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Financial Outreach, Bank Deposits, and Economic Growth

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Abstract

This paper explores the relationship between financial outreach and economic growth, both theoretically and empirically. Our theoretical framework suggests that financial outreach reduces household cash holdings and increases bank deposits by lowering transaction costs associated with intermediated activities, thereby boosting economic growth. This effect is more pronounced in regions with higher population density and less developed technology-based financial services. Empirical evidence from 281 prefecture-level Chinese cities supports the theory that financial outreach enhances economic growth indirectly by promoting bank deposits. These findings help explain the finance-growth puzzle in the context of China's economic dynamics.

Keywords: Financial outreach; Economic growth; Bank deposits; Technology-based financial services; China

JEL Classification: D14, G21, O40

1. Introduction

Does finance matter for economic development? A large body of literature has tried to understand the finance-growth nexus (Rajan and Zingales 1998; Rousseau and Wachtel 1998; Levine et al. 2000; Baier et al. 2004; Butler and Cornaggia 2011; Greenwood and Scharfstein 2013). Most studies have focused on the economic impact of financial sector depth, which is usually measured as the ratio of private credit to GDP (Levine 2005; Beck *et al.* 2007a) or the ratio of bank credit/stock market capitalization to GDP (Hsu *et al.* 2014). Yet, the economic impact of financial outreach—defined as physical access to formal financial services—remains relatively underexplored (Burgess and Pande 2005; Beck *et al.* 2007b; Honohan 2008; Kendall 2010; Efobi *et al.* 2014; Mialou *et al.* 2017).

Broad financial service outreach is important for several reasons. First, financial outreach is a crucial precondition for promoting financial inclusion. According to Demirguc-Kunt et al. (2017), physical distance from a bank remains a significant barrier preventing households from accessing formal accounts. Second, a number of studies have documented the positive economic impact of financial outreach on reducing income inequality and alleviating poverty in developing economies (Burgess and Pande, 2005; Beck and Demirgüç-Kunt, 2008; Bruhn and Love, 2014). Third, financial outreach can support informal businesses and provide start-up funding for new firms, facilitating their entry into the market and promoting the Schumpeterian process of "creative destruction" (Klapper et al., 2006; Bruhn and Love, 2014). Fourth, greater access to finance may foster technological and innovative progress, as innovative activities often require substantial external financial support (King and Levine, 1993).

In this study, we use bank branch density as a measure of financial sector outreach and examine the mechanisms through which financial outreach can promote economic growth. Specifically, we investigate both theoretically and empirically whether financial outreach fosters economic growth by increasing bank deposits. Additionally, we account for the roles of population density and the development of digital financial outreach.

Bank branches are instrumental in enabling users to deposit and withdraw cash from their accounts. Baumol (1952) argues that the optimal level of cash holding depends on the opportunity cost of holding cash and the transaction costs associated with withdrawing it. Higher transaction costs—such as time, effort, and transportation expenses—lead to increased cash holdings as individuals seek to minimize the frequency of bank visits. Financial outreach reduces these transaction costs by increasing the accessibility of banking services. In regions with lower bank branch density, households are more likely to hold cash rather than deposit it in banks due to higher implicit costs of accessing financial services. By contrast, greater financial outreach, characterized by a higher density of bank branches, reduces the costs of withdrawing cash, encouraging households to transition from holding cash to maintaining deposits in banks. Figure 1 illustrates this relationship by plotting the ratio of hard currency in circulation to the sum of hard currency and checkable deposits (M0/M1) against financial outreach (branch density) in China between 2005 and 2015. The figure demonstrates a significant negative association (slope==-0.0042***, R^2=0.69). This finding indicates that lower financial outreach is associated with a higher reliance on physical cash, where currency in circulation constitutes a larger share of the money supply. By contrast, regions with greater financial outreach exhibit a marked decline in cash holdings, reflecting a stronger preference for bank deposits.

[Insert Figure 1 here]

Local bank deposits can further influence local economic growth through the loans facilitated by banks (Becker, 2007; Butler and Cornaggia, 2011). Banking activities, such as bank deposits and lending, are often geographically confined due to the segmented nature of banking markets. This segmentation arises from regulatory constraints, financial intermediation costs, information asymmetries, and the localized nature of banking relationships (Degryse and Ongena, 2004; Jerzmanowski, 2017; Eid et al., 2024).[1] By promoting local bank deposits, banks can increase loan availability, thereby stimulating investment and output, as many banks rely heavily on deposit financing. For example, Becker (2007) and Butler and Cornaggia (2011) provide compelling evidence from city- and county-level bank deposits, showing that local

[1] Such geographic segmentation is not unique to China but is also observed in developed countries, including the United States.

deposit supply positively impacts local economic outcomes.

Building on a simplified growth framework inspired by Pagano (1993), our model considers a bank that collects deposits from households and uses them to invest in physical capital, which in turn produces economic output.[2] Due to a cash-in-advance constraint (Lucas 1987), households should make decisions regarding optimal cash holding and optimal frequency of withdrawing cash to manage expenses. In this context, we identify two types of transaction costs associated with withdrawing cash. The first is transportation cost, which decreases as bank branch density increases. The second is waiting cost, which is inversely related to branch density but positively associated with population density. We derive the analytical solution for balancing economic growth rates within this framework and establish the indirect effect of financial outreach on economic growth through its impact on bank deposits. Notably, the effect of financial outreach on deposit accumulation is more pronounced in regions with higher population density and less development of technology-based financial services.

We extend our theoretical framework to empirically test the relationship between financial outreach and economic growth in China. Following Zhang *et al*. (2012), we construct a panel data set comprising 281 prefecture-level cities over the period 2006–2011 in China, including novel bank branch density data sourced from the China Banking Regulatory Commission. In a spirit similar to Beck *et al.* (2007b), we use the ratio of the number of city-level bank branches to the city's area as a proxy for financial outreach. Using a two-step system GMM approach, we estimate the effect of financial outreach on bank deposits and economic growth. The results indicate that the positive effect of financial outreach is both statistically and economically significant. Specifically, a 10% increase in financial outreach leads to a 15.3% rise in bank deposits and a 7.16% increase in economic growth, measured as real per capita gross regional product (GRP) growth. These findings strongly corroborate the conclusions drawn from our theoretical model.

Employing the mediation analysis framework proposed by Baron and Kenny (1986), we find that bank deposits serve as a key channel through which financial

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[2] In a standard setup, banks issue loans to finance investments. However, our framework simplifies the bank's role by focusing solely on deposits and capital investment, where the bank directly invests in physical capital.

outreach influences economic growth. Furthermore, our analysis reveals significant regional heterogeneity: the effect of financial outreach on deposits is stronger in western and central regions, where financial access remains more limited. We also find that the "Big Five" banks[3] and rural financial institutions play a particularly prominent role in delivering financial services. Additionally, we uncover a substitution effect of digital financial outreach on conventional financial services. Specifically, as technology-based financial services expand, the impact of financial outreach on bank deposits and economic growth diminishes, suggesting that digital financial innovations can offset some of the benefits traditionally associated with physical bank branches. Our results are robust to a variety of model specifications and alternative estimation methods, further validating the strength and consistency of our findings.

Our paper makes an important contribution to the finance-growth literature in several key ways. First, while prior studies have largely focused on the impact of financial depth on economic growth (Levine, 2005), this paper offers a novel perspective by examining the role of financial outreach—the breadth of financial services—and identifying the mechanisms through which it influences economic growth. To the best of our knowledge, this is the first study to theoretically and empirically analyze the impact of financial outreach on economic growth. Second, our paper addresses an important gap in the literature by evaluating the role of digital financial technology in shaping financial access. Our findings reveal a substitution effect whereby digital financial outreach increasingly offsets the role of traditional physical financial outreach, particularly as technology-based financial services develop.

Furthermore, using Chinese prefecture-level data, our empirical analysis contributes to the ongoing discourse on the finance-growth puzzle in China. Despite being one of the largest and fastest-growing economies in the world, China's predominantly bank-based financial system is often characterized as inefficient (Allen et al., 2005).[4,5] China presents a unique case that challenges the positive correlation

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[3] China's banking sector is dominated by the "Big Five" state-owned commercial banks, which are the Bank of China (BOC), the People's Construction Bank of China (PCBC), the Agriculture Bank of China (ABC), the Industrial and Commercial Bank of China (ICBC), and Bank of Communications (BoCom).

[4] As of 2017, around 225 million adults—nearly one-fifth of the adult population—lacked formal bank accounts (Demirguc-Kunt et al. 2017).

[5] The dominance of state-owned banks also causes a massive misallocation of financial resources in China, as these banks have a preferential policy of lending to state-owned enterprises (SOEs), which

between financial development and economic growth (Allen *et al.* 2005; Guariglia and Poncet 2008; Hasan *et al.* 2009; Guariglia and Yang 2016). To unravel the complexities of this finance-growth paradox in China, prior research has explored alternative financial channels such as internal finance, informal finance, and foreign direct investment for China's rapid growth (Cull et al., 2009; Guariglia et al., 2011; Huang et al., 2016). Our paper distinguishes its

elf from previous studies by investigating the indirect effects of financial outreach on economic growth through its impact on bank deposits, offering new perspectives and insights into this ongoing enigma.[6]

From a more specific viewpoint, our paper relates to the work by Bhattarai (2015), who focuses on the difference between the actual financial deepening ratios (AFDR) and the optimal financial deepening ratios (OFDR), stressing that China's relatively prudent financial deepening has contributed to its high economic growth. Our paper also provides complementary evidence to the work by Zhang *et al.* (2012), who find a positive impact of financial development on economic growth based on city-level data.

The remainder of the paper is organized as follows. Section 2 documents the full theoretical model and develops our hypotheses. Section 3 presents the empirical strategy. Section 4 presents the dataset and summary statistics. Section 5 provides an analysis of the regression results and the robustness checks. Section 6 concludes.

2. Theoretical model and hypotheses development

Building on general equilibrium models (Mercenier and Srinivasan 1994; Altig et al. 1995; Ginsburgh and Keyzer 1997), we develop a tractable growth model with a financial sector that incorporates households' decisions on cash holdings and cash withdrawals.[7] We consider an economy with two sectors—households and banks.

crowds out the access to credit for SMEs (small- and medium-sized enterprises) and the private sector.

[6] One notable consequence of limited access to formal financial markets is the prevalence of precautionary savings among Chinese households. According to the OECD (2023), household savings in China have been on a consistent upward trend since the early 1990s, exceeding 30% of disposable income since 2004 and peaking at around 35% in 2019. In stark contrast, household savings rates in the United States and the European Union averaged approximately 6.7% and 6.5%, respectively, between 2000 and 2020. These elevated savings levels can play a critical role in driving China's investment-led growth (Lugauer et al., 2019).

[7] Here, we present a simplified model to illustrate the main intuition. To facilitate analysis and ensure tractability, we introduce several ad hoc assumptions. In Appendix B, we extend the framework to incorporate households' cyclical cash withdrawal behavior within a continuous-time growth model. In

Banks receive deposits from households, which in turn use them for investments and production.

2.1. Banks

Following Pagano (1993), the bank uses its accumulated capital stock (K_t) to produce output (Y_t), following the "AK" production function:

$$Y_t = AK_t \tag{1}$$

where Y_t represents output, K_t is capital stock, and A is a constant productivity parameter that reflects the level of technology. This production function exhibits increasing returns to aggregate capital in the economy.

The "AK" production function can be seen as an extension derived from two types of growth models. First, as in Romer's (1989) model, we consider N identical firms in an economy. Each firm produces output $y_t = Bk_t^{\alpha}$, where k_t is the capital of each firm. B is an exogenous parameter for each firm, which is influenced by the aggregate capital stock, i.e., $B = Ak_t^{1-\alpha}$. Then, the aggregate output can be expressed as $Y_t = Ny_t = AK_t$. Second, following Lucas's (1987) growth model, capital is a composite of physical capital and human capital. If both types of capital accumulate under identical technology, the resulting production function also takes the form of AK.

At the beginning of each period, the bank's balance sheet in our model can be expressed as:

$$K_t = E_t + D_{t-1} \tag{2}$$

where E_t is the bank's equity (net worth) and D_{t-1} represents the deposits collected from households in the prior period.[8] These deposits are entirely allocated to finance investments (I_{t-1}), i.e., $I_{t-1} = D_{t-1}$.

The capital stock is accumulated as:

$$K_t = K_{t-1}(1-\delta) + I_{t-1} \tag{3}$$

where δ is the depreciation rate. This implies that the bank's equity capital (E_t) is equal to the last period's capital stock after depreciation, i.e., $E_t = K_{t-1}(1-\delta)$.

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this extended setup, households are endowed with a utility function, and their consumption and cash withdrawal decisions are derived through intertemporal optimization. Numerical simulations confirm that the results remain robust and valid in the continuous-time model with endogenous consumption.

[8] In a standard setup, the bank's balance sheet would be represented as: $L = E+D$, where L is the stock of loans, D is the stock of deposits and E is equity capital. In contrast, our framework simplifies the bank's role by eliminating loans and focusing solely on deposits and capital investment.

The bank produces output (Y_t) using the "AK" production function: $Y_t = AK_t$. After covering investment costs (I_{t-1}) and paying interest on deposits ($D_{t-1}R$), the bank's profits (π_t) are given by

$$\pi_t = Y_t - D_{t-1}(1 + R) \tag{4}$$

where R is the deposit interest rate set by the bank, which we assume to be an exogenous constant. The profits are subsequently transferred to households in a lump sum at the end of each period.

