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To cite this article: Yaqian Wu, Chunkai Zhao & Jianhao Guo (2023) Mobile payment and subjective well-being in rural China, Economic Research-Ekonomiska Istraživanja, 36:1, 2215-2232, DOI: [10.1080/1331677X.2022.2097103](https://doi.org/10.1080/1331677X.2022.2097103)

To link to this article: <https://doi.org/10.1080/1331677X.2022.2097103>



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Published online: 20 Jul 2022.



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Mobile payment and subjective well-being in rural China

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ABSTRACT

We explore the impact of mobile payment usage on the subjective well-being (S.W.B.) of rural residents in China using unique data from the China Household Finance Survey (C.H.F.S.). The estimated results show that using mobile payment has increased the S.W.B. of rural residents, and this finding still holds through several robust checks. The mechanism analysis suggests that the positive effect of mobile payment is partially explained by the reduction in transaction costs, the promotion in consumption upgrade, and the increase in social networks. Additionally, the inclusive financial attributes of mobile payment are verified through several heterogeneity analyses. Results show that the positive impact of mobile payment on S.W.B. is more pronounced in socially vulnerable groups such as the elderly, people with lower income, or lower education. Our study enriches the research on the fields of happiness effect of rural financial convenience and function of inclusive finance and has practical significance for other developing countries.

ARTICLE HISTORY

Received 17 November 2020
Accepted 28 June 2022

KEYWORDS

mobile payment; subjective well-being (S.W.B.); rural China; inclusive finance

JEL CODES

I31; D12; G51; Q14

1. Introduction

With the development of China's economy and the improvement of people's material life, how to pursue happiness and spiritual abundance has been the focus of attention from all walks of life. Plenty of literature discusses the factors affecting the subjective well-being (S.W.B.) of residents. At the macro level, previous studies mainly focus on economic development (Easterlin et al., 2011; Novak & Pahor, 2017), social security (Fang & Sakellariou, 2016; Han & Gao, 2020), living environment (Gross-Manos & Shimoni, 2020; Knight & Gunatilaka, 2010), and infrastructure (Hunter et al., 2005). From the micro perspective, several elements are fully considered by scholars including economic factors such as income, consumption, employment, and entrepreneurship (Dunn et al., 2008; Wang et al., 2019; Zhao et al., 2020), demographic factors

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such as marriage, age, health, and education (Kivett, 1988; Zhao & Guo, 2022), and family factors such as couple and parent–child relationships (Liang et al., 2014).

A few studies have explored the relationship between individual financial activities and their S.W.B. in developed countries (Akay et al., 2014; Merkle et al., 2015). However, to the best of our knowledge, there is little literature examining whether and how the improvement in payment methods affects people's S.W.B. in developing countries. Therefore, to extend the existing research field, in this article, we attempt to figure out whether mobile payment, an emerging payment way, can improve the S.W.B. of rural residents in China. In our article, we define mobile payment as 'payments for goods, services, and bills with a mobile device by taking advantage of wireless and other communication technologies' following the existing studies (Dahlberg et al., 2015). The reason why we focus on mobile payment is that, in recent decades, with the popularity of smartphones and networks in rural China, mobile payment has become an indispensable payment tool. Moreover, with the continuous advancement of China's financial technology, faster payment methods such as fingerprint payment, face scan payment, and iris payment gradually appear on smartphones (Dijmărescu et al., 2022; Zhao et al., 2022), which makes mobile payment more convenient, efficient, and safe in rural China.

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 improving the welfare of rural households (Munyegera & Matsumoto, 2016). According to the China Payment and Clearing Industry Operation Report (2018) issued by the People's Bank of China, the usage or acceptance of mobile payments has reached 85% in rural areas, and the proportion of rural residents utilising offline mobile payment is also increasing.

The success of mobile payment in China has inevitably led to extensive discussion in academia. Some suppose that mobile payment may promote household entrepreneurship or small-scale and self-employed informal businesses. For example, Yin et al. (2019) found that mobile payment significantly increases the likelihood of household entrepreneurship. The mechanisms they note include changing people's attitudes towards risks, enriching households' social networks, and providing formal and informal lending support. Similarly, Huang et al. (2020) confirmed that mobile payment indeed improves people's risk-sharing and helps increase entrepreneurial opportunities. In addition, Wang (2020) used household panel data and argues that mobile payment facilitates prompter and more convenient fund transfer between friends and families, which is important for risk-sharing, thus promoting the small-scale and self-employed informal businesses.

