 5, with higher values indicating a greater preference for risk	1.8517	1.2310
Child dependency ratio	The ratio of the number of the elderly over 65 divided by the number of people aged 15–64 in the household	0.1055	0.1748
Elderly dependency ratio	The ratio of the number of the children less than 14 divided by the number of people aged 15–64 in the household	0.2304	0.3560
Household income	Household per capita income, 10,000 yuan	4.0449	2.2376
Fixed deposit	Household fixed deposit, 10,000 yuan	1.7588	5.9317
Current deposit	Household current deposit, 10,000 yuan	2.1919	5.5271
Household debt	Household total debt, 10,000 yuan	4.6672	14.423
Pension insurance	Proportion of people aged 16 years or older in the household with social pension insurance	0.7476	0.3463

**Table 2** (continued)

Variables	Definition	Mean	SD
Medical insurance	Proportion of people aged 16 years or older in the household with social medical insurance	0.8923	0.3777
Housing ownership	Owned = 1; not owned = 0	0.8440	0.3628
Shop ownership	Owned = 1; not owned = 0	0.0357	0.1856
Car ownership	Owned = 1; not owned = 0	0.2477	0.4317

“yuan” is the unit of the RMB, which is the official currency of China

**Table 3** The effect of mobile payments on residents' happiness

	(1)	(2)	(3)
	Ordered probit	IV (Ordered probit regression with endogenous treatment)	
	Happiness	Mobile payment (Probit)	Happiness (Ordered probit)
Mobile payment	0.0010 (0.0045)		0.1780*** (0.0239)
Mobile payment usage rate		0.2226*** (0.0135)	
Age	- 0.0079*** (0.0009)	- 0.0112*** (0.0012)	- 0.0030*** (0.0012)
Age squared	0.0102*** (0.0009)	0.0045*** (0.0011)	0.0071*** (0.0010)
Gender	0.0133*** (0.0042)	0.0078 (0.0048)	0.0098** (0.0043)
<i>Hukou</i>	- 0.0101** (0.0045)	0.0651*** (0.0054)	- 0.0271*** (0.0051)
Party member	0.0220*** (0.0047)	- 0.0145** (0.0058)	0.0254*** (0.0048)
Education	- 0.0045*** (0.0013)	0.0262*** (0.0013)	- 0.0110*** (0.0016)
Marriage	0.0746*** (0.0056)	- 0.0417*** (0.0065)	0.0796*** (0.0056)
Health	0.0594*** (0.0019)	0.0111*** (0.0020)	0.0569*** (0.0020)
Commercial insurance	0.0092 (0.0057)	0.0528*** (0.0060)	- 0.0057 (0.0061)
Social trust	0.0075*** (0.0019)	- 0.0225*** (0.0020)	0.0123*** (0.0020)
Risk attitude	- 0.0064*** (0.0014)	0.0177*** (0.0015)	- 0.0102*** (0.0015)
Child dependency ratio	- 0.0033 (0.0108)	0.0189 (0.0119)	- 0.0096 (0.0109)
Elderly dependency ratio	0.0358*** (0.0071)	- 0.1054*** (0.0090)	0.0466*** (0.0072)
Household income	0.0007 (0.0010)	- 0.0134*** (0.0012)	0.0024** (0.0011)
Fixed deposit	0.0012*** (0.0003)	0.0020*** (0.0003)	0.0007** (0.0003)
Current deposit	0.0015*** (0.0003)	0.0039*** (0.0003)	0.0005 (0.0003)
Household debt	- 0.0003*** (0.0001)	0.0003** (0.0001)	- 0.0005*** (0.0001)

**Table 3** (continued)

	(1)	(2)	(3)
	Ordered probit	IV (Ordered probit regression with endogenous treatment)	
	Happiness	Mobile payment (Probit)	Happiness (Ordered probit)
Pension insurance	0.0381*** (0.0054)	- 0.0059 (0.0056)	0.0352*** (0.0054)
Medical insurance	0.0101* (0.0052)	0.0898*** (0.0060)	- 0.0013 (0.0056)
Housing ownership	0.0228*** (0.0046)	- 0.0164*** (0.0054)	0.0285*** (0.0047)
Shop ownership	0.0383*** (0.0088)	0.0548*** (0.0088)	0.0268*** (0.0090)
Car ownership	0.0326*** (0.0041)	0.0881*** (0.0042)	0.0057 (0.0055)
$\rho_{\epsilon\mu}$		- 0.3824*** (0.0495)	
City fixed effects	Yes	Yes	Yes
N	36,998	36,998	36,998

