Mobile Payment in China: Practice and Its Effects*

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Abstract
This paper offers a comprehensive review and careful assessment of China's mobile payment business. With broad access, low costs, and reliable transactions, mobile payments are creating a revolution of financial inclusion, changing people's daily lives and commercial business models. This study also confirms that mobile payment improves risk sharing among individuals and increases entrepreneurial opportunities. These mobile payment successes can be traced to three key factors: supply shortages of alternative payment services, a friendly regulatory environment, and recent technological developments. A number of outstanding issues remain, however, including data ownership, data inequality, and regulatory shortcomings.

1. Introduction

Mobile payment services, dominated by two leading players, Alibaba's (now owned by Ant Financial Services) Alipay and Tencent's WeChat Pay, have become a fixture in China's daily lives and businesses. Both players have built eco-systems around their mobile payment tools. People use Alipay or WeChat Pay to purchase goods, order coffee and

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food delivery, pay electricity bills, book taxis, buy air tickets, make donations, transfer money, and even invest in financial products. Almost all commercial outlets in China, including streetside stores, widely utilize mobile payment services' Quick Response (QR) codes to conduct business. Chinese tourists also use mobile payment services to purchase souvenirs and luxury goods at international airports and major department stores around the world. In 2018, the mobile payment service made a total of 60.5 billion transactions, an increase of 61.2 percent from a year before, according to report by the People's Bank of China (PBOC).[1]

China was not the original inventor of mobile payment business—M-Pesa in Kenya and PayPal in the United States are both older and well known. But Alipay and WeChat Pay have turned mobile payment into a global phenomenon, attracting massive interest from business practitioners, academics, and policymakers around the world. Why did it grow? Can it be replicated in other countries? What are the major economic and financial consequences? How should it be regulated? There is a growing literature addressing these questions and more, looking at the effects of mobile money adoption on household welfare (Aker et al. 2016; Munyegera and Matsumoto 2016; Beck et al. 2018), saving behavior (Aker et al. 2016; Mbiti and Weil 2013), informal insurance network and risk sharing (Jack and Suri 2014; Klapper and Singer 2014; Riley 2018), financial inclusion (Demirguc-Kunt et al. 2018), and monetary frameworks (Mbiti and Weil 2013).

The success of China's mobile payment business could be attributed to three factors: a supply shortage of payment services, a friendly regulatory environment, and recent technological developments. With broad access, low cost, and reliable transactions, people's daily lives and commercial business models have been changed significantly. The empirical investigation also provides convincing evidence that mobile payment not only promotes household entrepreneurship in China, but also enhance the ability of households to smooth risks when experiencing negative idiosyncratic income growth shocks. Nevertheless, although revolutionary financial inclusion has been created, China's new mobile payment business still needs to evolve further to address outstanding issues, including consumer protection, data inequality, and regulatory arbitrage.

The rest of this paper is structured as follows. In the next section we introduce the innovation and development of mobile payment in China. Section 3 reviews the literature regarding the development and effects of mobile money in different countries. In Section 4 we provide evidence that mobile payment system has been complementary to the traditional bank-based financial sector by improving individual and household risk sharing and promoting entrepreneurship in China. Section 5 concludes.

1 Retrieved from: http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/3787878/index.html; accessed on 10 January 2020.

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2. Background

In retrospect, 2005 might be identified as the first year of China's mobile payment industry, with Alipay coming online at the very end of 2004. Since then, mobile payments have grown at a truly astonishing pace. A number of events played important roles in this development. First, the release of Apple's first iPhone in January 2007 marked the beginning of the new era of smartphones, making it possible to use mobile payment services anywhere, any time. Second, the success of Ant Financial's money market fund Yu'E Bao significantly boosted awareness of, and enthusiasm for, the financial technology (fintech) industry, including mobile payment. Third, the distribution of red (cash) envelopes on WeChat Pay during the Chinese New Year holiday in 2014 became almost viral and attracted hundreds of millions of new users. And finally, the adoption of the QR code for mobile payment made it possible for any businesses, formal and informal, to use mobile payment service by simply printing out the code on a piece of paper.

In recent years there has been a rapid expansion of China's mobile payment business, in terms of active users, number of transactions, and transaction values. The number of active users of Alipay increased from a little over 100 million in 2013 to 900 million in 2018, and that of WeChat Pay grew from about 350 million to 1.1 billion. The total transaction value jumped from RMB 14.5 trillion in 2013 to RMB 277.4 trillion in 2018, recording an annual growth rate of 80 percent (Figure 1). The number of mobile payment transactions reached 60.5 billion in 2018, rising by 61 percent from the previous year. The share of mobile payment in total non-cash payment value rose from less than 1 percent in 2013 to 7.4 percent in 2018, and the share of mobile payment in the total number of non-cash payment transactions increased from 3.3 percent in 2013 to 27.3 percent in 2018. Some mobile payment platforms also evolved into large ecosystems, covering a wide range of businesses such as funding, financial management, credit reference and big data.