Therefore, this framework demonstrates that the bank collects deposits to finance investment, which accumulates into the capital stock and drives economic growth. By simplifying the bank's operations to focus on the relationship between deposits, capital, and output, the model captures the essence of how financial outreach promotes economic growth through deposits.

2.2. Households

Households own banks' profits, consume goods, and deposit their savings in banks. Following Pagano (1993), we assume that the representative household consumes C_t at a constant consumption rate $c = C_t/Y_t$, which implies a constant saving rate.

In a traditional monetary economy where everyone is subject to a cash-in-advance constraint (Lucas and Stokey 1987), all goods should be paid by cash, requiring households to hold a minimum amount of hard currency to meet their consumption needs. However, with the rapid development of technology-based financial services—such as online payments via the Internet and mobile phones—households no longer need to withdraw excessive cash in advance. Instead, a fraction (α) of total consumption can be paid using online financial services, while the remaining portion must still be settled in cash. The parameter α (ranging from 0 to 1) reflects the development level of technology-based financial services.

Assume that households' consumption is continuously and evenly distributed during period t. As a result, households tend to deposit most of their savings in banks at the beginning of the period and hold only a small amount of cash. During this period, they withdraw some of their deposits to meet consumption needs once the cash in hand is depleted.

The optimization problem of the representative household involves choosing the optimal frequency of withdrawals to minimize the combined transaction costs of deposit withdrawals and the opportunity costs of holding cash (Baumol 1952). Transaction costs include both transportation and waiting costs. Intuitively, the average distance from households to the nearest bank branches is negatively associated with bank branch density (ρ). Thus, the transportation cost of withdrawing deposits from banks is $\theta_1 = a/\rho$, and for some, $a > 0$. Moreover, the waiting cost is positively associated with the average number of customers per branch and negatively associated with the bank branch density. Let v denote population density. Then, the waiting cost of making a withdrawal from a deposit account can be expressed as $\theta_2 = vb/\rho$, and for some, $b > 0$. Thus, the total transaction costs are $\theta = \theta_1 + \theta_2$. The opportunity costs of holding cash are equal to the deposit interest rate R, which we assume to be constant for simplicity.

Now, assume that the representative household evenly withdraws the deposits from banks m times per period t. Each time, the deposit amount decreases by $1/m$, where the interest rate is R/m. Then, the cost function for a unit of consumption of the representative household is

$$\min_{m}(1-x)\left\{m\theta - \frac{1}{m}\sum_{i=1}^{m-1}\frac{iR}{m}\right\} \tag{5}$$

Eq. (5) shows us both the transaction costs and the opportunity costs. The first-order condition suggests that the optimal frequency of deposit withdrawals is

$$m_t^* = \sqrt{\frac{R}{2\theta}} = \sqrt{\frac{\rho R}{2(a+bv)}} \tag{6}$$

The optimal level of cash holdings is

$$M^* = \frac{1-x}{m^*} = (1-x)\sqrt{\frac{2(a+bv)}{\rho R}} \tag{7}$$

Eqs. (6) and (7) show that households' optimal level of cash holdings (optimal frequency of deposit withdrawals) is negatively (positively) associated with bank branch density.

Let D_t denote average bank deposits during period t. The households' resource constraint is

$$C_t + D_t + m_t^*\theta(1-x)C_t = (1+R)D_{t-1} + \pi_t \tag{8}$$

where $m_t^*\theta(1-x)C_t$ is the total transaction costs associated with cash withdrawals.

2.3. Equilibrium

Combining the resource constraints of both households and banks, we have the market-clearing condition:

$$Y_t - C_t = I_t + (1 - x)m^*\theta C_t \tag{9}$$

The left-hand side of Eq. (9) represents the total financial resources (savings) available for investment. The right-hand side of Eq. (9) is the sum of investments and the transaction costs of withdrawing cash. Because transaction costs are negatively associated with financial outreach, higher financial outreach reduces these costs, enabling more financial resources to flow into the financial system and be transformed into deposits. This, in turn, promotes investment. If financial outreach increases to infinity ($\theta = 0$) and technology-based financial services are fully developed ($x = 1$), the transaction costs will converge to zero. In this case, total savings would equal investment, and the model collapses to the standard Solow growth model.

Combining Eqs. (1), (4), and (9), we can derive the steady-state growth rate:

$$g = \frac{Y_{t+1}}{Y_t} - 1 = \frac{K_{t+1}}{K_t} - 1 = A\frac{I_t}{Y_t} - \delta = A\left[(1-c) - (1-x)c\sqrt{\frac{(a+vb)R}{2\rho}}\right] - \delta \tag{10}$$

Differentiating Eq. (10), we get $dg/d\rho > 0$. This suggests that the effect of financial outreach on economic growth is positive. Thus, we propose our first hypothesis as follows:

H1*: An improvement in financial outreach promotes the formation of deposits, thereby stimulating economic growth.*

Second, from Eq. (10), we can also derive $\mathrm{d}^2 g/(\mathrm{d}\rho \mathrm{d}v) > 0$, which means the effect of financial outreach on economic growth is non-linear, and it is more pronounced when the population density is high. Thus, we can propose our second hypothesis as follows:

H2: *The effects of financial outreach on deposits and economic growth increase with regional population density.*

These hypotheses highlight two distinct channels through which financial outreach promotes deposit formation and economic growth. The first channel operates through the reduction of transportation costs. An increase in bank branch density reduces the distance between households and their nearest bank branch, thereby lowering transportation expenditures. The second channel works through the reduction of waiting costs. A greater number of bank branches decreases the number of customers served per branch, thus reducing waiting times for financial services. This effect is influenced by both bank branch density and the region's population density.

Third, from Eq. (10), we can also derive $\mathrm{d}^2 g/(\mathrm{d}\rho \mathrm{d}x) < 0$, which suggests that the effect of financial outreach on economic growth is less pronounced in cities with greater development of technology-based financial services. This leads to our third hypothesis:

***H3**: The effects of financial outreach on deposits and economic growth decrease with the development of technology-based financial services.*

This hypothesis suggests the substitution effect of technology-based financial services (e.g., digital financial outreach) for traditional financial outreach. The advancement of technology-based financial services provides households with alternatives such as online payments, peer-to-peer lending, and digital investments, which reduce the need for physical cash and branch-based transactions. Consequently, the positive effect of financial outreach on economic growth weakens in regions where technology-based financial services are more developed.

3. Model specifications

3.1. Baseline specification

To test Hypothesis (1), we first investigate the relationship between financial outreach and deposits using the following model:

$$Deposit_{i,t} = \beta_1 FOutreach_{it} + \gamma X_{it} + v_i + u_t + \varepsilon_{it} \quad (11)$$

where subscripts i and t index cities and years, respectively. Deposits ($Deposit$) are measured as the logarithm of the deposits per capita in a given city-year. Following Beck *et al.* (2007b), financial outreach ($FOutreach$) is measured as the logarithm of the ratio of the number of city-level bank branches to the city's area (per 1000 square kilometers). In a robustness check, we also use another measurement of financial outreach proposed by Beck *et al.* (2007b)—that is, the logarithm of the ratio of the number of city-level bank employees to the city's population. According to our model and Hypothesis (1), the coefficient on β_1 in Eq. (11) is expected to be positive, suggesting that financial outreach is positively associated with deposits.

X represents a set of control variables following Zhang *et al.* (2012), which consists of *CPI* (consumer price index); *FDI* (the ratio of foreign direct investment to GRP); *Education* (*Edu*, the ratio of the number of secondary school students to the population); *Post & Telecom* (the ratio of postal and telecommunication business volume to GRP), *Road density* (the ratio of total road length in kilometers per 1,000 km^2), *Government Size* (*Gov*, the ratio of government expenditure to GRP), and *State-owned investment share* (*SOE*, the ratio of state-owned entities to total fixed asset investments).[9]

The error term in Eq. (11) consists of three components. v_i and u_t are city- and time-specific effects, respectively, which we control for by including city and year dummies. The city fixed effects capture the idiosyncratic characteristics of the city, while the year fixed effects capture cyclical economic factors, which commonly affect deposits in an economy. $\varepsilon_{i,t}$ is the error term.

To further test Hypothesis (2), we augment Eq. (11) by including the interaction term between financial outreach ($FOutreach$) and population density (PD). We estimate the following model:

$$\begin{aligned} Deposit_{i,t} = \beta_1 FOutreach_{it} + \beta_2 FOutreach_{it} \times PD_{i,t} \\ +\beta_3 PD_{i,t} + \gamma X_{it} + v_i + u_t + \varepsilon_{it} \end{aligned} \quad (12)$$

Population density is measured as the logarithm of the number of people per square kilometer. We expect the interaction term (β_2) to be significantly positive, which suggests the presence of the waiting cost reduction channel. In densely populated cities, strengthened financial outreach tends to reduce the average wait time for households accessing banking services.

[9] We take the natural logarithm of these variables. The definitions of all variables used in the paper can be found in Appendix A. Similar results are obtained when we do not control for the information set in our regression models.

3.2. Mediator effect of financial outreach

Further, following Levine et al. (2000) and Beck and Levine (2004), we examine the effect of financial outreach on economic growth by estimating the following dynamic model:

$$\Delta ln\, Y_{it} = \beta_1\, ln\, Y_{i,t-1} + \beta_2 FOutreach_{it} + \gamma X_{it} + v_i + u_t + \varepsilon_{it} \quad (13)$$

$\Delta ln\, Y_{it}$ is the growth rate of real per capita gross regional product (GRP). We include the initial real GDP per capita in our model to control for convergence. We expect the coefficient β_1 to lie between -1 and 0, suggesting a tendency toward convergence. The information set (X) includes the same variables as those in Eq. (11), and we also control for the year fixed effects and city fixed effects. We expect the coefficient β_2 in Eq. (13) to be positive, suggesting that improvements in financial outreach contribute to economic growth (Hypothesis (1)).

Next, following Baron and Kenny (1986), we investigate whether $Deposit$ meditates the effect of financial outreach on economic growth. To this end, we include both financial outreach and deposits in the model:

$$\begin{aligned} \Delta ln\, Y_{it} = \beta_1\, ln\, Y_{i,t-1} + \beta_2 FOutreach_{it} \\ + \beta_3 Deposit_{it} + \gamma X_{it} + v_i + u_t + \varepsilon_{it} \end{aligned} \quad (14)$$

If bank deposits completely mediate the impact of financial outreach on economic growth, we expect the coefficient on deposits (β_3) in Eq. (13) to be significantly positive but the coefficient on financial outreach (β_2) becomes insignificant. Additionally, we include the interaction term of financial outreach and population density into Eqs. (13) and (14) to investigate the moderator effect of population density on the relationship between financial outreach and economic growth. Consistent with the conclusions of our theoretical models, we expect the coefficient on the interaction term to be significantly positive in Eq. (13), indicating a stronger impact of financial outreach on economic growth in densely populated areas. However, we do not expect the interaction term to be significant in Eq. (14), as the mediator (deposits) should account for this effect.

3.3. Moderator effect of digital finance

To test Hypothesis (3), we incorporate the interaction term of financial outreach and the indicator of technology-based financial services into Eqs. (11) and (13). This allows us to investigate the moderating effect of technology-based financial services on the relationship between financial outreach, deposits, and economic growth. We use Internet access (*InternetAccess*) as a proxy for technology-based financial services, which is measured as the ratio of the number of registered Internet users to the population in the province. With the development of Internet techniques, digital financial outreach has an increasingly significant substitution effect on traditional financial outreach. The demand for cash is declining, so individuals rely less on financial services offered by bank branches. As a consequence, the effects of financial outreach on deposits and economic growth are expected to be smaller in those provinces with greater access to the Internet. For a robustness concern, we also use two alternative proxies of digital finance: *InternetBuy*—the ratio of the total amount of online shopping transactions to gross domestic product (GDP), and *InternetPay*—the ratio of the total amount of online payments to GDP.

3.4. System generalized method of moments (GMM) estimator

The connection between financial development and economic growth is likely to be endogenously determined (Greenwood and Jovanovic 1990; Rajan and Zingales 1998; Yang *et al.* 2022). There is a possibility that economic outcomes that enhance resource availability may promote deposits, thereby influencing the demand for financial outreach. To account for the possible endogeneity of the regressors, we estimate all the models by the system Generalized Method of Moments (GMM) estimator with Windmeijer (2005) finite-sample correction, developed by Arellano and Bover (1995) and Blundell and Bond (1998).[10] We treat all independent variables, except year dummies, as potentially endogenous. Levels of these variables lagged twice and further are used as instruments in the first-differenced equations. Lagged first differences of these same variables are used as additional instruments in the level equations.[11] To mitigate weak instrument and overfitting concerns, we follow Roodman (2009) by limiting the lag depth of endogenous variables to a maximum of

[10] In the online Appendix C, we provide a summary of the finance-growth literature that employs various methodologies.

[11] Lagged differences can serve as weak instruments for levels, particularly in cases of low variability in the differenced series or in relatively small samples. To address this issue, the system GMM estimator introduces additional instruments (lagged differences) that are often stronger predictors of the endogenous variables in levels than lagged levels are for differenced variables.

four periods and collapsing the instrument set. Specifically, we began with instruments lagged by two periods and incrementally extended the lag depth to four periods, collapsing the instrument sets at each step until satisfactory test results were obtained. In our study, none of the *AR(2)* and *Hansen* statistics are significant, suggesting that the instruments are valid and/or the model specifications are correct.[12]

4. Data and summary statistics

4.1. Data

The primary data used in this study is drawn from the *China City Statistical Yearbook* and consists of 281 Chinese cities over the period 2006–2011. We source bank branch information manually from the hard copies of the filings to the China Banking Regulatory Commission. We winsorize observations in the 1% tails of the main variables in our regressions to minimize the potential influence of outliers. The city-year data in our final panel consists of 1,239 firm-year observations.