Others argue that the financial inclusive characteristic of mobile payment makes up for the lack of inclusiveness of traditional financial payment, thus promoting household consumption and reducing poverty (N'dri & Kakinaka, 2020; Suri & Jack, 2016; Zhao et al., 2022). For instance, Liu et al. (2020) found that mobile payment can overcome space–time limitations with its broader and easier access, lower costs, and more financial inclusiveness. These benefits of mobile payment would further induce the transition from offline to online consumption even during the COVID-19 pandemic, especially for urban households. Suri and Jack (2016) showed that the

introduction of mobile payment could increase households' per capita consumption levels in Kenya and reduce the number of households in extreme poverty by improving the efficiency of the allocation of labour. Similarly, N'dri and Kakinaka (2020) argued that mobile payment could facilitate consumption smoothing and reduce poverty concerning individuals' nonmonetary welfares such as nutrition, healthcare, and education by promoting resource mobilisation in Burkina Faso. Besides, Munyegera and Matsumoto (2016) found a positive relationship between mobile money access and households' real per capita consumption, and they attribute such a finding to the fact that mobile money helps facilitate remittance transfer among family members and friends. However, few papers have focused on the impact of mobile payment on the S.W.B. of rural residents in China.

Moreover, our study falls into the broad field on the impact of mobile payments on household welfare. Several previous studies highlighted the welfare effects of mobile payments (Munyegera & Matsumoto, 2016; N'dri & Kakinaka, 2020; Zhao et al., 2022). However, in contrast to these studies that measured household welfare in terms of consumption and poverty reduction, we investigate the effect of mobile payment on people's S.W.B. Therefore, they focused on household welfare in material terms, while we are more concerned with the subjective welfare and spiritual life of rural households. In addition, another major difference is that we further add the potential mechanisms by which mobile payments affect household welfare in multiple aspects.

In this article, we empirically test the impact of mobile payment on the S.W.B. of rural residents based on a nationally representative sample from the China Household Finance Survey (C.H.F.S.) in 2017 and draw several remarkable conclusions. First, considering the difficulty of identifying the causal effect between mobile payment and residents' S.W.B. due to the selectivity of mobile payment usage, we exploit an instrumental variable (I.V.) approach except for the ordinary least squares (O.L.S.) model. Both the results of O.L.S. and I.V. estimates show that mobile payment significantly improves the S.W.B. of Chinese rural residents. Second, we explore three potential mechanisms through which mobile payment promotes the S.W.B. of rural residents. The empirical results show that mobile payment usage is likely to reduce transaction costs, promote consumption upgrade, and increase the frequency of social networks. Third, the heterogeneous tests indicate that mobile payment plays a more significant role in promoting the S.W.B. of socially vulnerable groups, such as the elderly and people with lower income, or lower education. Last but not least, our conclusion still holds after a series of robustness tests.

Our study makes several contributions as follows. First, for all we know, this article is among the first to empirically examine what a role mobile payment plays in rural residents' S.W.B. In this vein, our findings add to the literature on the happiness effect of rural financial convenience (Akay et al., 2014; Merkle et al., 2015) and the impact of a modern mobile Internet application on the S.W.B. of residents (Zhan & Zhou, 2018).

Second, adequate data from the C.H.F.S. makes it possible for us to figure out the effect of mobile payment on the S.W.B. of rural residents as well as the potential mechanisms. In other words, the unique Chinese setting helps us thoroughly identify

whether we can make use of the modern revolution in science and technology to promote rural residents' S.W.B. and how it works in practice, which, finally, may provide good enlightenment for some developing countries to improve their residents' S.W.B.

Third, our article also contributes to the scarce literature on inclusive finance and the welfare of socially vulnerable groups in developing countries (e.g., Nizam et al., 2020; Saydaliyev et al., 2020). For example, the heterogeneity analyses indicate the inclusive function of mobile payment from several aspects such as residents' age, education and income, which helps us better find feasible ways to improve the S.W.B. of rural residents, especially in developing countries.

The remainder of our study is organised as follows. Section 2 outlines the theoretical analysis. Section 3 explains our estimation strategy and econometric models. Section 4 describes the data and variables. Section 5 presents the main results and conducts mechanism analysis, heterogeneity tests, and robustness checks. Section 6 concludes.

2. Theoretical analysis

2.1. Reducing transaction costs

Like most developing countries, rural China suffers from an inadequate financial system and insufficient supplies for financial services (Beck et al., 2015; N'dri & Kakinaka, 2020). Payment methods offered by traditional financial institutions are often accompanied by higher transaction costs (Fungáčová & Weill, 2015; Zhu et al., 2021); thus, cash payments become the preferred option for rural residents. For one thing, the payment methods provided by traditional financial institutions face higher fixed costs. Take the point of sales terminal as an example, it is generally installed in relatively high-end consumer places in China. Other payment methods, such as credit cards and checks, are also not widely available in rural China. These payment tools are rarely used by rural households, whether for consumption or business. For another, the increase in economic and geographic isolation further brings more transaction costs from using traditional payments such as cash in rural areas (Zhao et al., 2022). In other words, due to the inconvenience in transportation and information, rural households need to pay more transportation costs, communication costs, physical strength, and information acquisition costs when participating in economic activities.

It is clear that mobile payments can help overcome these difficulties. First of all, relying on mobile Internet and big data technology, mobile payment lowers the threshold of financial services and enhances the convenience of financial services (Huang et al., 2020; Liu et al., 2020), on the basis of avoiding the physical outlets of traditional financial institutions. Next, the mobile payment transaction process is online, breaking the time and space constraints between both parties to the transaction (Yin et al., 2019). Rural residents can quickly access a range of financial services such as spending, shopping, transfer, remittance, and wealth management through mobile payment, which saves their time costs and brings higher utilities. Last, with the help of mobile Internet technology, mobile payment users can obtain information more easily (Matemba et al., 2018; Wang, 2020), which alleviates the information

asymmetry in the transaction process. This is especially useful for rural households with higher information search costs.