China has consistently ranked number one in mobile payment markets (whether in transaction volume or penetration rate) in the world. The proportion of adults using mobile payment in China was as high as 76.9 percent in 2017, and even in rural areas the proportion was 66.5 percent. According to Ipsos statistics, the penetration rate of mobile payment in China was 77 percent in 2016, compared with rates in the United States, UK, Germany, and France of 48 percent, 47 percent, 48 percent, and 38 percent, respectively. The penetration rate in Japan was only 27 percent. The leapfrogging of China's mobile payment reflects the underdeveloped social credit system in China. In advanced economies like the United States, the primary method of payment is the credit card. Although China has the largest credit card system in the world with nearly 7.6 billion cards, according to PBOC, 91 percent of these are debit cards. The percentage of the population aged above 15 years with a credit card was only 20.8 percent in China at 2017, significantly lower than that in Japan

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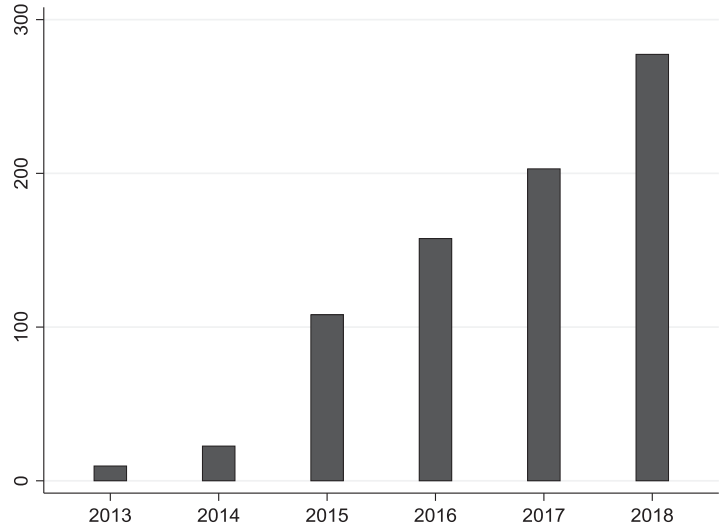
Figure 1. Transaction value of mobile payment in China, 2013–18 (RMB trillion)



Source: *CEIC; PBOC.*

(68.4 percent), the United States (65.6 percent), the United Kingdom (65.4 percent), and South Korea (63.7 percent).

The development of mobile payment services has contributed significantly to financial inclusion. Delivering responsible and sustainable financial services, including payment services, to small and medium-sized enterprises (SMEs) and low-income households is a global challenge (Nanda and Kaur 2016; Demirguc-Kunt et al. 2018). Mobile payment has overcome many difficulties, reaching massive numbers of SMEs and individuals. The Mobile Payment Coverage Sub-Index of the Peking University Index of Digital Financial Inclusion showed significant convergence among Chinese prefectures between 2011 and 2018 (Figure 2). In 1935, economic geographer Hu Huanyong drew a line on China's map from Heihe in Heilongjiang to Tengchong in Yunnan, which was later known as the Hu Huanyong Line (The line in the right panel of Figure 2).[2] On the right side of this line, about 46 percent of total land area supported 96 percent of the population, and on the left side of the line, about 54 percent of the land area supported only 4 percent of the population. During the past decades, these numbers have changed somewhat, but the basic point of extreme population concentration in one-half of the country's geography remains largely true. This was also true for the picture of mobile payment coverage in 2011 (the left panel

2 Hu Huanyong elaborated first presented the idea of this Hu Huanyong Line in the journal article "Distribution of China's Population" in *Journal of Geographical Sciences* (in Chinese) in 1935.

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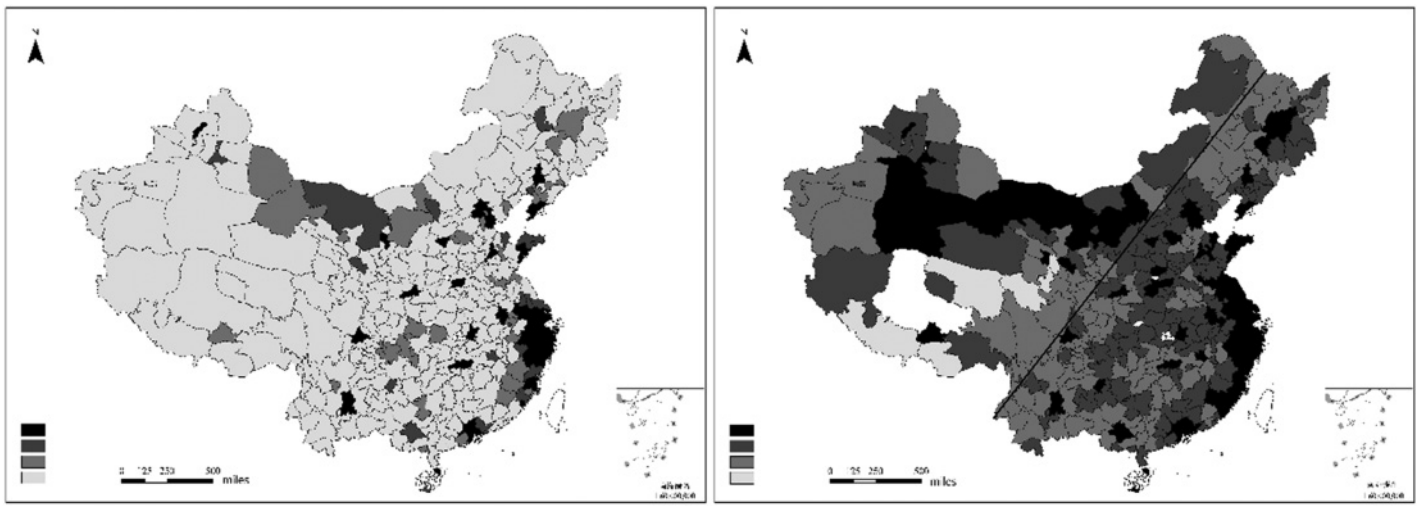
Figure 2. Peking University Index of Digital Financial Inclusion of China: Mobile payment coverage sub-index by prefecture, 2011 (left) and 2018 (right)