Column (1) reports the marginal effects when the explained variable *Happiness* is equal to 5. The ordered probit regression with endogenous treatment are used in the last two columns. Among them, column (2) shows the estimated results of the treatment equation and reports the marginal effects and column (3) presents the results of the outcome equation and reports the marginal effects when the explained variable *Happiness* is equal to 5

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

that the average happiness scores were 3.8628 and the percentage of residents using mobile payments was 26.67%, indicating that mobile payment services were not nationally widespread in 2017. The high standard deviation of *Mobile payment* suggests that the development of mobile payments and digital finance in China may be uneven.

## 6 Results

### 6.1 Baseline results

Table 3 reports the baseline results of the impact of mobile payment use on residents' well-being, with all standard errors have been cluster-corrected at the community (village) level. In column (1), the results by using the ordered probit method show that there is no association between mobile payment usage and residents'



happiness. However, the ordered probit estimation results may be biased because of potential endogeneity problems.

Columns (2) and (3) in Table 3 present results by using the ordered probit regression with endogenous treatment, where column (2) shows the results of the treatment equation and reports the marginal effects. The correlation coefficient ( $\rho_{\epsilon\mu}$ ), presented in the lower part of Table 3, is significant, indicating the presence of selection bias from unobserved factors. That is, it is more appropriate to use IV estimations [87, 88]. The IV, the mobile payment usage rate of the others within a community (village), is strongly positively correlated with household mobile payment usage status at the 1% significance level, indicating that the IV meets the correlation restriction. Column (3) presents the results of the outcome equation and reports the marginal effects when *Happiness* is equal to 5. We find that the coefficient on mobile payment is significantly positive at the 1% level, suggesting that mobile payment usage did increase Chinese residents' happiness after excluding potential endogeneity. Specifically, the results reveal that mobile payment usage increased the possibility that people rated their happiness as "very happy" by 17.80%. Furthermore, Table 12 in the appendix shows the results for happiness assignments of 1–4 and suggests that mobile payments reduced the probability that residents rated their happiness as "very unhappy", "unhappy", and "indifferent" by 2.00%, 4.69%, and 13.96%, respectively, and increased the probability of feeling "happy" by 2.85%. In summary, we caught a significant causal relationship between mobile payment usage and residents' happiness by adopting an IV method.

Among the control variables in column (3), it is clear that the coefficient on *Age squared* is significantly positive, suggesting that there is a U-shaped relationship between the age of householders and happiness. These results indicate that younger and older people are happier in China [85]. In addition, party membership, marriage, health, and social trust were positively associated with individual happiness, which is consistent with the findings in previous studies [20, 46, 79]. For household economic variables, the significantly positive coefficients on *Household income*, *Fixed deposit*, *Housing ownership* and *Shop ownership* indicate that householders' happiness will rise when they have higher assets, income, and savings [12, 15, 37, 57]. A significantly negative coefficient is found on *Household debt*, implying excessive household debt undermines people's happiness [43]. Moreover, there is a positive association between household pension insurance ownership rates and householders' happiness, which is consistent with the conclusions obtained in most of the prior literature [62, 88].

## 6.2 Mechanism analysis

In this subsection, we examined multiple potential mechanisms through which mobile payment usage increases residents' happiness. These channels include improving quality of life, reducing transaction costs, stimulating entrepreneurship, and increasing social interaction. Moreover, estimation methods are adjusted according to the types of mechanism variables.