4.2. Summary statistics

Table 1 shows the summary statistics of the main variables in our model. Column 1 refers to the entire sample, columns (2)–(4) to the eastern, central, and western subsamples, categorized by geographic location, respectively.[13] On average, there are around 45 bank branches per 1000 square kilometers, corresponding to a logarithmic value of 3.799 (*Foutreach*). The logarithm value of *Foutreach2* is -6.230, suggesting that there are around 197 bank employees per 100,000 people. Based on the Global Financial Development Database from the World Bank, the number of commercial bank branches per 1,000 square kilometers in China in 2014 was 28.1, which is more than that of the world average (19.6), the United States (11.3), and Japan (19.0).[14] In

[12] The use of the system GMM estimator, which employs lagged observations of explanatory variables as instruments, is a standard approach in dynamic panel models for analyzing economic growth. While it is acknowledged that these instruments can sometimes be weak, this method has been widely applied and supported in prior research (Levine et al., 2000; Levine, 2005; Arcand et al., 2015; Acemoglu et al., 2019).

[13] According to the Chinese National Bureau of Statistics, the 31 provinces can be split into three categories by means of geography: Eastern (Beijing, Fujian, Guangdong, Hainan, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, and Zhejiang); Central (Anhui, Heilongjiang, Henan, Hubei, Hunan, Jiangxi, Jilin, Neimenggu, and Shanxi); and Western (Chongqing, Gansu, Guangxi, Guizhou, Ningxia, Qinghai, Shaanxi, Sichuan, Xinjiang, and Yunnan).

[14] In our study, we have a broader definition of financial outreach, which includes commercial banks

addition, it appears that eastern regions have more financial outreach than central and western regions across both measures of financial outreach, suggesting eastern regions have a more developed financial system. Similar to financial outreach, the population density (*PD*), foreign direct investment (*FDI*), education (*Edu*), road density (*RoadDensity*), and Internet access (*InternetAccess*) are also greater in eastern regions than in western and central regions. Since China's accession to the World Trade Organization in 2001, eastern regions have benefitted the most from the open-door policy and the coastal development strategy. In contrast, government spending (*Gov*) and state-owned shares (*SOE*) are higher in central and western regions. This disparity reflects the regional development policies introduced by the Chinese government to address economic imbalances, such as the "Western Development Strategy," the "Northeast Revival Strategy," and the "Rise of Central China Strategy."

[Insert Table 1 here]

Figs 2a and 2b present the scatter plots of deposits per capita and real GRP per capita against financial outreach across cities over the period from 2006 to 2011, respectively. A visual inspection of these two plots suggests that financial outreach is significantly associated with deposits per capita as well as real GRP per capita, which is consistent with our hypotheses.

[Insert Figures 2a and 2b here]

5. Empirical results

5.1. Effect of financial outreach on deposits

Table 2 presents the system GMM estimates of the effect that financial outreach has on the formation of deposits. In column (1), the coefficient on financial outreach (*FOutreach*) is positive and significant at the 1% level, which suggests that financial outreach is positively associated with bank deposits. In other words, bank deposits tend to be higher in cities with more bank outreach. This result provides support for

and rural financial institutions.

Hypothesis (1), suggesting that higher financial outreach reduces transaction costs, thus decreasing households' cash holdings and increasing bank deposits. This finding is in line with Demirguc-Kunt *et al.* (2017), who point out that most deposits and withdrawals in developing economies are made at bank branches. It is also consistent with Bhattarai (2015), who argues that financial markets facilitate capital accumulation by channeling resources from risk-averse savers to risk-neutral borrowers. Taking into account the log form of both the dependent and the independent variables, the magnitude of the coefficient on financial outreach suggests that a 10% increase in financial outreach (i.e., the number of city-level bank branches) leads to a 15.3% increase in real deposits per capita, holding all other variables constant.

[Insert Table 2 here]

In column (2), we include population density (PD), which does not alter the significance and sign of the financial outreach coefficient. The coefficient on population density is not significant, suggesting that population density has no direct impact on deposits per capita. In column (3), we include the interaction term between financial outreach ($FOutreach$) and population density (PD) in the model. We find that the coefficient on the interaction term (0.127) is significantly positive, although the standalone coefficient on financial outreach becomes insignificant.[15] Specifically, a 10% increase in population density is associated with a 1.27% enhancement in the positive impact of financial outreach on real bank deposits per capita. These suggest that population density moderates the positive effect of financial outreach on bank deposits. In line with Hypothesis (2), improvements in financial outreach tend to reduce wait times at banks in densely populated cities, encouraging households to deposit more savings.

5.2. Heterogeneous effects of financial outreach on deposits

We further examine the heterogeneous effects that the branch density across

[15] The insignificant coefficient on financial outreach in column (3) indicates that financial outreach does not affect deposits when population density is zero. However, a population density value of zero is not intrinsically meaningful in this context.

different types of banks and regions has on bank deposits. We first compare the different ownership structures of banks, which is crucial given the country's historical reliance on a centrally planned system. There is a significant government stake in China's banking sector (Elliott and Yan 2013). Based on the ownership, size, and service types, we classify Chinese banks into four categories: 1) the five largest state-owned listed commercial banks (the "Big Five"); 2) Twelve joint-venture listed commercial banks; 3) city commercial banks; and 4) rural financial institutions. The "Big Five" are controlled by the central government and are heavily regulated and influenced by the central bank. For instance, the central bank explicitly sets primary deposit and lending interest rates, loan volume targets, and specific loan allocation. City commercial banks, in contrast, are primarily owned by local governments. Joint-venture listed commercial banks are more liberalized, facing less intervention from central and local governments. Meanwhile, rural financial institutions, which focus on rural areas and agriculture, primarily provide basic financial services.

[Insert Table 3 here]

As Panel A of Table 3 shows, we can find that the effect of financial outreach on bank deposit formation is most pronounced for rural financial institutions, with a coefficient of 1.277 significant at the 1% level. This is followed by the "Big Five," with a coefficient of 1.076.[16] These results reflect the dominance of the "Big Five" and rural financial institutions in China's bank-based financial system. During the sample period (2006–2011), these two categories accounted for 38.4% and 39.8% of total branch density in China, respectively. Additionally, the "Big Five" held more than half of the market share in assets and deposits. In rural areas, rural financial institutions play a pivotal role in providing financial services.

We also explore the regional heterogeneity in the effects of financial outreach on bank deposits. Following Qin and Song (2009), we classify China's 31 provincial-level units into three regions: eastern, central, and western. This classification accounts for China's vast geographical diversity and the lack of economic integration across regions,

[16] For brevity, we do not report the estimates of other control variables. The full results are given in Tables D1 and D2 of the online appendix.

which significantly affects financial sector development.

As shown in Panel B of Table 3, financial outreach does not have a statistically significant impact on bank deposits in eastern regions but exhibits a significant positive impact in central and western regions. This can be attributed to the relatively poor financial infrastructure and limited availability of technology-based financial services in these areas. In regions with underdeveloped financial systems, the distance to a bank branch plays a crucial role in facilitating deposits and withdrawals. Furthermore, financial outreach has a more pronounced effect in densely populated cities within central and western regions. Increased branch density in these areas significantly reduces transaction costs, particularly waiting times, thus encouraging greater deposit activity.

5.3. Mediator effect of deposits

Table 4 shows the estimates of the effect of financial outreach on economic growth. In column (1), the coefficient on financial outreach is 0.716, which is significant at the 1% level. This suggests that financial outreach promotes economic growth. A 10% increase in financial outreach is associated with a 7.16% increase in the growth of real GDP per capita, holding all other independent variables constant. For the sake of comparison, according to the World Bank, China's average growth of per capita gross domestic product between 2012 and 2016 was 6.76%. Thus, the estimated 7.16% increase is both statistically and economically significant. In column (2), we include the interaction term between financial outreach and population density. The coefficient on the interaction term is positive and significant (0.071), providing evidence of a moderating effect and supporting Hypothesis (2). This suggests that the positive impact of financial outreach on economic growth is amplified in regions with higher population density.

[Insert Table 4 here]

To examine the mediator effect, we include both financial outreach and deposits as explanatory variables in column (3). As expected, the coefficient on deposits is significantly positive, while the coefficient on financial outreach becomes insignificant.

This result suggests that deposits mediate the relationship between financial outreach and economic growth. In column (4), we further control for population density and its interaction term with financial outreach. The coefficient on the interaction term is insignificant, further supporting the mediator effect. These findings indicate that deposits fully mediate the impact of financial outreach on economic growth. In other words, financial outreach contributes to economic growth indirectly through its effect on deposit formation.

5.4. Substitution effect of digital financial outreach

To test Hypothesis (3), we introduce the variable of Internet access into the baseline model. We measure digital financial outreach using the number of Internet users in a given province. Table 5 shows the estimates of the GMM approach.[17] In column (1), the coefficient on financial outreach remains significantly positive, while the coefficient on Internet access is not statistically significant. This indicates that Internet access does not directly correlate with deposits. Moreover, the results show that the positive effect of financial outreach on deposits persists even after controlling for Internet access. In column (2), we include an interaction term between financial outreach and Internet access. The coefficient on the interaction term is -0.761 and significant at the 1% level. This suggests that the positive effect of financial outreach on deposits diminishes in cities with high Internet access. In other words, technology-based financial services or digital financial outreach can substitute for traditional financial outreach in promoting deposit formation. Digital financial services, such as online and mobile payments (e.g., AliPay, WeChat Pay, Apple Pay), reduce the need for individuals to visit bank branches for withdrawals or other transactions. These services enable individuals and small businesses to connect to a cashless world, thereby reducing the reliance on physical bank branches in cities with more advanced digital financial services.

[Insert Table 5 here]

In column (3), we regress economic growth on branch density while controlling

[17] For brevity, the table reports only the coefficients on the main explanatory variables.

for Internet access. In column (4), we introduce the interaction term between financial outreach and Internet access to re-examine the substitution effect of digital financial outreach on economic growth. Across both columns, the coefficients on financial outreach remain significantly positive, indicating that financial outreach continues to contribute to economic growth. However, Internet access does not show a direct correlation with economic growth. Notably, the coefficient on the interaction term between financial outreach and Internet access in column (4) is -0.220 and significant at the 5% level. This finding suggests that the presence of more advanced digital financial infrastructure reduces the impact of physical financial outreach on local economic growth. These results align with Hypothesis (3), highlighting the nuanced interplay between digital and physical financial outreach in driving economic growth.

5.5. Further tests

To assess the robustness of our results, we use an alternative measure of financial outreach to re-estimate its effect on deposits and growth. In addition to a measure of geographic penetration of financial outreach (bank branch density), following Beck (2007b), we also measure the demographic penetration of financial outreach, which is defined as the ratio of the number of bank branch employees to the city's total population (*FOutreach2*). Table 6 presents the estimates. In column (1), financial outreach (*FOutreach2*) is shown to have a positive and significant impact on deposits. Column (2) includes an interaction term between financial outreach and population density, which is also significantly positive, suggesting that the effect of deposits is more pronounced in densely populated cities. In column (3), we find a significant and positive impact of *FOutreach2* on economic growth. However, when deposits are included in column (4), the effect of *FOutreach2* on economic growth is completely mediated. These results align with the baseline model and support our hypotheses regarding the moderator and mediator effects.

[Insert Table 6 here]

While the system GMM approach employed in this paper tend to address concerns of endogeneity between financial outreach and economic outcomes, we adopt a cautious instrumental variable (IV) approach to further mitigate potential concerns regarding endogeneity and reverse causality. To this end, we re-estimate the empirical models presented in Table 7 using the two-stage least squares (2SLS) IV method. To use a source of exogenous variation in financial outreach, we instrument current financial outreach using bank branch density in 1937.[18] The instrument meets the criteria for validity as a good instrument. First, financial institutions established in earlier periods formed the foundation for current financial systems (Acemoglu *et al.* 2001), thereby satisfying the relevance condition. Second, regarding the exclusion restriction, the historical measure of bank branch density is unlikely to correlate with the error term in the second-stage regression equation. Bank branch density from 80 years ago should not directly affect current economic growth except through its influence on financial development.

[Insert Table 7 here]

The results in Table 7 are consistent with those of our baseline regressions, further confirming our hypotheses. In columns (1) and (3), the coefficients on financial outreach are significantly positive for deposits (1.050) and economic growth (0.079), respectively. Columns (2) and (4) show that the effect of financial outreach is more pronounced in densely populated areas and that bank deposits fully mediate the relationship between financial outreach and economic growth. To validate the instruments, we follow Stock and Yogo (2005) and report F-tests for the first-stage regressions, which confirm that the instruments are not weak. Additional tests, including the Cragg-Donald F statistic and the Anderson statistic, indicate that the model is identified and that the instruments are valid. These findings reinforce the robustness of our results, accounting for the potential endogeneity of financial development.

[18] The record of the bank density in 1937 is from the China Banking Yearbook, which was compiled by the Economic Research Department of the Bank of China.

We also use the average value of the independent variables in neighboring cities as instrumental variables. The intuition is that financial outreach and economic and financial factors in neighboring cities are likely to be related. However, it is doubtful that the economic growth or bank deposits in a given city can directly affect the average level of branch density in nearby cities. For example, the branch density in neighboring cities should impact deposits and economic growth in the city only through their correlation with the city's own branch density. Table D3 of the online appendix presents results similar to those of our baseline regression, which again confirms our hypotheses.