Source: *Guo et al. (forthcoming).*

Note: *The line in the right graph is the Hu Huanyong line. All prefectures each year are divided into four groups according to levels of mobile payment coverage, which are then colored (from high to low) in dark black, black, light black, and gray.*

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of Figure 2), in which we see that the mobile payment business was more developed on the right side of Hu Huanyong Line. In the following seven years, however, mobile payment coverage moved rapidly to western China—the gap between the regions on the right- and left-hand side of the Hu Huanyong Line has been narrowed greatly (Figure 2).

The promotion of financial inclusion is at least partly due to the better risk assessment of fintech companies having access to real-payments data—for example, social media activity and digital footprint. Fintech companies that offer payment services to consumers can acquire more accurate information about their consumption behavior and income streams to assess creditworthiness, and may therefore provide financing to borrowers who are unable to take personal loans from banks because of the lack of an established credit registry. Using real-time payments data, big data, machine learning technology, and other complex artificial intelligence algorithms, fintech credit platforms can also develop a more accurate picture about people's financial lives and creditworthiness both from the extensive (exclusion) and intensive (default and price) margins (Gambacorta et al. 2019; Jagtiani and Lemieux 2019). MYbank, an Internet-based commercial bank and one of the brands under Ant Financial Services Group, has lent RMB 2 trillion to over 15.74 million small companies. Borrowers apply with a few taps on a smartphone and receive loans within three minutes if approved. The default rate so far is about 1 percent.[3] The size of each loan is around RMB 10,000, reflecting the inclusive nature of MYbank business loans. The world's biggest market for digital payments is changing the way in which banks interact with smaller companies that were previously underserved by state-owned banking giants.

Three key factors contributed to the successful ascendancy of mobile payment in China: lack of supply, regulatory policy, and technological development.

First, while the initial motivation of developing Alipay was to solve the problem of a lack of trust among counterparties, there was generally a significant shortage of supply for payment services. Compared with financial systems in other countries, the Chinese system exhibits two unique features: the high proportion of banks in the financial sector (Zhong et al. 2019) and the high degree of financial repression (Figure 3) (Herrala and Jia 2015). Improving financial inclusion is an especially challenging task in China. For example, in the past the average penetration rate of credit cards was relatively low, and traditional card payment services, such as the point of sale machine, were often slow, inefficient and expensive. Most SMEs and low-income individuals had to rely on cash for financial transactions. When mobile payment services came online, they were immediately embraced by the market. Nowadays, withdrawals up to RMB 20,000 are free, with amounts above that charged with a 0.1 percent cost. Over 90 percent of residents in large cities use mobile payment as

3 Retrieved from: https://www.bloomberg.com/news/articles/2019-07-28/jack-ma-s-290-billion-loan-machine-is-changing-chinese-banking; accessed on 31 December 2019.

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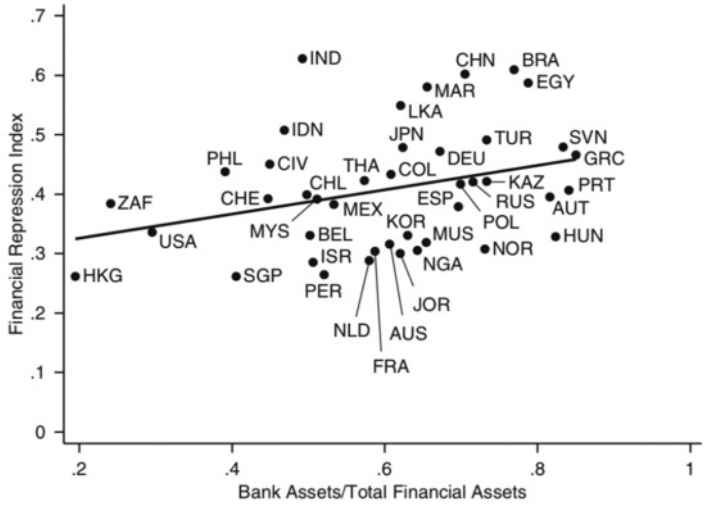
Figure 3. International comparison of financial systems, 2015



Source: *Huang and Ge (2019).*

Note: *The horizontal axis indicates share of banks in total financial assets and the vertical axis represents degree of financial repression.*

their primary payment method, followed by cash and debit/credit card. For these reasons, some experts argue that countries like the United States will not be able to replicate the Chinese experience of mobile payment service (Klein 2019).