2.2. Consumption upgrade

Consumption is an important channel of improving household welfare and promoting individual S.W.B. (Wang et al., 2019), yet Chinese households tend to save rather than consume, especially in rural China (Feng et al., 2011). A large body of research focused on the mystery of China's low consumption, finding that precautionary savings, consumption habits, traditional culture, and inadequate financial provision are the main reasons (e.g., Feng et al., 2011; Liu et al., 2020; Pan & Wu, 2021). Fortunately, the popularity of mobile payments may change rural households' consumption habits, alleviate their liquidity constraints, and promote consumption upgrade. We explain this in more detail from the following aspects.

First, mobile payments may boost household consumption, as it is a non-cash payment method (Liu et al., 2020; Zhao et al., 2022). Previous studies suggested that non-cash payments can mitigate psychological account loss, help consumers accelerate the consumption process, and gain pleasure (Qi et al., 2016). Second, mobile payment may change rural residents' consumption habits because it is easier for them to get their required goods and services through mobile networks. More importantly, mobile payment may also optimise the rural households' consumption structure. For instance, the ubiquitous information on health, culture, and service contained in mobile payment applications makes people pay more attention to these diversified fields, which helps to improve the household consumption structure and enhance the S.W.B. of family members. Third, mobile payment can ease rural households' liquidity constraints as well. On the one hand, mobile payment provides overdraft spending functions similar to credit cards. Here is a typical example. Alipay's Huabei is very popular in rural China as it provides overdraft limits for users. That is, users could obtain interest income through the time difference between consumption and loan repayment, thereby increasing their consumption utility and enhancing their subjective experience (Liébana-Cabanillas et al., 2017). On the other hand, mobile payment can also directly provide micro-loan services with a simpler operation process and no restrictions on borrowers.

2.3. Social networks

We believe that mobile payments may enhance people's happiness through social networks. China is a special relational society, and social networks play an important role in people's daily lives, especially in rural areas. On the one hand, social networks assume the functions of information transfer and financing, which can help rural households improve their economic situation (He et al., 2019; Yin et al., 2019). On the other hand, social networks, as a kind of social capital, can enhance people's physical and mental health and make them happier through social interaction and support (Arampatzi et al., 2018).

Mobile payments are likely to create satisfactory external conditions for social networks. First, as an informal system, the maintenance of Chinese social networks needs to be based on money gifts or red envelopes (Hudik & Fang, 2020). The emergence of mobile payments can make it easier to receive and pay for gifts and red envelopes. In particular, WeChat Pay, relying on China's largest social platform, developed the function of WeChat red envelopes, which plays an important role in maintaining and expanding social circles and interpersonal relationships in rural households (Matemba et al., 2018; Mater et al., 2021). Second, mobile payments also play an important role in the expansion of rural households' offline social networks, such as transportation, communication, offline gatherings, and dining out (Liébaná-Cabanillas et al., 2017). The convenience of mobile payment enhances the social support functions of social networks and expands the positive role of these social capitals in individual S.W.B.

3. Endogenous and empirical strategy

To investigate the effect of mobile payment on rural residents' S.W.B., we estimate the following linear model:

$$SWB_i = \beta_0 + \beta_1 MP_i + \beta_2 X_i + \theta_p + \mu_i \quad (1)$$

where SWB_i denotes the subjective well-being of the head of rural household i . MP_i is an indicator that takes the value of 1 if the household i uses mobile payment, and 0 otherwise. X_i denotes a set of control variables, θ_p refers to the province fixed effects, and μ_i is the error term.

The coefficient β_1 of MP_i is our main interest. However, O.L.S. estimates may suffer from selection bias. Clearly, mobile payment usage by rural households is self-selected (Zhao et al., 2022). Those who are more educated and risk appetite and have higher income are more likely to accept and use this emerging payment method. Since these factors that influence people's use of mobile payments are very complex and these confounders may also directly affect the S.W.B. (Chu et al., 2017; Mater et al., 2021), it is difficult to fully control them. Therefore, it is necessary to address the self-selection bias with the help of the I.V. approach.

Drawing on the practice of Rozelle et al. (1999) and Zhao et al. (2022), we exploit the mobile payment usage percentage of others within a village as the I.V. in this study. Such an I.V. may be a valid instrument for the following two reasons. One is that the I.V. meets the correlation assumption of the I.V. method. Specifically, the mobile payment usage of an individual can be affected by other people in the same village (Evans et al., 1992), that is, when most of the others within a village choose mobile payment, the individual will be more likely to use such a payment way. The other is that the I.V. also meets the exclusion restriction assumption of the I.V. method since the I.V. we use here only includes the mobile payment usage of the others within the same village, but the S.W.B. of a single rural resident is not likely to be influenced by this aggregation variable (Zhao & Guo, 2022).