Finally, we test the robustness of our findings by using two alternative measures of technology-based financial services, as presented in Table D4 of the online appendix. First, given the fact that technology-based financial services facilitate online shopping, in columns (1) and (3), we use the ratio of online shopping transactions to GDP (*InternetBuy*) as a proxy for digital financial outreach. Second, in columns (2) and (4), we use the ratio of online payment transactions to GDP (*InternetPay*) as an additional proxy for digital financial outreach.[19] The results, summarized in Table D4 confirm the substitution effect of digital financial outreach. Columns (1) and (2) examine the impact of financial outreach on deposits, while columns (3) and (4) investigate its impact on economic growth. Across all columns, the coefficients on financial outreach are significantly positive, indicating its continued positive effect on both deposits and economic growth. However, the interaction terms between financial outreach and digital financial outreach (*InternetBuy* and *InternetPay*) are significantly negative.[20] These findings align with our hypotheses, demonstrating that technology-based financial services mitigate the impact of traditional financial outreach on deposits and economic growth. Digital financial services, such as online shopping and online payments, provide an effective alternative to traditional bank branches, reducing households' reliance on physical financial infrastructure.

6. Conclusions

[19] Due to the availability of data, we can only obtain the data at the country level.

[20] *InternetBuy* and *Internetpay* drop in the regressions due to multicollinearity.

This paper examines the effect of financial outreach on bank deposits and economic growth. We developed a tractable two-sector growth model incorporating household decisions on cash holdings and cash withdrawals. The model demonstrates that financial outreach fosters economic development by promoting bank deposit formation, with its indirect effects being more pronounced in densely populated regions. Two primary channels drive this process: the reduction of transportation costs and the reduction of waiting costs. Additionally, we highlight the substitution effect of technology-based financial services, which allow households to make online or mobile payments instead of relying on cash. Consequently, the effect of bank branch density on deposits and economic growth diminishes as technology-based financial services develop.

We test these theoretical predictions using novel city-level panel data from China spanning 2006–2011. Consistent with our model and hypotheses, we find that financial outreach impacts economic growth indirectly through bank deposits. Specifically, a 10% improvement in financial outreach leads to a 15.3% increase in real deposits per capita and a 7.16% increase in real per capita GRP growth. This effect is stronger in cities with higher population density and less developed technology-based financial services.

We also find that state-owned and policy-driven financial institutions, such as the "Big Five" banks and rural financial institutions, play a critical role in enhancing financial outreach in China. These institutions provide essential financial services, particularly in western and central regions where financial infrastructure and technology-based financial services are underdeveloped. Finally, our results are robust across various model specifications and estimation methods, including alternative measures of financial outreach and controls for potential endogeneity.

Our findings suggest that improving financial outreach yields substantial economic gains by enhancing deposit formation. Financial outreach has been a key factor in driving China's recent economic growth. However, inefficiencies in credit allocation and high levels of state ownership in China's banking sector have been longstanding challenges. Further liberalization of the financial system and expansion of financial service outreach—such as the 2004 interest rate ceiling deregulation and the 2009 bank entry deregulation—could deliver significant economic benefits.

Given that most deposits and withdrawals in emerging economies are conducted at physical bank branches (Demirguc-Kunt et al., 2017), our study highlights the broader importance of financial outreach for development. Policymakers should prioritize financial outreach to support economic growth in densely populated, underdeveloped regions with limited technology-based financial services. While emerging economies often lack sophisticated financial infrastructure, technological and other innovations can help bridge the gap by reducing the barriers posed by physical distance and enabling the creation of financial products and services from the ground up. Digital financial outreach, in particular, offers a cost-effective way to enhance financial inclusion. Therefore, integrating both physical and digital financial outreach into development strategies should be a key policy priority for emerging economies.

Our study has limitations. First, the coarse nature of the available data prevents us from analyzing how access to financial services impacts bank deposits at the individual level. Future research with granular deposit-level data could provide deeper insights into the finance-growth relationship. Second, our study does not account for informal finance, which plays a significant role in China's economic growth. For instance, households may engage in securities markets through shadow banking, which involves entities and activities outside the regular banking system. The growth of shadow banking may increase financial fragility and dampen the impact of financial outreach on deposit formation.

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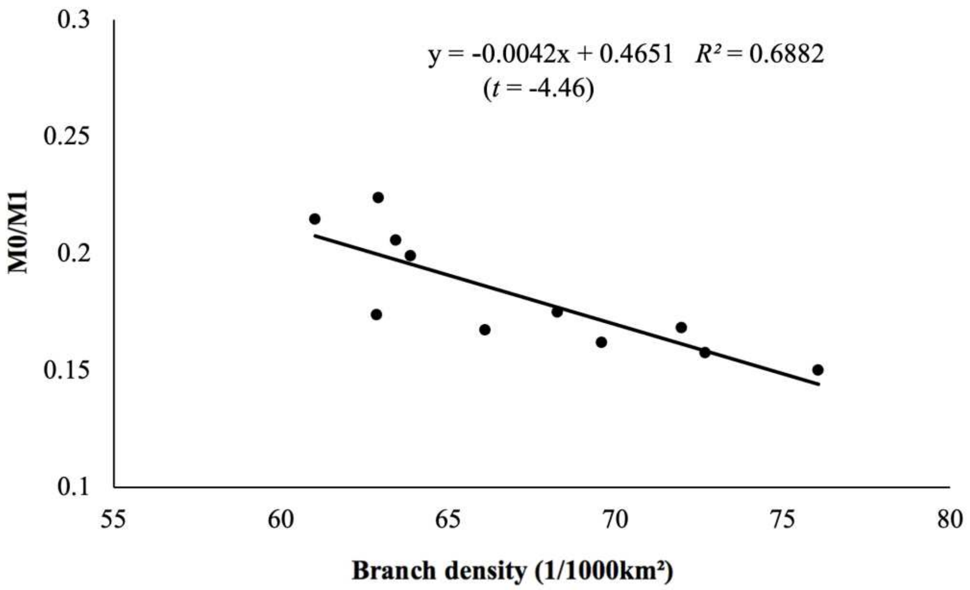

Fig. 1. The relationship between M0/M1 and financial outreach between 2005 and 2015 in China.

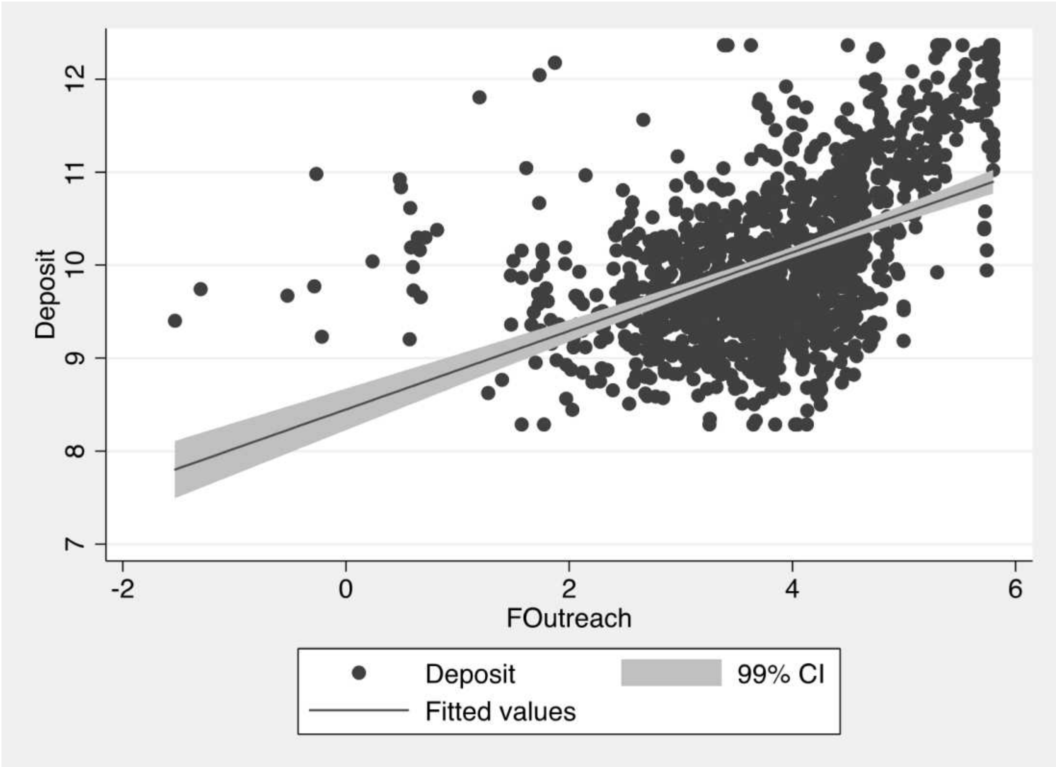

Fig. 2a. The relationship between deposits and financial outreach across cities between 2006 and 2011 in China.

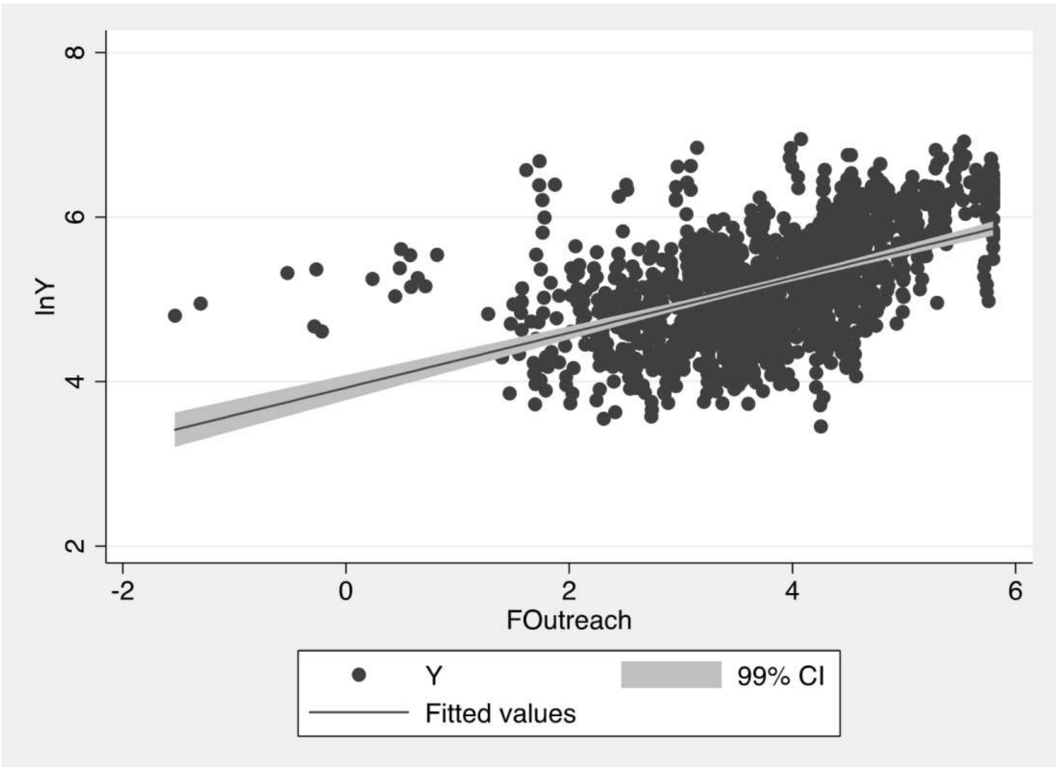

Fig. 2b. The relationship between GRP per capita and financial outreach across cities between 2006 and 2011 in China.

Table 1

Summary statistics.

	All	Eastern	Central	Western
ln*Y*	5.272	5.595	5.141	4.794
	(5.241)	(5.569)	(5.108)	(4.763)
Foutreach	3.799	4.179	3.583	3.322
	(3.834)	(4.220)	(3.617)	(3.463)
Foutreach2	-6.230	-6.076	-6.288	-6.475
	(-6.313)	(-6.150)	(-6.322)	(-6.557)
Deposit	10.053	10.374	9.786	9.793
	(9.910)	(10.217)	(9.705)	(9.671)
PD	5.721	6.044	5.561	5.275
	(5.908)	(6.215)	(5.685)	(5.388)
Gov	0.115	0.091	0.118	0.163
	(0.096)	(0.081)	(0.100)	(0.136)
FDI	0.020	0.027	0.019	0.007
	(0.013)	(0.02)	(0.014)	(0.003)
Edu	0.078	0.088	0.076	0.060
	(0.056)	(0.054)	(0.057)	(0.060)
Post&Telecom	0.056	0.055	0.061	0.049
	(0.047)	(0.05)	(0.049)	(0.036)
RoadDensity	6.691	6.827	6.649	6.459
	(6.841)	(6.911)	(6.866)	(6.616)
CPI	0.037	0.034	0.037	0.042
	(0.047)	(0.043)	(0.048)	(0.050)
SOE	0.294	0.247	0.292	0.405
	(0.293)	(0.229)	(0.291)	(0.415)
InternetAccess	0.237	0.298	0.188	0.184
	(0.228)	(0.303)	(0.192)	(0.19)
InternetPay	0.929	-	-	-
	(0.890)	-	-	-
InternetBuy	0.546	-	-	-
	(0.562)	-	-	-
Observations	1,239	559	430	250

Notes: This table reports mean and median (in parentheses) of key variables used in this paper. The detailed definitions of all variables are shown in Appendix A.