Second, a tolerant regulatory environment has also offered room for China's mobile payment system to experiment and grow. There were no strict regulatory restrictions on mobile payment until PBOC released its "Measures for the Administration of Payment Services for Non-Financial Institutions" report in June 2010. Since then, PBOC has issued nearly 270 third-party payment licenses. Although it now looks that the number of licenses is excessive, granting third-party payment licenses was an innovative policy step. In other countries, this kind of experimental approach might not be possible.

And, finally, technological development has provided the necessary conditions for both spread of payment coverage and improvement in service quality. According to a survey by Nielson, the smartphone penetration rate in China was 66 percent in 2017, which was similar to most developed countries but significantly higher than Brazil (36 percent), Turkey (19 percent), and India (10 percent). The number of transactions that Alipay can handle per second increased from about 200 in 2011 to 210,000 in 2017 and the fund-loss rate was reduced to below one in a million. The adoption of QR codes also brought about revolutionary changes to the extension of mobile payment services.

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In sum, lack of supply, tolerant regulatory attitudes, and a relatively mature fintech industry have underpinned China's domestic experience with mobile payment services. Chinese payment technology has also started to support mobile payment businesses in Asia. Alipay has cooperated with local partners to establish nine local e-wallets, including Thailand (TrueMoney), the Philippines (GCash), Indonesia (DANA), India (Paytm), Malaysia (TnGD), Pakistan (easypaisa), Bangladesh (bKash), Korea (Kakao pay), and Hong Kong (Alipay HK). Cross-border payment of local wallets is also available between Hong Kong and mainland China, and between Hong Kong and Japan, as are cross–border remittances supported by block chain from Hong Kong to the Philippines, and from Malaysia to Pakistan.

3. Relevant literature on mobile payments

Mobile payment in China is predominantly linked to pre-existing bank accounts but can be more easily accessed through mobile devices, enabling mobile phone owners to transfer money instantly, securely, and cheaply, leading to enormous changes in the organization of economic activity. The reduction in transaction frictions, including visible costs and invisible attrition such as theft, makes remittances and payments easier and safer than traditional payment methods, especially in developing economies. Suri (2017) notes that mobile money provides a dramatic reduction in transaction costs, as well as improvements in convenience, security, and time taken for the transaction.

The reduction in transaction frictions could facilitate trade by improving the existing trade efficiencies and by enabling new transactions that would not have happened without mobile money. For example, Plyler et al. (2010) find that M-Pesa in Kenya has promoted the growth rates of small-scale firms at the community-level, largely driven by the increased circulation of money. Beck et al. (2018) analyze the effects of payment technology innovation on entrepreneurship and economic development, and conclude that broader approaches to improving access to financial services, including payment services, are important for alleviating financial constraints and stimulating business performance.

Convenience and lower transaction frictions could also play an important role in informal insurance networks (Yang and Choi 2007; Aycinena et al. 2010); specifically, by connecting individuals to the broader economy beyond those physically proximate, and strengthening informal insurance networks (Klapper and Singer 2014). In developing and low-income countries, informal risk sharing through mechanisms such as inter-household transfers, marriage, precautionary saving, and state-contingent loan repayments provide important means by which households mitigate risk (Rosenzweig and Start 1989; Udry 1994; Townsend 1994, 1995). Despite intense academic and policy debates over the best way to improve household risk bearing, few studies have incorporated the effect of digital financial inclusion into the analysis. A recent exception is Jack and Suri (2014), who estimate

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the impact of using M-Pesa on risk sharing, and find that compared with non-users, the consumption of M-Pesa users is unaffected when facing negative shocks. In addition, such informal savings and insurance mechanisms could lead to more efficient business decisions by relaxing the tradeoff between risk and return that households would otherwise face (Jakiela and Ozier 2016; Di Falco and Bulte 2013).

We try to provide some preliminary evidence on the impact of mobile payment in China by examining the household's entrepreneurial decision and ability to smooth consumption risks. Previous studies gauging the impact of mobile money have almost exclusively focused on the adoption decision and welfare of the household, and few of them have addressed the importance of household entrepreneurial activity and risk sharing. Beck et al. (2018) show significant quantitative implications of mobile money for entrepreneurial growth and macroeconomic development. Using provincial-level data, Xie et al. (2018) provide evidence that the development of digital finance promotes the registration of new businesses. Yin et al. (2019) conduct cross-section analysis to study the impact of mobile payment on household entrepreneurial decisions and business performance. We extend further by using the panel data to better control for potential selection bias. And we examine how the transition between agricultural and business families changed due to mobile payment. Moreover, as far as we know, there is a lack of statistical evidence on the impact of digital financial instruments on household risk sharing.