**Table 4** Mobile payments, quality of life, and residents' happiness

	(1)	(2)	(3)	(4)	(5)
	Per capita household consumption	Engel's coefficient	Enjoyable consumption	Leisure consumption	Educational consumption
Panel A. Quality of life (IV estimations)					
Mobile payment	0.5757*** (0.0540)	-0.1691*** (0.0099)	0.1595*** (0.0084)	0.1738*** (0.0132)	0.2940*** (0.0184)
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
N	36,998	36,998	36,998	36,998	36,998
Panel B. Happiness (Ordered probit)					
Quality of life	0.0024*** (0.0009)	-0.0441*** (0.0090)	0.0020*** (0.0004)	0.0011*** (0.0003)	0.00036* (0.00021)
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
N	36,998	36,998	36,998	36,998	36,998

All columns in Panel A show the outcome equation results for the endogenous treatment effect model. Columns in Panel B report the marginal effects when *Happiness* is equal to 5. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

### 6.2.1 Improving the quality of life

We considered whether mobile payments improve the quality of life from the perspective of consumption upgrading. The reason why consumption is used as a measure of quality of life is plenty of studies confirmed the close relationship between consumption and household quality of life [31, 88], and some classical economic models widely assumed that consumption is a central element in maximizing household utility [8, 16]. According to the CHFS questionnaire, mechanism variables we selected include *Per capita household consumption*, *Engel's coefficient*, *Enjoyable consumption*, *Leisure consumption*, and *Education consumption*. The specific definitions of these variables are shown in Panel A of Table 13 in the Appendix.

Panel A of Table 4 reports the results of the impact of mobile payments on quality of life, using the endogenous treatment effect model. In column (1), the estimates show that mobile payments contribute to improving residents' happiness, with statistical significance at the 1% level, which is similar to the results of [38]. In column (2), we can see that the coefficient on *Mobile payment* is significantly negative, implying that mobile payments reduce the proportion of food consumption expenditures and enhances the quality of life of the household. More importantly, in the last three columns, mobile payments have positive effects on various types of consumption that are closely related to individual happiness, indicating that mobile payments enhance people's willingness to consume in enjoyment, leisure, and education. In Panel B of Table 4, as expected, consumption is positively correlated with residents' happiness, and there is a negative association between Engel's coefficient and happiness. To sum up, these results indicate that mobile payments facilitate the consumption upgrading and improve the consumption structure for more utility and happiness.

### 6.2.2 Reducing transaction costs

As highlighted in Sect. 3, mobile payments provide convenience and enhance residents' happiness by reducing transaction costs. High transaction costs are reflected in the payment methods offered by traditional financial institutions, such as cash payments and card payments. First, we aimed to confirm that mobile payments save the high costs associated with these traditional payment methods, and results using the endogenous bivariate probit model are shown in columns (1) and (2) of Table 5. In Panel A, the coefficient on *Mobile payment* is significantly negative in column (1), indicating that mobile payment usage reduces the frequency of cash transactions in daily life. In column (2), the results suggest that mobile payments facilitate card payments. Additionally, in Panel B, although there is a negative relationship between cash payments and residents' happiness, the effect of card payments on happiness is insignificant. These results indicate that mobile payments reduce transaction costs to enhance people's happiness mainly by reducing cash payments, possibly thanks to the psychological account loss effect of mobile payments and the avoidance of the risk of receiving counterfeit bills and cash theft [23, 42].

Second, we tested whether mobile payments promote residents' happiness through online shopping, which also brings more convenience and less transaction

**Table 5** Mobile payments, transaction costs, and residents' happiness

	(1)	(2)	(3)	(4)
	Cash payment	Card payment	Online shopping (dummy)	Online shopping consumption
<b>Panel A. Other payment methods and online shopping (IV estimations)</b>				
Mobile payment	- 0.1405*** (0.0089)	0.2035*** (0.0129)	0.2444*** (0.0248)	0.9187*** (0.1681)
Control variables	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
N	36,998	36,998	36,894	12,442
<b>Panel B. Happiness (Ordered probit)</b>				
Other payment methods and online shopping	- 0.0394*** (0.0076)	0.0047 (0.0044)	0.0144*** (0.0042)	0.0094** (0.0049)
Control variables	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
N	36,998	36,998	36,894	12,442

The first three columns of Panel A show the outcome equation results for the endogenous bivariate probit model, reporting the marginal effects, and the endogenous treatment effect model is used in column (4) of Panel A. All columns in Panel B report the marginal effects when *Happiness* is equal to 5. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

costs. Given that the CHFS not only investigated whether respondents shopped online, but also recorded the consumption of online shopping, we accordingly constructed two mechanism variables to measure online shopping. The specific definitions of these variables are shown in Panel B of Table 13 in the Appendix. Columns (3) to (4) of Table 5 report the estimated results, and we find whether online shopping or online shopping consumption, mobile payments both have positive effects in Panel A, implying that mobile payment usage is a vital driving force for more active household online economic activities. Moreover, in Panel B, two online shopping variables are also significant at the 5% and above level, suggesting that mobile payments reduce transaction costs through online shopping to increase residents' happiness.