A major concern with the validity of this aggregate instrument at the village level is that there may be village heterogeneities in the equation of residents' S.W.B.

Therefore, we adopt the village-level cluster standard errors which greatly help to reduce the potential endogenous problems. Correspondingly, we propose the following model to estimate the causal effect of mobile payment usage on the S.W.B. of rural residents:

$$MP_{iv} = \lambda_0 + \lambda_1 Z_v + \lambda_2 X_i + \theta_p + \varepsilon_{iv} \quad (2)$$

The formula (2) is the first stage of two-stage least squares (2S.L.S.), and Z_v is the I.V. we mentioned earlier. ε_{iv} indicates the error term. The definition of other variables is consistent with the formula (1).

4. Data and variables

4.1. Data

We obtain data from the fourth round of the China Household Finance Survey (C.H.F.S.) conducted by the Southwest University of Finance and Economics in 2017. The C.H.F.S. consists of 29 provinces (municipalities, autonomous regions), 228 prefecture-level cities, and 609 villages in China besides Tibet, Xinjiang, Hong Kong, Macao, and Taiwan. The microdata data exceeds 12,000 rural households. It covers detailed information on households' demographic characteristics, insurance and security, assets and liabilities, income and expenditure, and so on. What's more, the C.H.F.S. also contains information about people's choice of payment methods in the debt section. Thus, the C.H.F.S. offers an obtainable and credible source of data for our study on mobile payment and the S.W.B. of Chinese rural residents.

4.2. Variables

In the subjective attitude part of the questionnaire, respondents were asked about their overall S.W.B. at present. We set our explained variable *SWB* equal to 3, if the respondents considered 'very happy' or 'happy'. In sequence, *SWB* was assigned a value of 2 when their answer is 'indifferent' and 1 for 'unhappy' or 'very unhappy'.

To measure mobile payment, we construct the explanatory variable *Mobile payment* based on the C.H.F.S. questionnaire as well. Specifically, the C.H.F.S. requires the householders to answer the question about the payment methods they commonly use in daily life. There are five options: (1) payment in cash; (2) card payment, including bank cards, credit cards, etc.; (3) computer payment, including online banking, computer Alipay, etc.; (4) mobile terminal payment such as mobile phones and Pad, including Alipay, WeChat payment, mobile banking, Apple pay, etc.; and (5) others. It could be noted that the fourth choice in the C.H.F.S. questionnaire concerning the payment method is consistent with the definition we noted above in the introduction section. Thus, based on each household's response to this question, we generate *Mobile payment* that equals 1 if the rural householder uses mobile terminal payment, and 0 otherwise. This variable is also consistent with the previous research on mobile payment (e.g., Yin et al., 2019).

Table 1. Variable definition.

Variables	Definition
SWB	Happy = 3; indifferent = 2; unhappy = 1
Mobile payment	Use = 1; Non-use = 0
Percentage usage	Mobile payment usage percentage of others within a village
Age	Householder age
Age squared	The square of householder age divided by 100
Gender	Female = 1; male = 0
Marriage	Married = 1; others = 0
Education	Unschool = 1; primary school = 2; middle school = 3; high school = 4; college degree and above = 5
Politics status	Party member = 1; others = 0
Self-rated health	Healthy = 1; unhealthy = 0
Elderly dependency ratio	The percentage of the number of the elderly over 65 divided by the number of people aged 15–64 in the household
Child dependency ratio	The percentage of the number of children less than 14 divided by the number of people aged 15–64 in the household
Average household income	Household per capita income, 10,000 yuan
Agricultural income	Total family agricultural income, 10,000 yuan
Savings	Household fixed deposit, 10,000 yuan
Debt-income ratio	The percentage of total household debt divided by income
Consumption-income ratio	The percentage of total household consumption divided by income
Risk appetite	What kind of investment project are you willing to choose? (High risk = 3; average = 2; low risk = 1)
Housing	Housing ownership = 1; others = 0

Source: Variables and data are downloaded from the C.H.F.S. and calculated by authors.

Our I.V., *Percentage usage*, is measured by the mobile payment usage percentage of the others within a village. Specifically, by identifying the village codes provided by the C.H.F.S., we could confirm rural households living in the same village. By counting the number of households in each village and the number of other households using mobile payments, we calculate the percentage of mobile payment usage.

Following the existing literature (Cheng et al., 2020; Nielsen et al., 2010; Yang et al., 2019; Zhao et al., 2020), we include several control variables in our study. First, at the individual level, we control for *Age*, *Age squared*, *Gender*, *Marriage*, *Education*, *Political status*, and *Self-rated health*. Second, for household population structure, *Child dependency ratio* and *Elderly dependency ratio* are taken into consideration. Lastly, we select some economic variables including *Average household income*, *Agricultural income*, *Savings*, *Debt-income ratio*, *Consumption-income ratio*, *Risk appetite*, and *Housing*. The definition of all variables is listed in Table 1.