Table 2

Main regression: The effect of financial outreach on deposits.

	(1)	(2)	(3)
	$Deposit_{i,t}$	$Deposit_{i,t}$	$Deposit_{i,t}$
$FOutreach_{i,t}$	1.532^{***}	1.911^{***}	0.398
	(0.230)	(0.327)	(0.254)
$PD_{i,t}$		-0.719	-0.154
		(0.504)	(0.203)
$FOutreach_{i,t}*PD_{i,t}$			0.127^{***}
			(0.018)
$Gov_{i,t}$	-0.421	-0.078	-0.094
	(0.831)	(0.717)	(0.417)
$FDI_{i,t}$	-0.302	2.069	0.484
	(3.945)	(3.838)	(1.808)
$Edu_{i,t}$	0.418^{***}	-0.263	0.357^{*}
	(0.022)	(0.469)	(0.194)
$Post\&Tele_{i,t}$	-0.055	-0.050	0.103
	(0.046)	(0.035)	(0.318)
$Road_{i,t}$	-1.738^{***}	-1.206^{***}	-0.470
	(0.292)	(0.451)	(0.288)
$CPI_{i,t}$	-8.965	-9.171	-7.830^{*}
	(7.221)	(6.843)	(4.351)
$SOE_{i,t}$	-0.561	-0.360	-0.328
	(0.818)	(0.762)	(0.396)
City Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	1239	1239	1239
AR(2)	0.931	0.991	0.639
Hansen *p* -value	0.649	0.427	0.156

Notes: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript *i* indexes cities, and the subscript *t*, time, where $t = 2006–2011$. The dependent variable is the logarithm of bank deposits per capita. See Appendix A for the detailed definitions of all variables. *AR(2)* is a test for the second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen *J* test of over-identifying restrictions is distributed as Chi-square under the null of instrument validity. We treat all variables except year dummies as potentially endogenous variables. Levels of these variables dated *t-2* and further are used as instruments in the first-differenced equations, and the first-differences of these same variables lagged twice are used as additional instruments in the level equations. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3

The effect of financial outreach: Accounting for different types of banks and regions.

Panel A	*Deposit$_{i,t}$*			
	(1)	(2)	(3)	(4)
FO_big_five$_{i,t}$	1.076***			
	(0.198)			
FO_joint-equity$_{i,t}$		0.272***		
		(0.049)		
FO_city_banks$_{i,t}$			0.180**	
			(0.080)	
FO_argri_banks$_{i,t}$				1.277***
				(0.329)

Panel B	*Deposit$_{i,t}$*					
	Eastern		Central		Western	
	(1)	(2)	(3)	(4)	(5)	(6)
FOutreach$_{i,t}$	1.670	-0.462	0.484**	0.255	0.588**	0.260
	(1.188)	(4.083)	(0.209)	(0.174)	(0.243)	(0.163)
PD$_{i,t}$		0.406		-0.087		-0.290*
		(4.149)		(0.102)		(0.150)
*FOutreach*PD$_{i,t}$*		0.151		0.136***		0.147***
		(0.192)		(0.021)		(0.020)
City Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript *i* indexes cities, and the subscript *t*, time, where t = 2006-2011. The dependent variable is the logarithm of bank deposits per capita. See Appendix A for the detailed definitions of all variables. *AR(2)* is a test for the second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen *J* test of over-identifying restrictions is distributed as Chi-square under the null of instrument validity. We treat all variables except year dummies as potentially endogenous variables. Levels of these variables dated *t-2* and further are used as instruments in the first-differenced equations, and the first-differences of these same variables lagged twice are used as additional instruments in the level equations. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 4

The indirect effect of financial outreach on economic growth through deposits.

	(1)	(2)	(3)	(4)
	$\Delta \ln Y_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln Y_{i,t}$
$Deposit_{i,t}$			0.778**	0.570**
			(0.380)	(0.285)
$FOutreach_{i,t}$	0.716***	0.362	-0.523	0.204
	(0.251)	(0.612)	(0.611)	(0.430)
$FOutreach_{i,t}*PD_{i,t}$		0.071**		-0.026
		(0.035)		(0.036)
$PD_{i,t}$		-0.582		-0.268
		(0.865)		(0.541)
$\ln Y_{i,t-1}$	-0.724***	-0.618***	-0.716***	-0.623***
	(0.255)	(0.183)	(0.216)	(0.182)
$Gov_{i,t}$	-0.960	0.274	-0.430	0.039
	(1.785)	(0.628)	(1.621)	(0.656)
$FDI_{i,t}$	-1.383	0.776	1.185	2.451
	(2.841)	(3.067)	(3.229)	(1.930)
$Edu_{i,t}$	0.062**	-0.451	-0.267*	-0.450
	(0.027)	(0.798)	(0.154)	(0.541)
$Post\&Tele_{i,t}$	0.553	-0.621	-0.743	-0.009
	(0.881)	(1.186)	(1.024)	(0.017)
$Road_{i,t}$	-0.939**	0.284	0.644	0.149
	(0.382)	(0.641)	(0.681)	(0.401)
$CPI_{i,t}$	-13.456	-1.694	5.314	-0.113
	(8.206)	(5.488)	(6.675)	(4.032)
$SOE_{i,t}$	-1.094*	-1.130**	-0.513	-0.521
	(0.602)	(0.539)	(0.556)	(0.410)
City Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	1162	1156	1156	1156
AR(2)	0.285	0.130	0.363	0.196
Hansen *p* -value	0.307	0.339	0.751	0.454

Notes: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript *i* indexes cities, and the subscript *t*, time, where $t = 2006–2011$. The dependent variable is the growth rate of real per capita GRP. See Appendix A for the detailed definitions of all variables. *AR(2)* is a test for the second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen *J* test of over-identifying restrictions is distributed as Chi-square under the null of instrument validity. We treat all variables except year dummies as potentially endogenous variables. Levels of these variables dated *t-2* and further are used as instruments in the first-differenced equations, and the first-differences of these same variables lagged twice are used as additional instruments in the level equations. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5

The substitution effect of digital financial outreach on physical financial outreach.

	(1)	(2)	(3)	(4)
	$Deposit_{i,t}$	$Deposit_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln Y_{i,t}$
$FOutreach_{i,t}$	1.310***	1.357***	0.686***	0.419**
	(0.418)	(0.193)	(0.258)	(0.205)
$FOutreach_{i,t}$* $Internet\_Access_{i,t}$		-0.761***		-0.220**
		(0.293)		(0.108)
$Internet\_Access_{i,t}$	0.736	-1.571	0.665	0.146
	(1.102)	(1.239)	(0.723)	(0.534)
$\ln Y_{i,t-1}$			-0.640***	-0.517*
			(0.244)	(0.287)
City Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	1239	1239	1162	1162
AR(2)	0.931	0.805	0.231	0.339
Hansen *p* -value	0.474	0.881	0.791	0.183

Notes: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript *i* indexes cities, and the subscript *t*, time, where t = 2006–2011. The dependent variable is the logarithm of bank deposits per capita in columns (1) and (2), and the growth rate of real per capita GRP in columns (3) and (4). See Appendix A for the detailed definitions of all variables. *AR(2)* is a test for the second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen *J* test of over-identifying restrictions is distributed as Chi-square under the null of instrument validity. We treat all variables except year dummy as potentially endogenous variables. Levels of these variables dated *t-2* and further are used as instruments in the first-differenced equations, and the first-differences of these same variables lagged twice are used as additional instruments in the level equations. ***, **, and * indicate significance at the 1%, 5%m and 10% levels, respectively.

Table 6

Robustness check: An alternative measure of financial outreach.

	(1)	(2)	(3)	(4)
	$Deposit_{i,t}$	$Deposit_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln Y_{i,t}$
$Deposit_{i,t}$				0.335**
				(0.129)
$FOutreach2_{i,t}$	2.044***	-0.888	0.768*	0.351
	(0.478)	(1.248)	(0.417)	(0.342)
$PD_{i,t}$		2.925**		
		(1.232)		
$FOutreach2_{i,t}*PD_{i,t}$		0.346*		
		(0.208)		
$\ln Y_{i,t-1}$			-0.611*	-0.659***
			(0.312)	(0.189)
$Gov_{i,t}$	0.538	-1.033***	-0.376	0.163
	(2.588)	(0.390)	(0.943)	(0.782)
$FDI_{i,t}$	7.120	1.787	4.767	2.116
	(5.425)	(5.398)	(3.311)	(2.237)
$Edu_{i,t}$	-2.919***	2.599	-1.200*	-0.653
	(0.789)	(1.972)	(0.653)	(0.524)
$Post\&Tele_{i,t}$	1.010	-0.292	-0.054	-0.347
	(1.501)	(0.534)	(0.481)	(0.511)
$Road_{i,t}$	0.477	-0.774**	0.071	0.160
	(0.298)	(0.312)	(0.190)	(0.159)
$CPI_{i,t}$	-25.435	-6.083	-9.216	-0.806
	(18.984)	(12.429)	(8.982)	(7.136)
$SOE_{i,t}$	2.284***	0.869	0.030	-0.328
	(0.844)	(0.698)	(0.515)	(0.453)
City Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	1239	1239	1162	1156
AR(2)	0.160	0.542	0.159	0.107
Hansen p -value	0.413	0.106	0.477	0.364

Note: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript i indexes cities, and the subscript t, time, where $t = 2006–2011$. The dependent variable is the logarithm of bank deposits per capita in columns (1) and (2), and real per capita GRP growth rate in columns (3) and (4). See Appendix A for the detailed definitions of all variables. *AR(2)* is a test for the second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen J test of over-identifying restrictions is distributed as Chi-square under the null of instrument validity. We treat all variables except year dummies as potentially endogenous variables. Levels of these variables dated $t-2$ and further are used as instruments in the first-differenced equations, and the first-differences of these same variables lagged twice are used as additional instruments in the level equations. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 7

Robustness check: The 2SLS IV approach (Instrument with bank branch density as of 1937).

	(1)	(2)	(3)	(4)
	$Deposit_{i,t}$	$Deposit_{i,t}$	$\Delta \ln Y_{i,t}$	$\Delta \ln Y_{i,t}$
$Deposit_{i,t}$				0.102***
				(0.033)
$FOutreach_{i,t}$	1.050***	0.957***	0.079*	0.022
	(0.061)	(0.246)	(0.041)	(0.056)
$FOutreach_{i,t}*PD_{i,t}$		0.082***		
		(0.016)		
$PD_{i,t}$		-0.744***		
		(0.172)		
$\ln Y_{i,t-1}$			-0.176***	-0.251***
			(0.028)	(0.022)
$Gov_{i,t}$	-0.332***	-0.130***	-0.103**	-0.103**
	(0.111)	(0.050)	(0.049)	(0.048)
$FDI_{i,t}$	9.555***	2.412***	0.992**	0.472
	(1.149)	(0.682)	(0.481)	(0.454)
$Edu_{i,t}$	0.299***	-0.341*	0.013	-0.013
	(0.046)	(0.197)	(0.020)	(0.022)
$Post\&Tele_{i,t}$	-0.086	-0.017	-0.017	-0.016
	(0.084)	(0.036)	(0.037)	(0.037)
$Road_{i,t}$	-0.920***	-0.211***	-0.072*	-0.022
	(0.065)	(0.054)	(0.040)	(0.052)
$CPI_{i,t}$	-9.733***	-1.702	-4.498***	-4.241***
	(2.501)	(1.169)	(1.175)	(1.166)
$SOE_{i,t}$	1.551***	0.081	-0.163	-0.400***
	(0.221)	(0.110)	(0.104)	(0.117)
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	918	901	871	868
First Stage F-stat	322.23	48.93	178.81	125.73
Anderson p-value	0.000	0.000	0.000	0.000
Cragg-Donald F-stat	322.233	8.985	178.811	125.734

Notes: All specifications were estimated using the instrumental variable (IV) estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript i indexes cities, and the subscript t, time, where t = 2006-2011. The dependent variable is the logarithm of bank deposits per capita in columns (1) and (2) and the real per capita GRP growth rate in columns (3) and (4). See Appendix A for the detailed definitions of all variables. We instrument for financial outreach and its interaction term with the logarithm of bank branch density as of 1937. The Anderson canonical correlation statistic and the Cragg-Donaldson Wald statistics are distributed as chi-square under the null that the equation is unidentified. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Appendix A. Definitions of variables used

Foutreach: City-level financial outreach, measured as the logarithm of the number of bank branches per 1000 square kilometers in the city

FOutreach2: City-level financial outreach, measured as the logarithm of the number of bank branch employees divided by the city's population

Deposit: City-level deposits, measured as the logarithm of the ratio of average deposits per capita in the city

PD: City-level population density, measured as the logarithm of the city's population per square kilometers

ln*Y**:* City-level economic development level, measured as the logarithm of the ratio of real gross regional product (GRP) per capita in the city

Gov: City-level government size, measured as the logarithm of one plus the ratio of the city's government expenditures to its gross regional product (GRP)

FDI: City-level foreign direct investment, measured as the logarithm of one plus the ratio of the city's *FDI* (foreign direct investment) to its gross regional product (GRP)

Edu: City-level education, measured as the logarithm of one plus the ratio of the city's number of secondary school students to its total population

Post&Telecom: City-level postal and telecommunication services, measured as the logarithm of one plus the ratio of the city's postal and telecommunication business volume to its gross regional product (GRP)

RoadDensity: City-level density of roads, measured as the logarithm of the ratio of the city's total road length (in kilometers) per 1,000 square kilometers.