### 6.2.3 Stimulating entrepreneurship

Next, we considered whether mobile payments stimulate household entrepreneurship. We constructed three dummies to measure household entrepreneurial behaviors, *Entrepreneurship*, *Entrepreneurial intention*, and *Online business*, of which the details are in Panel C of Table 13 in the Appendix.

In columns (1), (3) and (5) of Table 6, the estimates from the endogenous bivariate probit model suggest that mobile payment usage significantly increase the

**Table 6** Mobile payments, entrepreneurial behaviors, and residents' happiness

	(1)	(2)	(3)	(4)	(5)	(6)
	Entrepreneurship	Happiness	Entrepreneurial intention	Happiness	Online Business	Happiness
	IV	Ordered probit	IV	Ordered probit	IV	Ordered probit
Mobile payment	0.0272*** (0.0033)		0.0286*** (0.0032)		0.0477*** (0.0066)	
Entrepreneurial behavior		0.0102** (0.0042)		0.0108** (0.0043)		0.0243*** (0.0089)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	36,998	36,998	36,778	36,778	36,986	36,986

Columns (1), (3), and (5) show the outcome equation results for the endogenous bivariate probit model, reporting the marginal effects. Columns (2), (4), and (6) report the marginal effects when *Happiness* is equal to 5. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

likelihood of entrepreneurship and having entrepreneurial intention and online businesses. Consistent with previous studies, mobile payments are certainly helping Chinese families start businesses [29, 73, 79]. In addition, the results of columns (2), (4), and (6) show that there are positive relationships between these entrepreneurship-related variables and residents' happiness, which are consistent with the previous studies [63, 85]. All in all, we provided evidence that mobile payments can promote residents' happiness by stimulating household entrepreneurship.

#### 6.2.4 Social interaction

As noted above, mobile payment may increase residents' happiness by social interaction. According to the CHFS questionnaire, we considered three important categories of social interaction that are closely associated with individual happiness, including network interaction, human relationship spending, and daily communication. In terms of network interaction, two binary variables *Online social activities* and *Online entertainment* were selected. *Money gift receive* was used to measure the household human relationship spending. For daily communication, we chose *Traffic expenditure* and *Communication expenditure* for proxies. These variables are defined as shown in Panel D of Table 13 in the Appendix.

Table 7 explored the effects of mobile payment on household social interaction. In Panel A, we find that the coefficients on *Mobile payments* are significantly positive in all columns, which means households that use mobile payments are more active in social interaction than those who don't. For example, mobile payment has increased the probability of residents' online social activities by 7.21%, and the probability of online entertainment has also increased by 5.64%. In Panel B, the ordered probit estimates suggest a positive association between social interaction and individual happiness, with the exception of traffic expenditure, which is consistent with previous studies [3, 59]. Therefore, we concluded that mobile payments bring happiness by facilitating social interactions.

### 6.3 Further studies

#### 6.3.1 Do mobile payments lead to over-consumption and over-indebtedness?

Previous literature found that the painless shopping and income illusion generated by non-cash payments may cause people to over-consume and fall into debt cages [44]. With the increasing convenience of online shopping and non-cash payments, the phenomenon of unplanned consumption, irrational consumption, and compulsive buying may be more and more serious [66, 77]. As an emerging non-cash payment method and a bridge to online shopping, whether mobile payments lead Chinese households to over-consumption or over-indebtedness to damage happiness needs further study.