4.3. Descriptive statistics

Table 2 presents descriptive statistics of the variables used in the analysis. On average, 10.5% of rural households use mobile payments, and the S.W.B. score is 2.630. Standard t-tests indicate a significant level of the direct comparisons between mobile payment usage and non-use, and rural residents using mobile payments score 0.037 higher in the S.W.B. Besides, compared with rural households without mobile payment usage, households using mobile payment have higher agricultural income and savings, and the head of the household is younger and obtains more education. In addition to *Debt-income ratio* and *Housing*, other control variables are obviously different in the two groups, suggesting that the control variables we choose are reasonable.

Table 2. Descriptive statistics.

	Full sample			Mobile payment non-use	Mobile payment use	T-test
	N	Mean	SD	Mean	Mean	
SWB	12,392	2.630	0.605	2.626	2.663	-0.037**
Mobile payment	12,408	0.105	0.307			
Percentage usage	12,408	0.104	0.107	0.096	0.176	-0.080***
Age	12,404	57.030	12.170	58.013	48.619	9.394***
Age squared	12,404	34.000	13.990	35.095	24.681	10.414***
Gender	12,408	0.888	0.315	0.883	0.933	-0.050***
Marriage	12,403	0.873	0.333	0.865	0.943	-0.078***
Education	12,395	2.466	0.899	2.411	2.933	-0.522***
Political status	12,016	0.066	0.250	0.065	0.084	-0.019**
Self-rated health	12,400	0.839	0.367	0.831	0.907	-0.076***
Child dependency ratio	12,404	0.117	0.190	0.108	0.188	-0.080***
Elderly dependency ratio	12,404	0.229	0.335	0.246	0.083	0.163***
Average household income	12,404	3.232	1.760	3.276	2.856	0.420***
Agricultural income	12,408	1.000	2.359	0.941	1.501	-0.561***
Savings	12,408	0.157	0.515	0.139	0.305	-0.166***
Debt-income ratio	12,345	1.835	6.649	1.856	1.649	0.207
Consumption-income ratio	12,345	3.616	10.170	3.746	2.523	1.223***
Risk appetite	12,407	1.320	0.588	1.303	1.462	-0.159***
Housing	12,402	0.934	0.249	0.933	0.940	-0.007

Source: Variables and data are downloaded from the C.H.F.S. and calculated by authors.

5. Results

5.1. Benchmark results

Table 3 reports the benchmark results of the effects of mobile payment usage on the S.W.B. of rural residents. All standard errors have been cluster-corrected at the village level. In columns (1) and (2) of Table 3, the results from the ordered probit and O.L.S. estimations show that there is a positive correlation between mobile payments and the S.W.B. of rural residents. However, these results may be disturbed by potential endogenous problems. Thus, we further present the I.V. estimation results for 2S.L.S. in Table 3. Specifically, the first stage estimation result is reported in column (3). The I.V. is strongly positively correlated with householders' mobile payment usage status, with statistical significance at the 1% level. In addition, in the first stage, the F value is 99.438, and the P values of the Anderson-Rubin (A.R.) Wald test are less than 0.05, suggesting that the I.V. meets the correlation restriction and the weak instrument variable problem does not exist. The I.V. estimate of mobile payment in column (4) is significantly positive at the 5% level, suggesting that using mobile payment has increased the S.W.B. of rural residents by 34.7%. The estimate is larger in magnitude than the O.L.S. estimate in column (2). This may be explained by the fact that I.V. estimates may overestimate the effect of mobile payment, which is quite common in the existing literature because of the local average treatment effect (L.A.T.E.) features of the I.V. approach (Angrist & Pischke, 2008). Whereas the causal identification still supports the result of mobile payment improving the S.W.B. of rural residents.

5.2. Robustness checks

To ensure the reliability of our benchmark results, we perform several untabulated robustness checks. Specifically, we replace the I.V. in our main test with the provincial mobile Internet access percentage,¹ adopt the IV-oprobit method, employ the

Table 3. The effect of mobile payment on the S.W.B. of rural residents.