4. Empirical analysis

It is not difficult to observe the positive changes that mobile payment has brought to the Chinese economy, particularly to ordinary households and SMEs. In this section, we provide some empirical evidence, focusing on household entrepreneurship and risk sharing among households. We use two sets of data: the China Household Finance Survey conducted in 2013, 2015, and 2017; and the Peking University Index of Digital Financial Inclusion for China (PKU-DFI) for the years between 2011 and 2018 (Guo et al. 2020).

The China Household Finance Survey is a nationally comprehensive household-level survey conducted via face-to-face interviews. The questionnaire is composed of four parts: demographics, financial assets and liabilities, social security and insurance, and income and expenditure. The survey tracks households every two years and adds new households to the sample in each wave. The tracked sample allows us to construct a balanced panel using the 2011, 2013 and 2015 surveys (34,430 household-year observations) for the analysis of household entrepreneurial activities. After controlling for the necessary non-missing variables, 7,963 households were left in the 2013, 2015, and 2017 surveys. Because we focus only on the change of consumption and income, we then take the first difference of the variables between three rounds, the final sample consists of 15,926 household-year observations ($7{,}963 \times 2$) for the analysis of household risk sharing.

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PKU-DFI is developed by Peking University's Institute of Digital Finance, in collaboration with Ant Financial Services Group of Alibaba. Using the data from Ant Financial, a large representative mobile payment platform, PKU-DFI measures digital inclusive finance in China during 2011–18 at three levels (national, provincial, and municipal) and from three dimensions (breadth of coverage, depth of usage, and level of digitization).[4] The three dimensions include 33 dimensionless bottom indicators. More specifically, the PKU-DFI is constructed from bottom to top using the bottom indicators. First, the coefficient of variation method is used when calculating the weights of each specific indicator. Then, the analytic hierarchy process method is applied to calculate the weights for each sub-dimension that are used to calculate the breadth of coverage, the depth of usage, and the level of digitalization. Finally, the PKU-DFI Index is aggregated using these three dimensions whose weights are again determined by the analytic hierarchy process method. The PKU-DFI is comparable both horizontally (in a regional dimension) and vertically (in a time dimension).

4.1 Promoting entrepreneurship and informal business

With mobile payment, the rate of processing fees varies from 0 to 0.3 percent—the lower transaction fees matter considerably for informal small-scale business. With the help of mobile payments, there is no need to fumble for cash, write out checks, or wait for invoices, which greatly improves settlement efficiency (Jack and Suri 2011). The reduction in transaction frictions could facilitate trade from two aspects: on the one hand, by improving the efficiency on existing trade, and on the other, by enabling new transactions that would not have happened without mobile money. These reductions in transaction costs, along with the strengthening of informal insurance networks and increasing financial inclusion, could help households make more efficient decisions by relaxing the trade-off between risk and return that households would otherwise face (Di Falco and Bulte 2013; Jakiela and Ozier 2016).

We examine the association between the adoption of mobile payment and business activity from a micro perspective. We disaggregate business into formal and informal businesses. Formal business includes four types: company limited by shares, limited liability company, partnership enterprise, solely owned enterprise. Informal business includes two types: registered self-employed business and unregistered business, such as market stalls or street musicians. Compared with formal businesses, informal businesses are often small in scale and without standardized management systems.

Although the mobile payment tool came out in 2004, mobile payment business exploded in 2013, after the advent of Yu'E Bao, and 2013 is always regarded as the start year of digital

4 See more in Guo et al. (2020).

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Table 1. Impact on entrepreneurial activity by pre-MP activity

	Dependent variables			
Pre-MP activity	Agriculture^{d} (1)	Informal^{d} (2)	Formal^{d} (3)	Income (4)
Agriculture^{d}	−0.1275***	0.0852***	0.0008	2998.1578***
	(−6.5412)	(4.4491)	(0.1277)	(2.8294)
Informal^{d}	0.0016	0.0648***	0.0091	4175.3053**
	(0.0882)	(2.9864)	(1.5550)	(2.3724)
Formal^{d}	0.0533	−0.2035*	0.0515	10100.00
	(1.0125)	(−1.7579)	(0.4777)	(0.6050)

Note: *Reported are coefficients on the interaction term $MP^{d} \times Post\text{-}2013^{d}$. t-statistics are in parentheses. Each row is a regression in sub-samples that split by households' pre-MP period activities. Regressions include time and household fixed effects, municipality × year dummies, as well as household control variables. As the space is limited here, coefficients on control variables are available upon request from the authors. The superscript "d" indicates a dummy variable. MP = mobile payment.*

****Statistically significant at the 1 percent level; **statistically significant at the 5 percent level; *statistically significant at the 10 percent level.*

finance in China. This allows us to use the following difference-in-difference estimation, which compares households with and without mobile payment before and after the explosive growth of mobile payment.