We constructed two binary variables, *Over-consumption* and *Over-indebtedness*, of which definitions are reported in Pane E of Table 13 in the Appendix. In columns (1) and (2) of Table 8, we find that mobile payments significantly increase the

**Table 7** Mobile payments, social interaction, and residents' happiness

	(1)	(2)	(3)	(4)	(5)
	Online social activities	Online entertainment	Money gift receive	Traffic expenditure	Communication expenditure
Panel A. Social interaction (IV estimations)					
Mobile payment	0.0721*** (0.0268)	0.0564** (0.0264)	0.3059*** (0.0270)	1.6820*** (0.1090)	0.5522*** (0.0437)
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
N	36,986	36,986	36,887	36,998	36,998
Panel B. Happiness (Ordered probit)					
Social interaction	0.0074* (0.0040)	0.0097** (0.0043)	0.0191*** (0.0032)	0.0001 (0.0003)	0.0041*** (0.0009)
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
N	36,986	36,986	36,887	36,998	36,998

The first three columns of Panel A show the outcome equation results for the endogenous bivariate probit model, reporting the marginal effects, and the endogenous treatment effect model is used in the last two columns of Panel A. All columns in Panel B report the marginal effects when *Happiness* is equal to 5. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

**Table 8** Mobile payments and over-consumption and over-indebtedness

	(1)	(2)	(3)	(4)
	Over-consumption	Happiness	Over-indebtedness	Happiness
	IV	Ordered probit	IV	Ordered probit
Mobile payment	0.2788*** (0.0247)		- 0.0263 (0.0383)	
Over-consumption		- 0.0290*** (0.0035)		
Over-indebtedness				- 0.0565*** (0.0055)
Control variables	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
N	36,998	36,998	36,998	36,998

Columns (1) and (3) show the outcome equation results for the endogenous bivariate probit model, reporting the marginal effects. Columns (2) and (4) report the marginal effects when *Happiness* is equal to 5. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

probability of household over-consumption, and over-consumption is indeed negatively related to the happiness of householders. These results imply that over-consumption caused by mobile payments leads to a decrease in residents' happiness. In addition, we find that although over-indebtedness is negatively related to individual happiness in column (4), the coefficient on *Mobile payment* is insignificant in column (3), suggesting that the use of mobile payment is not sufficient to cause over-indebtedness among Chinese households. Overall, our estimates indicate that mobile payments may cause a decline in happiness through over-consumption, implying a potential mechanism by which mobile payments impair residents' happiness.

### 6.3.2 Heterogeneity analysis

Considering that different individual and household characteristics may have impacts on residents' mobile payment usage status and happiness, we further explored the heterogeneity effect from multiple perspectives. First, based on the traditional definition, we divided the sample into two groups, the young and middle-aged and the elderly, using age 60 as the cutoff. Columns (1) and (2) of Table 9 report estimation results from the ordered probit regression with endogenous treatment. We find that mobile payments only increase the happiness of elderly residents, while having a significant negative effect on younger people instead. These results may be related to inclusive financial attributes of digital finance and mobile payments [6, 30, 79]. As a typically socially disadvantaged group, elderly individuals are more likely to experience financial exclusion [13]. The popularity of mobile payments has provided greater convenience for some older adults to access financial services, which in turn enhances their happiness.



**Table 9** Heterogeneity effects: IV estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Young and middle-aged	Elderly	Urban	Rural	Better educated	Less educated	High-income households	Low-income households
Mobile payment	- 0.1001* (0.0544)	0.2220*** (0.0639)	0.1380*** (0.0272)	0.2657*** (0.0912)	0.0196 (0.0416)	0.2187*** (0.0275)	0.0533 (0.0328)	0.2145*** (0.0338)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	21,873	15,125	25,126	11,872	13,105	23,893	18,489	18,509

All columns show the results of the outcome equation by using the ordered probit regression with endogenous treatment, reporting the marginal effects when *Happiness* is equal to 5. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

Second, China's dualistic urban–rural economic model may not only make urban and rural households differ in their acceptance and frequency of mobile payment use [79, 87], but also in their happiness [32]. Therefore, we divided the sample into two subsamples according to the *hukou*. In columns (3) and (4) of Table 9, the coefficients on *Mobile payment* are both significantly positive, but the values are larger in the rural subsample. Similarly, rural areas in China face the problems of insufficient financial supply and poor financial accessibility for residents [25, 71]. The rise of digital finance, represented by mobile payments, has effectively broadened the scope of financial services, allowing more rural residents to enjoy financial services. Therefore, mobile payments have a higher marginal utility in improving the happiness of rural households.