	(1) Ordered probit	(2) OLS	(3)	(4) IV-2SLS
Mobile payment	0.034*** (0.013)	0.055*** (0.017)		0.347** (0.147)
Percentage usage			0.416*** (0.041)	
Age	-0.015*** (0.003)	-0.018*** (0.004)	-0.018*** (0.002)	-0.012*** (0.005)
Age squared	0.017*** (0.003)	0.021*** (0.003)	0.012*** (0.002)	0.018*** (0.004)
Gender	0.024* (0.014)	0.041* (0.021)	-0.012 (0.007)	0.045** (0.022)
Marriage	0.098*** (0.014)	0.144*** (0.021)	0.012 (0.007)	0.140*** (0.022)
Education	0.016*** (0.005)	0.024*** (0.006)	0.029*** (0.003)	0.014* (0.008)
Political status	0.049*** (0.017)	0.060*** (0.019)	0.007 (0.011)	0.058*** (0.020)
Self-rated health	0.034*** (0.011)	0.047*** (0.015)	0.005 (0.006)	0.045*** (0.016)
Child dependency ratio	0.047** (0.022)	0.071** (0.029)	0.096*** (0.018)	0.043 (0.034)
Elderly dependency ratio	0.020 (0.018)	0.021 (0.023)	-0.012 (0.009)	0.026 (0.024)
Average household income	0.007*** (0.003)	0.011*** (0.004)	-0.004** (0.002)	0.012*** (0.004)
Agricultural income	0.011*** (0.002)	0.012*** (0.002)	0.004*** (0.002)	0.011*** (0.002)
Savings	0.036*** (0.008)	0.041*** (0.009)	0.035*** (0.008)	0.030*** (0.011)
Debt-income ratio	-0.004*** (0.001)	-0.006*** (0.001)	-0.000 (0.000)	-0.006*** (0.001)
Consumption-income ratio	-0.000 (0.000)	-0.001 (0.001)	-0.001** (0.000)	-0.000 (0.001)
Risk appetite	-0.001 (0.003)	-0.001 (0.005)	0.015*** (0.002)	-0.005 (0.005)
Housing	0.009 (0.016)	0.013 (0.021)	-0.013 (0.010)	0.018 (0.022)
Constant		2.585*** (0.131)	0.578*** (0.075)	2.406*** (0.154)
Province fixed effects	Yes	Yes	Yes	Yes
First stage F value			99.438	
Anderson-Rubin Wald test				5.437
p-value				0.020
N	11,919	11,919	11,933	11,919

Note: The significance levels of 1%, 5% and 10% are denoted by ***, ** and *, respectively. Standard errors clustered at the village level are reported in parentheses. Column (1) reports the marginal effect value when *SWB* equals 3.

Source: Variables and data are downloaded from the C.H.F.S. and calculated by authors.

endogenous treatment effect model, control for birth cohort fixed effects, strictly control the prefecture-level city fixed effects, and exclude some extreme observations such as those over 80 years old, uneducated, non-rural *hukou*, female heads, unmarried, or observations whose per capita income and consumption are at the top or bottom 10% in the sample. These untabulated results remain unchanged.

5.3. Mechanisms of mobile payment

5.3.1. Reducing transaction costs

In section 2, we highlight that mobile payment provides more convenience for rural households to reduce their transaction costs when participating in economic activities.

Table 4. Reducing transaction costs effect of mobile payment.

	(1) Payment in cash OLS	(2) Online shopping OLS	(3) Online sales OLS	(4) Payment in cash IV	(5) Online shopping IV	(6) Online sales IV
Mobile payment	-0.057*** (0.008)	0.597*** (0.013)	0.054*** (0.007)	-0.165*** (0.052)	0.954*** (0.108)	0.043 (0.032)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
First stage F value				100.890	101.191	101.441
Anderson-Rubin Wald test				9.664	67.615	1.688
p-value				0.002	0.000	0.194
N	11,933	11,868	11,856	11,933	11,868	11,856

Note: The significance levels of 1%, 5% and 10% are denoted by ***, ** and *, respectively. All regressions include the same control variables and province fixed effects as Table 3. Standard errors clustered at the village level are reported in parentheses.

Source: Variables and data are downloaded from the C.H.F.S. and calculated by authors.

On the one hand, the emergence of mobile payment makes people less dependent on cash payment, therefore, we choose *Payment in cash* as the first channel variable, which equals 1 if the respondent still uses cash in daily transactions, and 0 otherwise. On the other hand, mobile payment can also break geographic isolation and increase transaction rates through online transactions, so we construct two binary variables, namely *Online shopping*, and *Online sales*, as the alternatives.

In columns (1) to (3) of Table 4, the estimation results from the O.L.S. models show that mobile payment usage is negatively associated with cash payment, while positively correlated with online shopping and online sales. In the last three columns of Table 4, we estimate a 2S.L.S. model in which the mobile payment is instrumented. Mobile payment usage significantly decreases the likelihood of using cash payment and also leads to a significant increase in the likelihood that rural people shop on the Internet. However, column (6) shows that mobile payment does not significantly increase the possibility of rural residents' online sales. In summary, these results indicate that by using less cash and promoting online shopping, mobile payment reduces transaction costs for Chinese rural residents.

5.3.2. Consumption upgrade

The C.H.F.S. provides multiple types of household consumption, which helps us to test whether mobile payment facilitates household consumption upgrade. First, we select *Per capita household consumption* to measure the overall consumption level upgrade of rural households.² Second, we construct five variables to measure consumption structure upgrade, namely *Durable goods consumption*, *Health care consumption*, *Enjoyment consumption*, *Entertainment consumption*, and *Education and training expenditure*.³ Among them, *Health care consumption* includes the expenditures on medicine, health products, and fitness. *Enjoyment consumption* mainly focuses on beauty and luxury goods. *Education and training expenditure* measures the spending on household human capital development. Third, considering that Engel's coefficient is closely related to household welfare and consumption structure, we consider that the use of mobile payment may reduce Engel's coefficient of rural households. Specifically, *Engel's coefficient* is measured by the proportion of food costs to total consumption.