CPI: City-level consumer price index, measured as the logarithm of CPI

SOE: Province-level state-owned shares (an inverse proxy for the progress of economic reforms), measured by the logarithm of one plus the ratio of the city's share of state-owned entities to its total fixed asset investments

InternetAccess: Province-level Internet access, measured as the logarithm of one plus the ratio of the number of Internet registers to the total population in the province

InternetBuy: Country-level online transactions, measured as the logarithm of one plus the ratio of the total amount of online shopping transactions to gross domestic product (GDP)

InternetPay: Country-level online payment, measured as the logarithm of one plus the ratio of the total amount of online payment to gross domestic product (GDP)

Appendix B: Continuous-time model with endogenous consumption

The model in section 2 is subject to some ad hoc assumptions in several dimensions. The interest rate is exogenously given rather than endogenously determined. Households are not endowed with a utility function, so a constant marginal propensity to consume is assumed for simplicity, which implies a constant marginal propensity to save. Moreover, households' withdrawal decision-making, including how frequently to withdraw and how much to withdraw every time, is constructed via a static mechanism *à la* Baumol (1952). Based on these assumptions, the model is simple enough to capture the main insights and is able to develop useful hypotheses for empirical tests. We need to check whether the results obtained in a simplified setting can continue to hold in a more general framework. Here, we analyze a continuous-time growth model that overcomes the abovementioned drawbacks. Due to its complexity, the model is hard to get comparative statics results in analytical solutions, and we resort to numerical simulations. It turns out that all the relevant predictions are obtained in this new setting.

Specifically, consider a continuous-time growth model with endogenous households' decision-making on cash holdings and cash withdrawals. Banks receive deposits from households and use them for investments and production. For simplicity, households are not endowed with labor and thus receive no labor income. They receive income from two sources: interest payments on savings and dividends distributed by the competitive banking sectors. Subject to a cash-in-advance constraint, households go to banks periodically to withdraw some cash and finance consumption through cash holdings between two consecutive withdrawal dates. Each withdrawal incurs some additional transaction fees, so households have to determine how often and how much to withdraw to trade off consumption against loss of interest payments and capital gains. By aggregating individual household savings and investments, we explore the related macroeconomic implications on capital formation and growth rate.

The rest of this section is organized as follows. Subsection B.1 presents the model setup. Subsection B.2 provides the main equilibrium results. All detailed derivations are shown in subsection B.3.

B.1. Model setup

Banks can transform capital into final products through an "*AK*" production function. As in Romer's (1989) model, we consider that the production side of the economy consists of a continuum 1 of firms. Each firm produces output according to $y_t(i) = A(\bar{K}_t)^{1-a} k_t^a(i)$, where $a \in (0,1)$ and $k_t(i)$ is the capital employed by firm $i \in [0,1]$. Here, $\bar{K}_t = \int_0^1 k_t(i)di$ is the aggregate capital stock in the economy and its presence in the firm's production function captures the positive effect of knowledge spillover. In equilibrium, $k_t(i) = \bar{K}_t$ for all firms $i \in [0,1]$. The interest rate is given by

$$r_t = \left.\frac{\partial y_t(i)}{\partial k_t(i)}\right|_{k_t(i)=\bar{K}_t} = aA \equiv r$$

The banking sector is competitive, so no bank earns any positive profit. Hence, the dividend rate (the dividend payment per unit of invested capital) is $A - r$.

There is a continuum 1 of households in the economy. Time is continuous and infinite. Each household has a CRRA preference and discounts future consumption flow at rate $\rho > 0$, so each one wants to maximize his lifetime discounted sum of utility

$$\int_0^\infty \frac{c_t^{1-\sigma}}{1-\sigma} e^{-\rho t} dt,$$

where c_t is one's instantaneous consumption flow and $0 < \sigma \neq 1$.

Similarly, a fraction $x \in (0,1)$ of households' total consumption could be paid through an online financial service, while the remaining part must be paid in cash. A larger x means a higher level of technology-based financial services. To pay for consumption in cash, households must take some cash out of their bank account in advance at the cost of interest payments and capital gains. However, the consumption paid via online payment is withdrawn in real time when such consumption takes place.

Moreover, households must pay some extra transaction costs whenever they withdraw cash from the bank. Two different transaction costs are in play. First, households have to pay a fraction $(1-\alpha)$ (with $0<\alpha<1$) of the contemporaneous wealth in the bank account as a management fee. Second, withdrawing each yuan incurs an additional cost. Both costs are a deadweight loss, so they are not included in bank profit.

In the empirical study, we use the bank branch density as a proxy for α. As banks are more densely distributed, competition among neighboring banks drives management fees down. In contrast, in a place where banks are more sparsely distributed, a local bank can enjoy monopoly power to some degree by charging a higher management fee. Hence, a higher bank branch density corresponds to a smaller management fee. We will discuss the empirical proxy for withdrawal cost when we formally model that part. Though the two sources of transaction cost eat one's wealth away, each may play a different role in forming investments and may affect economic growth through different channels.

Given such a cost structure, each household decides how much cash to withdraw from his bank account and how frequently to go to the bank. Let t_j, $j=1,2,3,...$ be the discrete time at which the household withdraws some cash from the nearest bank. Let X_{t_j} be the amount of cash to finance consumption from time t_j to time $t_j+\tau$, so

$$X_{t_j}(\tau)=\int_0^{\tau}(1-x)c_{t_{j+s}}ds. \tag{B1}$$

The dynamics of wealth accumulation in one's bank account is governed by

$$dW_t=(rW_t+D_t-xc_t)dt, t\in(t_j,t_j+\tau).$$

Here, r is the deposit interest rate set by banks, and D_t is the dividend payment. Thanks to the *AK* production function, the dividend payment is proportional to a household's invested capital (i.e., a household's savings in his bank account). It follows that $D_t=(A-r)W_t$ and the wealth dynamics becomes

$$dW_t=(AW_t-xc_t)dt, t\in(t_j,t_j+\tau). \tag{B2}$$

Throughout, we denote by W_{t_j-} and W_{t_j+} the amount of wealth in the bank account immediately before and after withdrawal at time t_j. After taking cash X_{t_j} out, the household wealth under bank management becomes

$$\begin{aligned} W_{t_j+} &= \left(W_{t_j} \quad X_{t_j}\right) \quad \left(1 \quad \right)\left(W_{t_j} \quad X_{t_j}\right) \quad \left(\qquad \right) X_{t_j} \\ &= \quad W_{t_j} \qquad X_{t_j}. \end{aligned} \tag{B3}$$

where $\beta > \alpha$. The three components on the first line lay out how the household's deposit changes after withdrawal: the first term is the wealth net of the cash withdrawal, the second term reflects the management fee, and the last term captures the withdrawal cost. In the empirical study, we use population density as a proxy for the withdrawal cost. Admittedly, if banks are crowded with more customers, one has to wait for a long time and thus incur a substantial cost. In other words, a higher population density translates into a larger β.

B.2. Equilibrium results

Before exploring the equilibrium results for this model, we first review the benchmark model with no transaction costs. In this case, an individual household holds no cash in hand. On the balanced growth path, the savings rate is constant and both consumption and capital (with no depreciation) are growing at the same rate g_b:

$$g_b = \frac{A - \rho}{\sigma} > 0. \tag{B4}$$

We call this the "frictionless" growth rate. To guarantee a positive savings rate, we impose the usual condition:

$$\kappa \equiv \frac{\rho + (\sigma - 1)A}{\sigma} > 0. \tag{B5}$$

Now let's turn to the more realistic model with transaction costs. The following proposition summarizes the optimal decision choices of cash holding and withdrawal frequency for households. Formal proofs are relegated to subsection A.3.

Proposition A1. In equilibrium, the following hold:

1. During two withdrawal dates $\left[t_j, t_{j+1}\right)$, consumption flows are given by

$$c_{t_j+s} = \frac{\frac{\rho}{\sigma}}{1-e^{-\frac{\rho}{\sigma}\tau}} \frac{X_{t_j}}{1-x} e^{-\frac{\rho}{\sigma}s}, \text{ for any } s \in \left[0, \tau\right). \tag{B6}$$

2. At withdrawal date t_j, a household withdraws cash $X_{t_j} = \theta W_{t_j-}$, i.e., a constant fraction of his/her wealth in the bank account, where $\theta \in (0,1)$ is given by

$$\theta = \frac{\alpha - \alpha^{\frac{1}{\sigma}} e^{-A\tau} e^{\frac{(A-\rho)\tau}{\sigma}}}{\beta + \frac{x}{1-x} \frac{\frac{\rho}{\sigma}}{A+\frac{\rho}{\sigma}} \frac{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}}}. \tag{B7}$$

3. The optimal withdrawal period τ is determined by the following equation, subject to $\alpha^{1-\frac{1}{\sigma}} e^{-\kappa\tau} > 1$:

$$\frac{\frac{\rho}{\sigma}}{e^{\frac{\rho}{\sigma}\tau}-1} + \frac{\sigma-1}{\sigma} \frac{\frac{x}{1-x} \frac{\frac{\rho}{\sigma}}{A+\frac{\rho}{\sigma}} \frac{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}} \left(\frac{\left(A+\frac{\rho}{\sigma}\right) e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}} - \frac{\frac{\rho}{\sigma} e^{-\frac{\rho}{\sigma}\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}} \right)}{\beta + \frac{x}{1-x} \frac{\frac{\rho}{\sigma}}{A+\frac{\rho}{\sigma}} \frac{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}}} = \frac{\kappa}{\alpha^{1-\frac{1}{\sigma}} e^{-\kappa\tau} - 1}. \tag{B8}$$

Claim 1 implies that between two consecutive withdrawal dates, consumption decreases at rate ρ / σ. This is simply because holding cash in hand delivers zero return and therefore the consumption path evolves just as predicted by the classical Euler equation. Claim 2 is obtained due to the homotheticity of preferences. Claim 3 shows that the timing of withdrawals is independent of the value of wealth or any other state variable and the time between two consecutive withdrawals is constant, so an individual household goes to the bank every τ periods.

Moreover, we are also interested in the growth rate. It can be shown on the balanced growth path that

$$W_{(t_{j+1})-} = \alpha^{\frac{1}{\sigma}} e^{\frac{(A-\rho)\tau}{\sigma}} W_{t_j -}. \tag{B9}$$

Now observe the following chain of equations:

$$\frac{c_{t_{j+1}+s}}{c_{t_j+s}} = \frac{X_{t_{j+1}}}{X_{t_j}} = \frac{\theta W_{(t_{j+1})-}}{\theta W_{t_j -}} = \frac{W_{(t_{j+1})-}}{W_{t_j -}}, \text{ for any } s \in [0, \tau).$$

It follows that the average consumption growth rate at horizon τ is equal to the average growth rate of wealth between two consecutive withdrawal dates:

$$g = \frac{1}{\tau} \ln\left(\frac{c_{t_j+\tau}}{c_{t_j}} \right) = \frac{1}{\tau} \ln\left(\frac{W_{(t_j+\tau)-}}{W_{t_j}} \right) = \frac{A-\rho}{\sigma} + \frac{\ln \alpha}{\tau\sigma}. \tag{B10}$$

It is clear from the last equation that the growth rate consists of two parts. The first component is g_b, the "frictionless" growth rate given in (3). The second component, which is negative due to $\alpha < 1$, reflects the erosion of transaction costs and periodic withdrawal on the economic growth. The one-shot wealth dissipation rate subject to the management fee ($\ln \alpha$) is averaged over τ periods and adjusted by inter-temporal consumption smoothing (captured by σ). An interesting point worth mentioning is that α shows up explicitly in (10) while β does not. β does affect the growth rate implicitly through the channel of τ. When the management fee is absent (i.e., $\alpha = 1$, which means that perfect competition among banks leads to zero management fee), the growth rate is identical to its frictionless benchmark.

Since the solution form of the equilibrium is quite complicated, we resort to numerical simulation for further empirical implications. Consider the baseline case with $A = 8\%$, $\rho = 2\%$ (both are rates per year), and $\sigma = 2$ so that the frictionless (annual) growth rate is $g_b = (8\% - 2\%)/2 = 3\%$. We set $x = 10\%$, i.e., 90% of consumption must be paid in cash. We choose $\alpha \in (0.9991, 0.9999)$ and $\beta \in (1, 2)$. Choosing such parametric space yields a reasonable range of τ , the optimal withdrawal interval. For example, when $\beta = 1$ and $\alpha \in (0.9991, 0.9999)$, the optimal τ ranges from 0.05 years (i.e., 20 times per year) to 0.35 years (approximately 2.86 times per year). When $\alpha = 0.999$ and $\beta \in (1, 2)$, the optimal τ ranges from 0.36 years (approximately 2.78 times per year) to 0.50 years (twice per year).

We now vary the value of related parameters one at a time from their baseline values to explore some useful results of comparative statics.