Third, we sought to examine the educational heterogeneity. In our sample, the median education level of householders is junior high school, so we defined the less educated group as those who have not attended school or only attended primary and junior high school. The columns (5) and (6) of Table 9 show that in the subsample of householders with relatively low education levels, the coefficient on *Mobile payment* is significantly positive, suggesting that mobile payments have a greater impact on enhancing the happiness of socially disadvantaged groups with low education.

Last, due to the dual impact of household income on residents' mobile payment usage and happiness [12, 48], heterogeneity effects by income deserve to be further explored. The full sample is divided into two groups respectively, based on the median of total household income (54,000 yuan), and results by using the ordered probit regression with endogenous treatment are shown in the last two columns of Table 9. The positive effect of mobile payments on residents' happiness is only found in the low-income group, indicating that mobile payments promoted happiness of residents with relatively disadvantaged incomes. These estimates also reflect the inclusive financial characteristics of mobile payments in terms of individual happiness.

## 6.4 Robustness checks

We conducted several robustness checks. First, we used the provincial mobile Internet access ratio as an alternate IV, and the data come from the China Statistical Yearbook. On the one hand, mobile Internet is the basis for residents to use smart phones, thus, provincial network access ratio is positively correlated with residents' mobile payment usage. On the other hand, the proportion of provincial mobile network access as a macro aggregation variable is difficult to directly individual happiness when city fixed effects are controlled [27]. In column (1) of Table 10, we find that the results are unchanged.

Second, in our main specifications, we employed the ordered probit regression with endogenous treatment. Now we utilized the endogenous treatment effect model (linear) to perform robustness tests [82]. In column (2) of Table 10, it is clear that our estimates are similar with the main results in column (3) of Table 3, indicating that our results are insensitive to the cardinal and ordinal assumptions of happiness [19, 37].

**Table 10** Robustness checks of using alternative specifications: IV estimations

	(1)	(2)	(3)	(4)	(5)
	Using the alternative IV	Endogenous treatment effect model	Controlling for age and education fixed effects	Adding macro control variables	Binary variable for <i>Happiness</i>
Mobile payment	0.1246*** (0.0260)	0.2867*** (0.0454)	0.1901*** (0.0234)	0.1764*** (0.0269)	0.0921*** (0.0264)
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
N	36,998	36,998	36,998	36,998	36,998

Columns (1), (3), and (4) show the results of the outcome equation by using the ordered probit regression with endogenous treatment, reporting the marginal effects when *Happiness* is equal to 5. Column (2) shows the outcome equation results for the endogenous treatment effect model. Column (5) presents the outcome treatment equation results for the endogenous bivariate probit model, reporting the marginal effects. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significant at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

Third, according to the heterogeneity analysis, age and education are strongly associated with individuals' use of mobile payments, so we attempted to further control for age and education fixed effects. In column (3) of Table 10, the estimates show the conclusion that mobile payments enhance residents' happiness remains unchanged, suggesting that our main specification is satisfactory for capturing age and education fixed effects.

Forth, although we controlled for city fixed effects in main regressions, the spread of digital finance and mobile payments is associated with regional economic development and financial development, and previous studies also found that these macro variables could affect residents' happiness [37, 82]. We added some city characteristics variables for robustness tests, including per capita GDP, savings, public expenditure, and air pollution<sup>6</sup>. In column (5) of Table 10, the estimated coefficient on *Mobile payment* keeps significantly positive at the 1% level.

Fifth, we changed the definition of the core explained variable by converting it into a binary variable [85]. In other words, we assigned the value of 1 if householders' answer is "very happy" or "happiness", and 0 otherwise. We employed the probit method to estimate the outcome method of the endogenous treatment effect [27], and results are presented in column (5) of Table 10. We can see that a similar positive effect of mobile payment usage on residents' happiness, suggesting that our results are also insensitive to change the definition of our core explained variable.

<sup>6</sup> The unit of per capita GDP is 10,000 yuan. Public expenditure is measured by the proportion of prefecture-level city government expenditure to GDP. Savings is defined as the ratio of savings of total financial institutions in GDP, and air pollution is the amount of smoke and sulfur dioxide emissions per unit of GDP.