$$y_{ict} = \alpha + \beta_i + \gamma_t + \delta MP_{ict} + \pi X_{ict} + \eta_{ct} + \varepsilon_{ict}, \quad (1)$$

where y_{ict} is outcome variables for household i in municipality c in period t, β_i is a household fixed effect, γ_t is a year fixed effect, X_{ict} is a matrix of household control variables, and η_{ct} are a set of municipality-by-time dummies. The main variable of interest is the dummy MP_{ict}, which is an interaction between a post-2013 dummy and a dummy that equals one for households using mobile payment after 2013 and zero for all other households in the sample. The coefficient δ estimates the effect of using mobile payment on outcomes. We cluster the standard errors at the household level.

Table 1 shows how transactions between agricultural, informal business, and formal business households changed through mobile payment adoption. To save space, only the coefficients on $MP^{d} \times Post\text{-}2013^{d}$ are reported. More specifically, each cell is the coefficient on $MP^{d} \times Post\text{-}2013^{d}$ from the estimation of equation (1) in the subsamples split by households' pre-mobile payment (pre-MP) period business participation.

The first row shows that households that engaged in agricultural production in the pre-MP period are less likely to remain operating agricultural activities, but more likely to be informal business owners after the adoption of mobile payment. Results in the second row indicate that households who owned an informal business in the pre-MP period are more likely to continue operating after adopting mobile payment than to transition into formal

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business owners. This suggests that mobile payment mainly tends to help agricultural families start self-employed informal business and existing informal business to continue their operations, rather than transition into formal business owners.[5] In developing countries, informal firms account for up to half of economic activity, and they provide livelihood for billions of people (Porta and Shleifer 2014), thus the positive impact of mobile payments on informal business that we found is both economically and statistically significant. Column (4) shows that those previously in the agricultural and informal business categories experienced a significant increase in income following the use of mobile payments, which confirms the finding of the positive impact on the probability of starting business. To better understand how the support on the continuation of informal business could be associated with an increase in income, there are some intuitive explanations. It is plausible that a more convenient and safe payment tool improves the transaction efficiency and lowers the risk of these informal business, among which most are businesses without a brick-and-mortar storefront. In addition, the accumulated payment data enables the fintech companies to profile the business owners who have no credit history, and makes providing further financial services for these business owners possible.

There are two possible explanations for the weak evidence on the previously formal business owners. First, the payment efficiency gains from the lower transaction costs, shorter settlement time, and lower possibility of losing cash are relatively subtle for those who have owned a business with larger scale and more standardized management. Second, we admit that there is some noise in our estimates because the fraction of households owning a formal business is relatively small in our sample.

One of the channels through which mobile payment may affect household business activity is the enhanced informal networks through transfers among friends and families due to lower transaction costs. We examine whether there is any difference in the remittance behavior across mobile payment users and non-users. The results in Table 2 show that being a mobile payment user is associated with a significantly higher probability of both transferring funds out and receiving remittances compared with non-users. The proportion of households who transferred funds out is 3.51 percent higher among the mobile payment adopters, and the difference in the proportion of households who received remittances is even greater, at 6.82 percent higher for mobile payment users. Two-way flows of remittances among friends and relatives are also more likely to be observed for households using mobile payment. It is plausible that the increase in the proportion of households having remittances among mobile payment users is more likely to reinforce and expand their informal insurance network, which could relax the trade-off between risk and return that they would otherwise face (Jack and Suri 2011).

5 More detailed analysis is conducted in Wang (2019).

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Table 2. Impact on remittance: Full sample

Dependent variables			
	Transfer out[d] (1)	Remittance received[d] (2)	Two-way flow remittance[d] (3)
$MP^d \times Post\text{-}2013^d$	0.0351***	0.0682***	0.0619***
	(3.9651)	(5.5972)	(5.0866)
Adj. R^2	0.19	0.17	0.18
Observations	34,098	34,074	33,992
HH.Controls	Yes	Yes	Yes
HH.FE	Yes	Yes	Yes
Municipality × year	Yes	Yes	Yes

Note: *Reported are coefficients on the interaction term $MP^d \times Post\text{-}2013^d$, and t-statistics are in parentheses. The average proportion of households transferred out, received, and had two-way remittances in the pre-MP period are 81 percent, 48 percent, and 43 percent, respectively. Regressions include time and household fixed effects, municipality × year dummies, as well as household control variables. As the space is limited here, coefficients on control variables are available upon request from the authors. The superscript "d" indicates a dummy variable.*

***Statistically significant at the 1 percent level.*

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4.2 Improving household risk-sharing

Enhanced informal social networks through more convenient remittances could provide an important means by which households and individuals share risk, especially for those previously underserved by the formal financial system. Having access to a transaction account is the first step toward broader financial inclusion because it allows people to store money and send and receive payments (Demirguc-Kunt et al. 2018). Rapid development and acceptance of mobile payment could help individuals rapidly transfer purchasing power within the ecosystems of Alipay or WeChat Pay, improving their financial inclusion, and hence their ability to smooth risk.