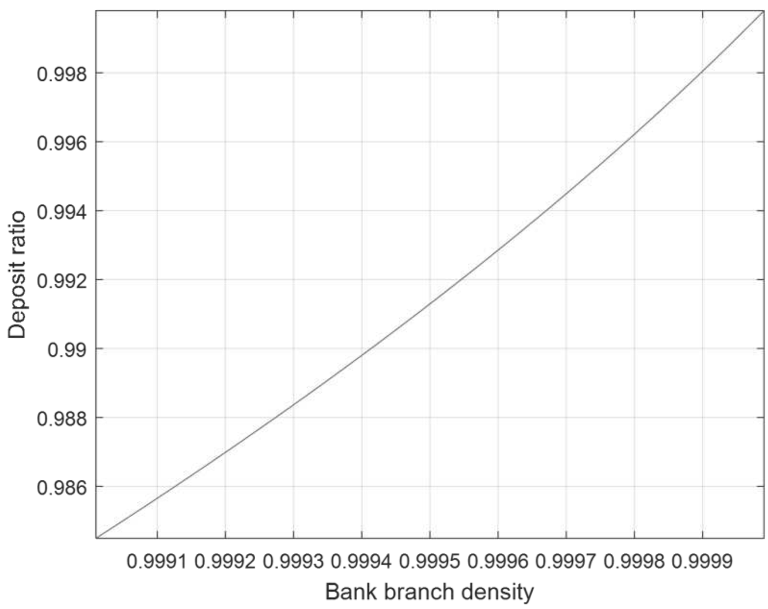

Fig. B1. The equilibrium deposit ratio $\left(1 - \frac{X}{W}\right)$ increases in bank branch density.

Fig. B1 shows that the deposit ratio is increasing in bank branch density. An increase in the bank branch density fosters competition among banks and pushes down the management fee. Households therefore feel willing to go to the bank more frequently, so they reduce cash holdings. As a result, more wealth is kept in bank accounts and transformed into capital. This suggests that the effect of financial outreach on economic growth is positive, as shown in Fig. B2, which is in line with Hypothesis (1).

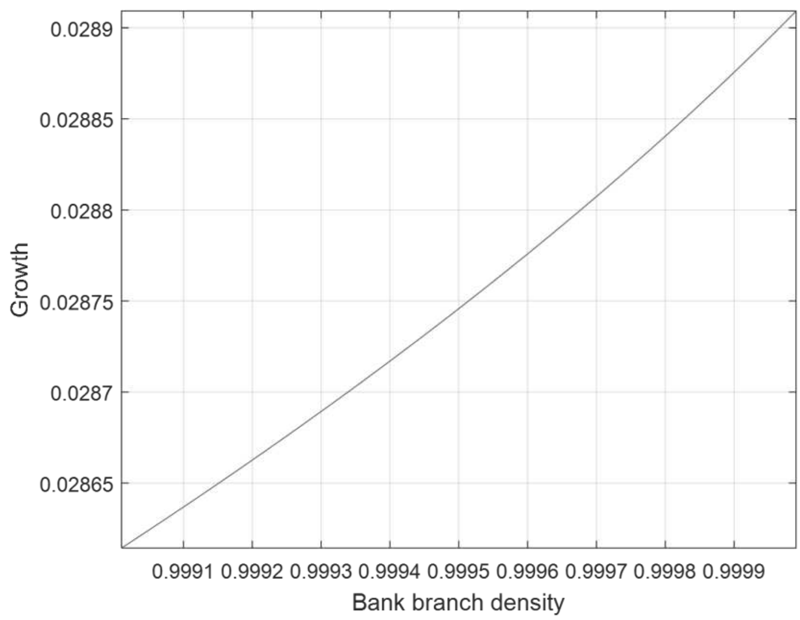

Fig. B2. The growth rate increases in bank branch density.

Fig. B3 shows that $\mathrm{d}^2 g / (\mathrm{d}\alpha \mathrm{d}\beta) > 0$, which means the effect of financial outreach on economic growth is non-linear and is more pronounced when the population density is high. This is in line with Hypothesis (2). In a crowded city, the waiting cost looms large and households choose to go to banks with low frequency, but each withdrawal takes more cash, which incurs high withdrawal costs and impedes deposit formation. Increasing bank branches in crowded cities may alleviate this problem more and thus its positive effect on growth is more pronounced in these areas.

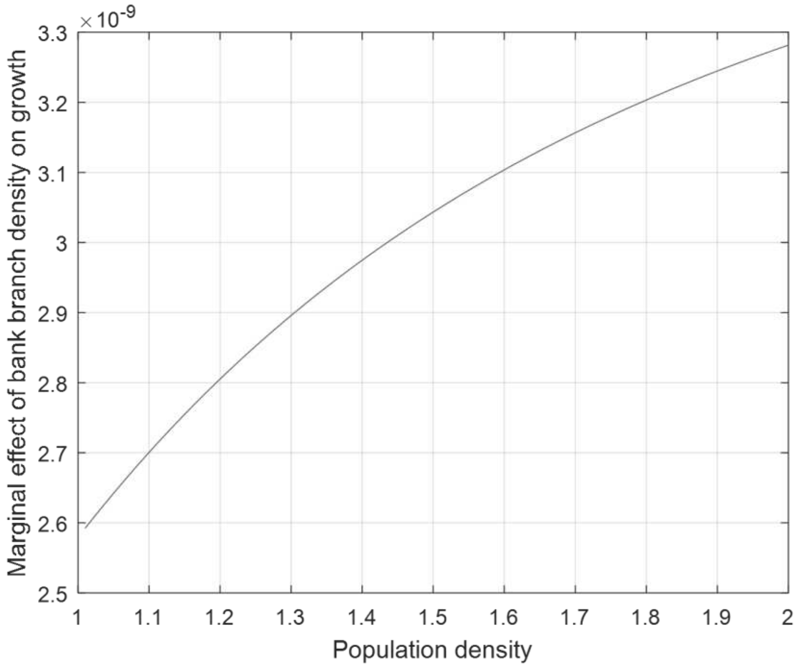

Fig. B3. The marginal effect of bank branch density on growth increases in population density.

Fig. B4 illustrates that the marginal effect of bank branch density on growth decreases in the increasing strength of technology-based financial services, e.g., $\mathrm{d}^2 g/(\mathrm{d}\alpha \mathrm{d}x) < 0$. This implies that the effect of financial outreach on economic growth is less pronounced in cities with a higher development of technology-based financial services. This is in line with Hypothesis (3).

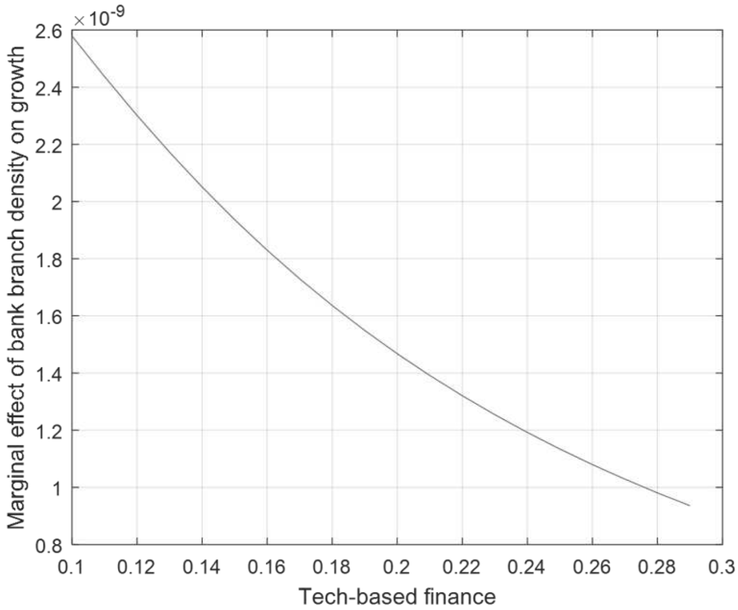

Fig. B4. The marginal effect of bank branch density on growth decreases in the increasing strength of technology-based financial services.

B.3. Detailed derivations

We illustrate all mathematical derivations in this subsection. Following Abel *et al.* (2007), we derive the equilibrium of the model in four steps.

Step 1. Given X_{t_j} and τ, a household determines his consumption flow during time interval $\left[t_j, t_j+\tau\right)$ by solving the following optimization problem:

$$U_{t_j} \equiv \max_{\{c_s\}_{s\in[0,\tau]}} \int_0^{\tau} \frac{\left(c_{t_j+s}\right)^{1-\sigma}}{1-\sigma} e^{-\rho s} ds \tag{B12}$$

Subject to Eq. (B1), optimality requires $c_{t_j+s} = c_{t_j} e^{-\frac{\rho}{\sigma}s}$ for $s \in \left[0,\tau\right]$. Substituting c_{t_j+s} into Eq. (B1), we obtain

$$X_{t_j} = \left(1-x\right) c_{t_j} \frac{\sigma}{\rho}\left(1-e^{-\frac{\rho}{\sigma}\tau}\right) \tag{B13}$$

It follows that

$$c_{t_j+s}=\frac{\frac{\rho}{\sigma}}{1-e^{-\frac{\rho}{\sigma}\tau}}\frac{X_{t_j}}{1-x}e^{-\frac{\rho}{\sigma}s}\text{, for } s\in[0,\tau]. \tag{B14}$$

Substituting c_{t_j+s} from the above equation into (B9) gives

$$U_{t_j}=\frac{1}{1-\sigma}\left(\frac{X_{t_j}}{1-x}\right)^{1-\sigma}\left(\frac{1-e^{-\frac{\rho}{\sigma}\tau}}{\rho/\sigma}\right)^{\sigma}. \tag{B15}$$

Step 2. Let $V\left(W_{t_j-}\right)$ be the value function at time t_j just before the j[th] withdrawal, which satisfies

$$V\left(W_{t_j}\right)=\max_{X_{t_j}}\left[U_{t_j}+e^{-\rho\tau}V\left(W_{t_{j+1}-}\right)\right] \tag{B16}$$

Recall that the evolution of one's total wealth during this period is given by (B2), with the initial condition given by (B3). Substituting c_t from Eq. (B14) into the dynamic Eq. (B2) and integrating it from t_j to $t_j+\tau$ yields

$$W_{(t_j+\tau)-}=e^{A\tau}\left(\alpha W_{t_j-}-\Phi_1 X_{t_j}\right), \tag{B17}$$

where

$$\Phi_1=\beta+\frac{x}{1-x}\frac{\frac{\rho}{\sigma}}{A+\frac{\rho}{\sigma}}\frac{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}}>0., \tag{B18}$$

Obviously, $W_{(t_j+\tau)-}$ is decreasing in X_{t_j} as the more one withdraws at time t_j, the less wealth to be accumulated afterward:

$$\frac{dW_{(t_j+\tau)-}}{dX_{t_j}}=-e^{A\tau}\Phi_1<0.,$$

Conjecture that

$$V(W)=\frac{1}{1-\sigma}\gamma W^{1-\sigma}, \tag{B19}$$

where $\gamma>0$ is to be determined. Substituting Eq. (19) and U_{t_j} from Eq. (B15) into (B16) yields

$$\frac{1}{1-\sigma}\gamma\left(W_{t_j-}\right)^{1-\sigma}=\max_{X_{t_j}}\left[\frac{1}{1-\sigma}\left(\frac{X_{t_j}}{1-x}\right)^{1-\sigma}\left(\frac{1-e^{-\frac{\rho}{\sigma}\tau}}{\rho/\sigma}\right)^{\sigma}+e^{-\rho\tau}\frac{1}{1-\sigma}\gamma\left(W_{t_{j+1}-}\right)^{1-\sigma}\right] \quad \text{(B20)}$$

The optimal amount of cash withdrawn from a bank account is determined by the FOC wrt X_{t_j}:

$$\frac{1}{1-\sigma}\frac{\left(X_{t_j}\right)^{-\sigma}}{\left(1-x\right)^{1-\sigma}}\left(\frac{1-e^{-\frac{\rho}{\sigma}\tau}}{\rho/\sigma}\right)^{\sigma}+e^{-\rho\tau}\frac{1}{1-\sigma}\gamma\left(W_{t_{j+1}-}\right)^{-\sigma}\frac{dW_{t_{j+1}-}}{dX_{t_j}}=0,$$

which can be further simplified to

$$X_{t_j}=\frac{\alpha W_{t_j}}{\Phi_1+\left(\gamma\Phi_1\right)^{\frac{1}{\sigma}}\Phi_2}, \quad \text{(B21)}$$

where

$$\Phi_2=\left(1-x\right)^{\frac{1-\sigma}{\sigma}}\frac{\frac{\rho}{\sigma}e^{-A\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}}e^{\frac{A-\rho}{\sigma}\tau}>0., \quad \text{(B22)}$$

Notice that we require an interior solution, i.e., $\alpha W_{t_j-}-\beta X_{t_j}>0$, which will be checked later.