Last, we excluded some extreme observations, including those over 80 years old, because the oldest old may have greater difficulty using mobile payments. Householders that are very unhealthy<sup>7</sup> and have not attended school were excluded, due to the potential adverse impact of the health and education of the use of mobile payment according to previous estimated results. Observations with very low social trust were removed<sup>8</sup> because they may be less receptive to emerging payment methods. Moreover, we removed the sample that used other electronic payment tools, like computer payments, so that the control group that did not use mobile payments would only use traditional payment methods. In Table 11, we find that excluding these extreme observations has little effect on our main results.

## 7 Conclusion and discussions

### 7.1 Main findings

Previous studies focused on online happiness and the potential benefits of inclusive finance [6, 21, 57, 81, 86], but rarely addressed the happiness effects of digital finance or mobile payments. In this study, adopting the nationally representative microdata from the CHFS, we attempted to investigate the effects of mobile payment usage on people's happiness in China. Considering the selectivity of mobile payment use, we employed the ordered probit regression with endogenous treatment to overcome potential endogeneity issues. Our main results suggested that mobile payments significantly improve residents' happiness, which is supported by a series of robustness checks, such as using an alternative IV, replacing the explained variable, and removing some extreme observations.

Moreover, we explored several potential mechanisms by which mobile payments affect residents' happiness. We found that the positive impact from mobile payment usage can be explained by promoting quality of life, reducing transaction costs, stimulating entrepreneurship, and increasing social interaction. Interestingly, our results confirmed a mechanism by which mobile payments undermined people's happiness, over-consumption. Furthermore, we analyzed the heterogeneity effects from several aspects and tried to verify the digital financial inclusion characteristics of mobile payments. Our estimates showed that the happiness effect of mobile payments was valid for some socially vulnerable groups, such as elderly individuals, rural residents, the low-educated, and low-income households. These results indicated that digital finance, represented by mobile payments, can reach more socially disadvantaged people and give them more access to financial services to enhance their welfare.

<sup>7</sup> Observations with an assigned value of 1 for self-rated health are deleted.

<sup>8</sup> Here, the householders whose social trust is assigned to 1 are removed.

**Table 11** Robustness checks of removing some extreme observations: IV estimations

	(1)	(2)	(3)	(4)	(5)
	Excluding 80 years old and above	Excluding very unhealthy householders	Excluding unschooled householders	Excluding households with low social trust	Excluding samples using other electronic payments
Mobile payment	0.1724*** (0.0254)	0.1338*** (0.0257)	0.1649*** (0.0243)	0.1879*** (0.0226)	0.1947*** (0.0391)
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
N	35,393	29,956	34,340	34,781	27,620

All columns show the results of the outcome equation by using the ordered probit regression with endogenous treatment, reporting the marginal effects when *Happiness* is equal to 5. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

## 7.2 Theoretical implications

Even though the benefits of digital finance and mobile payments received some attention in prior literature (e.g., [2, 29, 30, 56, 73, 79, 83]), they ignored the impact on residents' happiness [87]. Our findings further confirmed the role of mobile payments in enhancing people's happiness by using an IV method. Moreover, we reconciled previous theories about online happiness. The results from mechanism analysis showed that mobile payments improve people's happiness through multiple channels, however, over-consumption behaviors caused by mobile payments may harm users' happiness, which complemented previous literature emphasizing the potential risks of the mobile Internet [34, 42, 81].

Additionally, the findings of this paper add the research on the field of inclusive finance. Although the inclusive properties of digital finance have received attention from scholars [6, 36, 56, 61], it is still unknown how mobile payments enhance the happiness of socially disadvantaged groups. Through heterogeneity analysis, this study reveals the inclusive characteristics of digital finance from the perspective of subjective well-being.

## 7.3 Managerial implications

This research has several practical implications. To raise residents' happiness, it is necessary to develop a better mobile payment system to reduce the risk of over-consumption. Mobile payment practitioners should increase over-consumption alerts for their products and services. While it may be impossible to completely eliminate risks from over-consumption, making users aware of potential risks will lower their expectations and improve their happiness. In addition, some additional features could be implemented in the design of mobile payment-related products, such as consumption assessment and optimization of consumption information push.