Table 5. Mobile payment and consumption upgrade.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Per capita household consumption	Durable goods consumption	Health care consumption	Enjoyment consumption	Entertainment consumption	Education and training expenditure	Engel's Coefficient
Panel A. OLS							
Mobile payment	0.532*** (0.034)	1.349*** (0.128)	0.222*** (0.045)	1.982*** (0.117)	1.423*** (0.099)	1.194*** (0.127)	-0.026*** (0.005)
Panel B. IV							
Mobile payment	1.868*** (0.315)	3.666*** (0.873)	0.882*** (0.234)	5.923*** (1.085)	4.401*** (0.717)	3.533*** (0.933)	0.045 (0.051)
First stage F value	100.890	100.890	100.890	100.890	100.890	100.890	100.890
Anderson-Rubin Wald test	36.320	18.032	16.894	38.158	36.814	15.157	0.792
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.374
N	11,933	11,933	11,933	11,933	11,933	11,933	11,933

Note: The significance levels of 1%, 5% and 10% are denoted by ***, ** and *, respectively. All regressions in the two panels include the same control variables and province fixed effects as Table 3. Standard errors clustered at the village level are reported in parentheses.

Source: Variables and data are downloaded from the C.H.F.S. and calculated by authors.

In panels A and B of Table 5, both O.L.S. and I.V. estimates of mobile payment are significantly positive at the 1% level in column (1), suggesting that mobile payment usage has significantly boosted the per capita consumption of rural households. More importantly, we find that mobile payment has a positive effect on various consumption types, which indicates that mobile payment usage can not only stimulate the consumption level of rural households but also improve the consumption structure, making them pay more attention to fields such as health care entertainment and education. Lastly, in column (7), although O.L.S. estimates show a significant negative correlation between mobile payment usage and household Engel's coefficient, I.V. estimates of mobile payment are insignificant. Considering the close positive relationship between consumption upgrade and the S.W.B. of residents (Wang et al., 2019), we confirm that mobile payment plays a role in rural households' consumption upgrade and S.W.B.

5.3.3. Social networks

As noted above, another important channel for mobile payment on the S.W.B. of rural residents is social networks. We consider four variables for social networks that are closely associated with people's S.W.B. (Currie et al., 2013; Hudik & Fang, 2020), including *Money gift expenditure*, *Getting money from non-family members* (binary variable), *Transportation spending*, and *Communication spending*.⁴

Table 6 examines the effect of mobile payment usage on the social networks of rural households. The O.L.S. estimates in panel A show that mobile payment is positively correlated with all social network sub-terms. The I.V. estimates in panel B show that rural households that use mobile payments are more active in social networks; however, there is no evidence that mobile payment has an effect on getting money from non-family members in our samples. Taken together, these findings provide evidence that mobile payment brings higher social networks for rural residents. Given the positive association between social networks and the S.W.B. (Arampatzi et al., 2018; Dunn et al., 2008), we believe that improving social networks is another important channel through which mobile payment usage could promote rural residents' S.W.B.

Table 6. Mobile payment and social networks.

	(1) Money gift expenditure	(2) Getting money from non-family members	(3) Transportation spending	(4) Communication spending
Panel A. OLS				
Mobile payment	0.707*** (0.121)	0.095*** (0.017)	1.690*** (0.100)	0.589*** (0.029)
Panel B. IV				
Mobile payment	3.184** (1.478)	0.197 (0.177)	3.410*** (1.058)	2.071*** (0.395)
First stage F value	111.496	101.397	100.890	100.890
Anderson-Rubin Wald test	5.034	1.265	10.209	31.048
p-value	0.025	0.261	0.001	0.000
N	11,677	11,881	11,933	11,933

Note: The significance levels of 1%, 5% and 10% are denoted by ***, ** and *, respectively. All regressions in the two Panels include the same control variables and province fixed effects as Table 3. Standard errors clustered at the village level are reported in parentheses.

Source: Variables and data are downloaded from the C.H.F.S. and calculated by authors.

Table 7. Heterogeneity effects by age, education and income (I.V.-2S.L.S. estimations).

	(1) (2)		(3) (4)		(5) (6)	
	Age		Education		Income	
	Young and middle-aged	Elderly	Primary school and below	Junior middle school and above	low- income	high- income
Mobile payment	0.247* (0.148)	0.929** (0.441)	0.595** (0.264)	0.159 (0.176)	0.420** (0.207)	0.321 (0.207)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
First stage F value	72.410	39.329	56.872	60.116	50.359	61.718
Anderson-Rubin Wald test	2.804	5.107	5.314	0.820	4.328	2.344
p-value	0.094	0.024	0.021	0.365	0.037	0.126
N	6,656	5,263	6,322	5,597	5,846	6,073

Note: The significance levels of 1%, 5% and 10% are denoted by ***, ** and *, respectively. All regressions include the same control variables and province fixed effects as Table 3. Standard errors clustered at the village level are reported in parentheses.

Source: Variables and data are downloaded from the C.H.F.S. and calculated by authors.