We seek to identify the effects of digital financial inclusion on household risk-sharing. We use a fixed-effect strategy to examine the impacts of digital finance development in China and also of traditional banking credit on risk-sharing by investigating their role in affecting the sensitivity of a household's idiosyncratic consumption growth to idiosyncratic income growth in the following specification (similar to that used by Kose et al. [2009], Jack and Suri [2014], and Li and Liu [2018]):

$$\Delta log\tilde{C}_{ijt} = \alpha_i + \beta \Delta log\tilde{Y}_{ijt} + \gamma' log(FI_{jt}) \times \Delta log\tilde{Y}_{ijt} + \psi Z_{ijt} + \phi Z_{ijt} \times \Delta log\tilde{Y}_{ijt} + \alpha_t + \varepsilon_{ijt}, \quad (2)$$

where $\Delta \log \tilde{C}_{ijt} = \Delta \log C_{ijt} - \Delta \log \bar{C}_t$ $\Delta \log \tilde{Y}_{ijt} = \Delta \log Y_{ijt} - \Delta \log \bar{Y}_t$ C_{ijt} and Y_{ijt} represent annual per capita consumption and annual per capita income (income) for household i in city j at period t, respectively; $\bar{C}_t$ and $\bar{Y}_t$ are the sample average of per capita household consumption and income, respectively; and the subtraction of the common component of each variable from household growth captures idiosyncratic household-specific fluctuation in that variable (Sørensen et al. 2007). α_i is the household fixed effect, α_t is the time fixed effect, FI_{jt} is a vector of financial indices that measure the development of digital inclusive finance (DF_{jt}) and traditional bank lending (BC_{jt}), proxied by the ratio of bank credits to

Table 3. The effect of digital finance on household risk sharing

	Full sample:HH idiosyncratic consumption growth		
	(1)	(2)	(3)
$\Delta\log\tilde{Y}_{ijt}$	0.849***	0.678**	0.632**
	(0.285)	(0.285)	(0.291)
$\log DF_{jt} \times \Delta\log\tilde{Y}_{ijt}$	−0.147***	−0.114**	−0.150***
	(0.055)	(0.055)	(0.057)
$\log BC_{jt} \times \Delta\log\tilde{Y}_{ijt}$	0.027	0.019	0.019
	(0.017)	(0.017)	(0.018)
Controls	N	Y	Y
Controls interactions	N	N	Y
HH. FE, time FE	Y	Y	Y
Observations	15,926	15,926	15,926
R^2	0.30	0.31	0.31

Note: *Dependent variable: household idiosyncratic consumption growth. DF_{jt} is the measure of digital inclusive finance, and BC_{jt} is the ratio of bank credits to GDP in city region. Controls: household demographics, employment dummies, gender and age of the household head, the education level of family members, smartphone ownership, the use of financial instruments (bank card, participation in social insurance), and city level GDP growth. Control interactions are the interactions terms of controls with $\Delta log\tilde{Y}_{ijt}$. Robust standard errors reported in brackets are clustered at household level.* ***Statistically significant at the 1 percent level; **statistically significant at the 5 percent level.

GDP in city region j in period t; and Z_{ijt} is a vector of controls containing both household- and city-level variables. Household demographics, employment dummies, gender and age of the household head, education level of family members, smartphone ownership, and the use of financial instruments (bank card, participation in social insurance) are at the household level. Besides FI_{jt}, the city-level variable GDP growth is also included to control for local economic conditions. The interaction term captures other household factors that might affect the ability of the household to smooth risks.

Therefore, $\beta + \gamma' log(FI_{jt})$ captures the average level of co-movement between the idiosyncratic consumption growth and income growth across households; it can be used to measure the degree of risk sharing/smoothing, as a smaller magnitude indicates a greater degree of risk sharing across households. Table 3 presents the results of our baseline estimation. The negative coefficient on the interaction term $\log DF_{jt} \times \Delta\log\tilde{Y}_{ijt}$ indicates/suggests that the improvement of digital finance helps households reduce the sensitivity of household idiosyncratic consumption growth to income growth (i.e., delinking the fluctuations in household-specific consumption and income growth), which implies that digital inclusive finance plays a significantly positive role in household risk-sharing. The coefficient on the interaction of idiosyncratic income and digital finance is negatively significant and robust through column (1) to column (3). In column (3), we include household fixed effects, time fixed effects, covariates, and the interactions between covariates and idiosyncratic income growth. Households are estimated to suffer a 6.32 percent reduction in consumption when facing a 10 percent decrease in income growth, and a 1 percent increase in digital financial inclusion index is able to help households smooth this shock and leads only to a 4.82 percent reduction in consumption. This difference is both

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Table 4. Mechanism: Where do remittances come from?