Given the inclusive nature of mobile payments, there is a need to actively promote digital finance to reach more socially disadvantaged groups to improve their happiness. Feasible methods include enhancing publicity through electronic advertisements, on-site publicity, sitcoms, and short videos, introducing personalized mobile payment products and services, and providing appropriate business tilts and subsidies to rural and remote areas. In addition, mobile payment can be further promoted in conjunction with online shopping platforms, telecommunication companies, e-commerce sites, and social software to increase mobile payment usage among socially disadvantaged groups.

Moreover, considering the negative impact of the global outbreak of COVID-19 on people's offline economic activities, adopting flexible ways to promote mobile payments might help more households compensate for the loss of welfare caused by COVID-19 through online activities [41]. These measures are not only applicable to China, but also useful for other countries suffering from the COVID-19. Taken

together, we highlighted the potential positive effect of digital finance and mobile payments on people's happiness during the epidemic.

#### 7.4 Limitations and future research

Some limitations of this study warrant discussion. First, in the linear IV method, two-stage least squares (2SLS), we can identify the validity of an IV by observing multiple statistics, such as the F value of the first stage, Anderson-Rubin Wald test, and Kleibergen-Paap rk LM statistic [38, 84]. However, considering the type of our key explanatory and explained variables, these statistics are not available using the ordered probit regression with endogenous treatment. Second, even though our study addressed one potential mechanism by which mobile payments are detrimental to people's happiness, other adverse channels, such as privacy concerns, digital divide, and potential risks [34, 42, 81], could not be verified due to unavailability of data. These factors that cause digital finance or mobile payments to harm people's welfare should be supplemented in follow-up research.

## Appendix

Tables 12 and 13.

**Table 12** Marginal effects of happiness in column (3) of Table 3

	Happiness = 4 (1)	Happiness = 3 (2)	Happiness = 2 (3)	Happiness = 1 (4)
Mobile payment	0.0285*** (0.0033)	- 0.1396*** (0.0162)	- 0.0469*** (0.0069)	- 0.0200*** (0.0039)
Control variables	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
N	36,998	36,998	36,998	36,998

All columns show the results of the outcome equation by using the ordered probit regression with endogenous treatment, reporting the marginal effects when the explained variable *Happiness* is 4, 3, 2, and 1, respectively. Baseline control variables and fixed effects are added in all regressions

\*\*\*, \*\*, \* indicate significance at the levels of 1%, 5%, and 10%, respectively. Standard errors clustered at the community (village) level are reported in parentheses

**Table 13** Definition of mechanism variables

Variables	Definition
<b>Panel A. Quality of life</b>	
Per capita household consumption	Total household expenditure divided by household size (10,000 yuan)
Engel's coefficient	The ratio of household meal expenditure to total consumption
Enjoyable consumption	Household spending on beauty and luxury goods (10,000 yuan)
Leisure consumption	Household spending on tourism, culture, and entertainment (10,000 yuan)
Educational consumption	Household spending on education and training (10,000 yuan)
<b>Panel B. Other payment methods and online shopping</b>	
Cash payment	Use = 1; nonuse = 0
Card payment	Use = 1; nonuse = 0
Online shopping (dummy)	= 1 if the householder shops online last year; others = 0
Online shopping consumption	Total household spending on online shopping last year (yuan, logarithmic)
<b>Panel C. Entrepreneurial behaviors</b>	
Entrepreneurship	= 1 if the household has entrepreneurial behaviors (running a business or project); others = 0
Entrepreneurial intention	= 1 if the householder has the desire to start a business in the future; others = 0
Online Business	= 1 if the householder starts a business or sells goods on the Internet; others = 0
<b>Panel D. Social interaction</b>	
Online social activities	= 1 if the householder conducts online social activities (e.g., making friends); others = 0
Online entertainment	= 1 if the householder conducts online recreational activities (e.g., playing games, listening to songs, and watching movies); others = 0
Money gift receive	= 1 if the householder receives more than 100 yuan in cash or non-cash income from non-family members; others = 0
Traffic expenditure	Total household transportation expenses last year (1000 yuan)
Communication expenditure	Total household telephone and Internet expenses last year (1000 yuan)
<b>Panel E. Over-consumption and over-indebtedness</b>	
Over-consumption	= 1 if the total household consumption is not less than income; others = 0
Over-indebtedness	= 1 if the total household debt is not less than income; others = 0



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