5.4. Heterogeneity analysis

We investigate the heterogeneity of mobile payment on the S.W.B. of rural residents from three aspects: age, education, and income. First, we divide the sample into the elderly group and the young and middle-aged group with the age of 60 as the boundary. The I.V. estimated results in columns (1) and (2) of Table 7 show that the coefficient on *Mobile payment* for the elderly is larger than that for the young and middle-aged group. This indicates that mobile payment has a higher marginal effect on improving the utility and well-being of the elderly in rural households.

Second, we define the low education group as those who haven't attended school or had only attended primary school, and the remaining observations are regarded as a relatively highly educated group. In columns (3) and (4) of Table 7, the I.V. estimates of mobile payment are only significantly positive at the 5% level in the low education group, suggesting that mobile payment has a greater benefit to the well-being of rural residents with lower education.

Third, we divide the sample into two sub-samples, namely, low-income, and high-income households based on the median of per capita income in the full sample

(27,488.1 yuan/year) to explore the income heterogeneity. The results of I.V. estimates in columns (5) and (6) of Table 7 show that mobile payment plays an active role in the S.W.B. of low-income while insignificant estimate is found for high-income rural residents.

To sum up, our heterogeneous tests indicate that mobile payment plays a greater role in promoting the utility and the S.W.B. of rural residents of socially vulnerable groups, such as the elderly, people with lower income, or lower education, which reflects the inclusive financial attributes of mobile payment (Wang, 2020; Yin et al., 2019). The main reason may be that socially disadvantaged groups usually encounter higher financial thresholds and financial exclusion, and mobile payment makes it easier for them to receive financial services and obtain higher utilities.

6. Conclusion

This article empirically examines the impact of mobile payment usage on the S.W.B. of residents in rural China by using unique data from the C.H.F.S. An I.V. method is employed to overcome the possible endogenous problems. Overall, our results suggest that mobile payments are valuable for the welfare of rural residents. Specifically, we find that using mobile payment increases the S.W.B. of rural residents by 34.7%, and our results still exist under several robustness tests like using an alternative I.V., adopting other estimated methods, or removing some extreme observations. In addition, we explore some potential mechanisms through which mobile payment improves the S.W.B. of rural residents. We find that our main result is partially explained by the reduction in transaction costs, promotion in consumption upgrade, and increase in social networks brought by mobile payment. Moreover, the heterogeneity results of sub-samples show that mobile payment has a greater positive effect on improving the S.W.B. of socially disadvantaged groups like the elderly, people with lower income, or lower education.

This study adds to the existing literature on finance and the S.W.B. of rural residents (Akay et al., 2014; Merkle et al., 2015), especially the benefits brought by new payment methods and technology finance. Moreover, our study enriches the research on inclusive finance and the welfare of socially vulnerable groups in developing countries (e.g., Fungáčová & Weill, 2015; Nizam et al., 2020; Saydaliyev et al., 2020; Zhao et al., 2022). More importantly, our study provides many practical implications and they are listed as follows.

For China, the following measures may accelerate the spread of mobile payments in rural areas. First, the Chinese government is supposed to transform rural residents' non-cash payment habits and payment security awareness by strengthening the promotion of mobile payment. Feasible publicity methods include electronic advertisements, mobile phone text messages, live publicity, sitcoms, and small videos. Second, mobile payment companies need to innovate business products to meet the payment needs of rural residents. For example, according to the current status of rural payment, they can launch personalised mobile payment products and services, especially in the field of living payment. Another example is that they could give appropriate business tilts and subsidies to the poor areas and remote areas.

For other developing countries, most also suffer from the problems such as imperfect credit systems and a high threshold of financial services for rural residents. These problems lead to more inconvenience and transaction costs, especially for socially vulnerable groups. Our study lends evidence from rural China and demonstrates that mobile payment is beneficial to raising the S.W.B. of rural residents, especially for socially vulnerable groups. This finding can be explained by the fact that mobile payment allows rural residents to participate in economic activities more efficiently, promote consumption upgrade, and provide them with more social network methods. Hence, we believe that mobile payment provides good enlightenment for some developing countries to promote people's S.W.B.

Notes

1. The original data is obtained from the China Statistical Yearbook.
2. The unit of per capita household consumption is 10,000 yuan.
3. These five consumption variables are all logarithmic, and the unit is yuan.
4. As before, the three continuous variables, *Money gift expenditure*, *Transportation spending*, and *Communication spending* are all logarithmic and the units are yuan.

Credit author statement

Yaqian Wu: Data analysis, Writing-Review, Editing & Revisions, Funding acquisition. Chunkai Zhao: Conceptualisation, Methodology, Software, Formal analysis, Writing-Original Draft. Jianhao Guo: Data curation, Writing-Review & Editing, Resources.

Disclosure statement

We declare that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted.

Funding

This work was supported by the Fundamental Research Funds for the Central Universities (No. QCDC-2020-21); the Fund for Young Teachers of College of Finance, Nanjing Agricultural University; the Humanities and Social Science Fund Project of Fundamental Research Funds for the Central Universities, Nanjing Agricultural University (SKYC2022006) and the Research Start-up Fund for Nanjing Agricultural University (No. 804023).

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