	From parents			From relatives & friends		
	Full sample	Low income	High income	Full sample	Low income	High income
$\Delta \log \tilde{Y}_{ijt}$	0.381**	0.460**	0.078	0.136	0.438*	−0.249
	(0.166)	(0.186)	(0.251)	(0.239)	(0.260)	(0.505)
$\log DF_{jt} \times \Delta \log \tilde{Y}_{ijt}$	−0.074**	−0.087**	−0.017	−0.027	−0.086*	0.044
	(0.033)	(0.036)	(0.050)	(0.047)	(0.051)	(0.098)
$\log BC_{jt} \times \Delta \log \tilde{Y}_{ijt}$	0.003	0.014	−0.028	0.012	0.033*	−0.014
	(0.010)	(0.009)	(0.018)	(0.014)	(0.017)	(0.025)
Controls	Y	Y	Y	Y	Y	Y
Controls interactions HH FE, time FE	Y	Y	Y	Y	Y	Y
Observations	2,560	1,118	1,442	2,560	1,118	1.442
R^2	0.73	0.70	0.75	0.65	0.65	0.66

Note: *Dependent variable: whether household received transfer from parents and parents in law (columns 1–3), received transfer from friends and relatives (column 4–6).* DF_{jt} *is the measure of digital inclusive finance, and* BC_{jt} *is the ratio of bank credits to GDP in city region. Controls: household demographics, employment dummies, gender and age of the household head, the education level of family members, smartphone ownership, the use of financial instruments (bank card, participation in social insurance), and city level GDP growth. Control interactions are the interactions terms of controls with* $\Delta log\tilde{Y}_{ijt}$*. Robust standard errors reported in brackets are clustered at household level.*

**statistically significant at the 5 percent level; *statistically significant at the 10 percent level.

statistically and economically significant, which indicates that the improvement of digital finance services significantly enhances the ability of the household to insure against shocks of income growth. Households that suffer from negative income shocks exhibit a lower reduction in consumption growth in regions with better developed digital finance. For more complete and detailed analysis, please refer to Wang et al. (2019).

Table 4 reports the results of the mechanism. Column (1) examines the response of transfer from parents to income shocks in the full sample, then we divide the full sample into poor households (with income below the median level) and rich households (with income above the median level) in column (2) and (3), respectively. The interaction term of interest is negative and significant in columns (1) and (2), implying that when suffering from negative income shocks, households in areas with better-developed digital finance receive more remittance from parents in terms of the probability of receipt, and this effect is more significant for poor households. Columns (4) through (6) show similar evidence: It is more likely for low-income households in areas with better-developed digital finance to receive transfer from friends and relatives when facing income risks.

5. Conclusions

The mobile payment business in China is a revolution of financial inclusion. It connects hundreds of millions of individuals and tens of thousands of SMEs that previously had no access to payment services other than cash. The mobile payment business is also a revolution in the broader financial industry. Building on mobile payment records and other

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digital footprints, mobile payment service providers have developed comprehensive ecosystems, covering all sorts of services. The financial industry itself has also started to change with a new credit assessment system, online lending, digital insurance, robot investment advice, and more.

We believe this success can be attributed to three key factors: a significant supply shortage of payment services in the traditional financial industry; a friendly regulatory environment that encourages and even supports payment innovation; and the rapid development of internet technology, including smartphones, big data analyses, and cloud computing. The empirical analysis in this study show that mobile payments significantly improve risk-sharing among individuals, which is particularly important in a society where there are massive numbers of migrant workers. Our study also provides preliminary evidence that the adoption of mobile payment increases one's chance of starting a new business and raising one's income.

Second, although mobile payment strongly supports financial inclusion, it also creates new problems because of digital inequality. Ono (2005) finds that pre-existing inequality in other socioeconomic areas leads to inequality in information and communication technologies access, use, and skills. In fact, if one does not own a smartphone and have a mobile payment account, life could become extremely inconvenient and even difficult. It is now common in some Chinese cities for shops to refuse to accept not only credit cards but also cash. Therefore, policymakers and business practitioners need to find ways to reduce the negative consequences of digital inequality.

And, finally, financial regulation needs to adapt to the new characteristics of mobile payment specifically, and fintech more generally. Unlike in the United States and Europe, China's fintech industry is dominated by a number of unicorn Internet companies. Although this has been helpful for promoting financial inclusion, it also complicates the task of financial regulation. One problem relates to the speed and scope of risk transmission of financial risks because of the new technology. Another problem is the possible/likely abuse of market power by the unicorn firms' duopoly. Although potential entry threats motivate these firms to continue providing a more convenient and efficient market infrastructure and higher quality services, consumer protection will remain a large concern, given the highly concentrated market structure. Additionally, the general universal banking business model pursued by these Internet companies can be a problem. The current regulatory system in China, which is industry-segregated and institution-focused, is not suitable for managing financial risks for this new business—as it tends to result in regulatory gaps and arbitrage. Regulatory authorities should improve the efficiency by transforming the institution-based framework to functional-based regulation and adopting more advanced supervision technology (so-called suptech). Finally, protection of financial consumers should be emphasized and strengthened in China by regulating conducts of financial institutions and improving consumers' financial literacy.

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