Using (B21) to substitute for X_{t_j} in Eq. (B17) yields

$$W_{t_j+\tau}=e^{A\tau}\alpha W_{t_j}\frac{\gamma^{\frac{1}{\sigma}}\Phi_1^{\frac{1}{\sigma}-1}\Phi_2}{\Phi_1+\gamma^{\frac{1}{\sigma}}\Phi_1^{\frac{1}{\sigma}-1}\Phi_2}. \quad \text{(B23)}$$

Step 3. Substituting X_{t_j} from Eq. (B21) and $W_{t_j+\tau}$ from Eq. (B23) into the Bellman Eq. (B20), we obtain

$$\gamma\left(W_{t_j}\right)^{1-\sigma}=\frac{\alpha^{1-\sigma}\left(W_{t_j}\right)^{1-\sigma}\left(\frac{1-e^{-\frac{\rho}{\sigma}\tau}}{\rho/\sigma}\right)^{\sigma}}{\left(1-x\right)^{1-\sigma}\Phi_1^{1-\sigma}\left(1+\gamma^{\frac{1}{\sigma}}\Phi_1^{\frac{1}{\sigma}-1}\Phi_2\right)^{1-\sigma}}+e^{-\rho\tau}\gamma e^{(1-\sigma)A\tau}\alpha^{1-\sigma}\left(W_{t_j}\right)^{1-\sigma}\frac{\gamma^{\frac{1}{\sigma}-\sigma}\Phi_1^{\left(\frac{1}{\sigma}-1\right)(1-\sigma)}\Phi_2^{1-\sigma}}{\left(1+\gamma^{\frac{1}{\sigma}}\Phi_1^{\frac{1}{\sigma}-1}\Phi_2\right)^{1-\sigma}}.$$

Cancel out the common term $\left(W_{t_j}\right)^{1-\sigma}$ on both sides and simplify to obtain

$$\gamma^{\frac{1}{\sigma}} = \frac{1}{\Phi_1^{\frac{1-\sigma}{\sigma}}\Phi_2} \frac{e^{-\frac{\rho}{\sigma}\tau} e^{\frac{1-\sigma}{\sigma}A\tau}}{\alpha^{\frac{1-\sigma}{\sigma}A\tau} - e^{-\frac{\rho}{\sigma}\tau} e^{\frac{1-\sigma}{\sigma}A\tau}}$$

$$= \frac{1-e^{-\frac{\rho}{\sigma}\tau}}{(1-x)^{\frac{1-\sigma}{\sigma}} \frac{\rho}{\sigma}\left(\alpha^{\frac{1-\sigma}{\sigma}A\tau} - e^{\frac{A-\rho}{\sigma}\tau} e^{-A\tau}\right)} \left[\beta + \frac{x}{1-x} \frac{\frac{\rho}{\sigma}}{A+\frac{\rho}{\sigma}} \frac{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}}\right]^{1-\frac{1}{\sigma}}. \quad \text{(B24)}$$

Substituting the expression for $\gamma^{\frac{1}{\sigma}}$ in Eq. (B24) into Eq. (B23) yields

$$W_{t_j+\tau} = e^{\frac{(A-\rho)\tau}{\sigma}} \alpha^{\frac{1}{\sigma}} W_{t_j}.$$

To obtain the deposit, now we go back to Eq. (B21):

$$\frac{X_{t_j}}{W_{t_j}} = \frac{\alpha - \alpha^{\frac{1}{\sigma}} e^{-A\tau} e^{\frac{A-\rho}{\sigma}\tau}}{\beta + \frac{x}{1-x}\frac{\frac{\rho}{\sigma}}{A+\frac{\rho}{\sigma}}\frac{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}}}.. \quad \text{(B24)}$$

Finally, we check

$$\alpha W_{t_j-} - \beta X_{t_j} = W_{t_j} \frac{\alpha \frac{x}{1-x}\frac{\frac{\rho}{\sigma}}{A+\frac{\rho}{\sigma}}\frac{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}} + \beta\alpha^{\frac{1}{\sigma}} e^{-A\tau} e^{\frac{A-\rho}{\sigma}\tau}}{\beta + \frac{x}{1-x}\frac{\frac{\rho}{\sigma}}{A+\frac{\rho}{\sigma}}\frac{1-e^{-\left(A+\frac{\rho}{\sigma}\right)\tau}}{1-e^{-\frac{\rho}{\sigma}\tau}}} > 0,$$

so an interior solution is already ensured.

Step 4. Now the value function for an individual investor who is born at t_0 with initial wealth endowment W_{t_0} is given by

$$V\left(W_{t_0}\right) = \frac{1}{1-\sigma}\gamma\left(W_{t_0}\right)^{1-\sigma}.$$

Note that only γ is involved with τ, so maximizing $V\left(W_{t_0}\right)$ with respect to τ is equivalent to maximizing γ with respect to τ. Hence, the following first-order condition determines the optimal withdrawal frequency τ:

$$\frac{d\gamma^{\frac{1}{\sigma}}}{d\tau} = 0 \, ,$$

which can be expanded more explicitly as shown in Eq. (B8).

Online Appendix C: Summary of relevant literature that has used similar methods

Literature	Approaches	Findings
Greenwood and Jovanovic (1990)	General equilibrium model	Financial intermediation and economic growth are endogenously determined
King and Levine (1993)	Schumpeterian endogenous growth model, Cross-country panel regressions and Case studies	A robust financial system can facilitate innovation, thereby accelerating economic growth.
Mercenier and Srinivasan (1994)	General equilibrium model	Provide a detailed summary and systematic analysis of the general equilibrium model.
Altig, Carlstrom and Lansing (1995)	General equilibrium model	A computable general equilibrium model, incorporating a central bank, monetary policy, and interest rates within a limited participation framework, demonstrates its applicability for real-time forecasting.
Ginsburgh and Keyzer (1997)	General equilibrium model	Outline the structure of general equilibrium models and present the theoretical models in a unified manner.
Rajan and Zingales (1998)	Cross-country panel regressions	Financial development lowers firms' external financing costs, thereby enhancing growth, particularly in industries heavily reliant on external finance.
Rousseau and Wachtel (1998)	Vector error correction models and Granger causality tests	Financial intermediation positively impacts output, but output does not directly affect intermediation.
Levine, Loayza and Beck (2000)	GMM dynamic panel regressions And cross-sectional instrumental-variable approach	A positive correlation exists between financial intermediaries and economic growth. Legal and accounting systems explain cross-country differences in financial development.

Levine (2005)	Theoretical model and GMM dynamic panel regressions	Financial intermediaries and markets play a crucial role in driving economic growth.
Beck, Demirgüç-Kunt and Levine (2007)	Cross-country panel regressions	Financial development boosts income levels among the poor and mitigates income inequality.
Butler and Cornaggia (2011)	DID panel regressions	Access to finance has a causal effect on productivity.
Rousseau and Wachtel (2011)	Cross-country panel regressions	During financial crises, the positive economic impact of financial deepening is dampened.
Farmer (2013)	Rational expectations model	Economic policies aimed at reducing volatility in asset markets can increase economic welfare.
Bruhn and Love (2014)	DID panel regressions	Access to finance can promote informal businesses, reduce unemployment, and increase incomes, particularly for low-income individuals and those who are underserved or excluded from the traditional banking.
Arcand, Berkes and Panizza (2015)	Cross-country panel regressions	The impact of financial deepening on economic growth shifts from positive to negative when private credit reaches 100% of GDP.
Bhattarai (2015)	General equilibrium model	In developed countries, the gap between the actual financial deepening ratios (AFDR) and the optimal financial deepening ratios (OFDR) causes massive macroeconomic fluctuations, resulting in financial crises and deep recessions. In contrast, a smaller gap leads to accelerated economic growth.

Online Appendix D: Robustness checks for empirical tests

Table D1

The effect of financial outreach: Accounting for different types of banks on deposits.

	(1)	(2)	(3)	(4)
	$Deposit_{i,t}$	$Deposit_{i,t}$	$Deposit_{i,t}$	$Deposit_{i,t}$
$FO\_big\_five_{i,t}$	1.076***			
	(0.198)			
$FO\_joint\text{-}equity_{i,t}$		0.272***		
		(0.049)		
$FO\_city\_banks_{i,t}$			0.180**	
			(0.080)	
$FO\_argri\_banks_{i,t}$				1.277***
				(0.329)
$Gov_{i,t}$	0.899	-0.919	-5.531**	-2.507*
	(1.295)	(1.216)	(2.292)	(1.341)
$FDI_{i,t}$	-1.580	-1.046	-1.078	2.187
	(3.574)	(2.724)	(4.273)	(3.570)
$Edu_{i,t}$	0.411***	0.293***	0.417***	0.387***
	(0.018)	(0.047)	(0.048)	(0.019)
$Post\&Tele_{i,t}$	-0.092**	-1.027	-0.016	0.047*
	(0.043)	(2.449)	(0.031)	(0.027)
$Road_{i,t}$	-1.164***	-0.147	-0.237	-1.559***
	(0.299)	(0.197)	(0.175)	(0.329)
$CPI_{i,t}$	-9.100	2.875	-10.608	-3.056
	(8.299)	(8.215)	(8.639)	(5.167)
$SOE_{i,t}$	0.252	1.151	3.026***	0.149
	(0.972)	(0.945)	(1.154)	(0.839)
City Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	1238	627	906	1235
AR(2)	0.892	0.423	0.356	0.386
Hansen *p* -value	0.291	0.953	0.126	0.263

Notes: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript *i* indexes cities, and the subscript t, time, where t = 2006-2011. The dependent variable is the logarithm of bank deposits per capita. See Appendix A for the detailed definitions of all variables. *AR(2)* is a test for the second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen *J* test of over-identifying restrictions is distributed as Chi-square under the null of instrument validity. We treat all variables except year dummies as potentially endogenous variables. Levels of these variables dated *t-2* and further are used as instruments in the first-differenced equations, and the first-differences of these same variables lagged twice are used as additional instruments in the level equations. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table D2

The effect of financial outreach on deposits: Accounting for different regions.

	$Deposit_{i,t}$					
	Eastern		Central		Western	
	(1)	(2)	(3)	(4)	(5)	(6)
$FOutreach_{i,t}$	1.670	-0.462	0.484**	0.255	0.588**	0.260
	(1.188)	(4.083)	(0.209)	(0.174)	(0.243)	(0.163)
$PD_{i,t}$		0.406		-0.087		-0.290*
		(4.149)		(0.102)		(0.150)
$FOutreach*PD_{i,t}$		0.151		0.136***		0.147***
		(0.192)		(0.021)		(0.020)
$Gov_{i,t}$	1.414	3.180	-0.616	-0.005	-1.802**	-0.164
	(4.505)	(7.749)	(1.019)	(0.333)	(0.823)	(0.201)
$FDI_{i,t}$	-8.342	0.821	-0.009	-0.435	6.025	-2.050
	(10.848)	(43.240)	(7.835)	(1.454)	(12.820)	(2.280)
$Edu_{i,t}$	0.416***	1.490	0.493*	0.239	2.459	1.683
	(0.119)	(6.663)	(0.286)	(0.211)	(2.185)	(1.081)
$Post\&Tele_{i,t}$	-0.053	6.433	0.001	0.101	2.637	-0.406
	(8.126)	(25.433)	(0.011)	(0.144)	(2.250)	(0.956)
$Road_{i,t}$	-1.413	0.122	-0.598***	-0.247**	-0.708**	-0.119
	(1.013)	(1.262)	(0.206)	(0.118)	(0.310)	(0.098)
$CPI_{i,t}$	-16.802	-34.815	-3.394	-0.932	6.530	3.620
	(15.572)	(124.745)	(4.248)	(1.624)	(6.118)	(3.020)
$SOE_{i,t}$	-0.886	-2.688	0.356	0.129	1.220	-0.786
	(1.743)	(9.554)	(0.869)	(0.451)	(1.564)	(0.531)
City Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	559	559	430	430	250	250
AR(2)	0.889	0.882	0.791	0.906	0.776	0.113
Hansen *p* -value	0.548	0.940	0.435	0.117	0.383	0.204

Notes: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript i indexes cities, and the subscript t, time, where t = 2006–2011. The dependent variable is the logarithm of bank deposits per capita. See Appendix A for the detailed definitions of all variables. *AR(2)* is a test for the second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen *J* test of over-identifying restrictions is distributed as Chi-square under the null of instrument validity. We treat all variables except year dummy as potentially endogenous variables. Levels of these variables dated *t-2* and further are used as instruments in the first-differenced equations, and the first-differences of these same variables lagged twice are used as additional instruments in the level equations. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table D3

Robustness check: The 2SLS IV approach (Instrument with bank branch density in neighboring cities).

	(1)	(2)	(3)	(4)
	$Deposit_{i,t}$	$Deposit_{i,t}$	$\ln Y_{i,t}$	$\ln Y_{i,t}$
$Deposit_{i,t}$				0.679*
				(0.355)
$FOutreach_{i,t}$	1.434*	0.123	0.954*	-0.153
	(0.872)	(0.351)	(0.578)	(0.109)
$FOutreach_{i,t}*PD_{i,t}$		0.125***		
		(0.033)		
$PD_{i,t}$		-0.275		
		(0.229)		
$\ln Y_{i,t-1}$			-0.141***	-0.139***
			(0.052)	(0.046)
$Gov_{i,t}$	0.015	0.021	0.641*	-0.038
	(0.073)	(0.021)	(0.371)	(0.053)
$FDI_{i,t}$	0.448	0.227	1.783*	1.600*
	(1.155)	(0.329)	(1.004)	(0.865)
$Edu_{i,t}$	0.254***	0.187	0.009	-0.161*
	(0.025)	(0.278)	(0.021)	(0.092)
$Post\&Tele_{i,t}$	0.047	0.007	-0.001	0.012
	(0.210)	(0.015)	(0.043)	(0.039)
$Road_{i,t}$	-1.214	0.051	-0.818*	0.119
	(0.745)	(0.096)	(0.494)	(0.089)
$CPI_{i,t}$	-4.564	0.298	-9.800**	-6.050***
	(5.126)	(1.041)	(3.913)	(2.185)
SOE	0.268	-0.331***	-0.080	-0.358
	(0.416)	(0.093)	(0.370)	(0.259)
City Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	1,171	1,158	1,098	1,128
First Stage F-stat	436.13	642.90	367.84	132.75
Anderson p-value	0.051	0.035	0.065	0.044
Cragg-Donald F-stat	1.889	2.194	1.802	2.676

Notes: All specifications were estimated using the instrumental variable (IV) estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript i indexes cities, and the subscript t, time, where t = 2006-2011. The dependent variable is the logarithm of bank deposits per capita in columns (1) and (2), and the logarithm of real GDP per capita in columns (3) and (4). See Appendix A for the detailed definitions of all variables. All endogenous variables are instrumented using the average value thereof in neighbor cities. The Anderson canonical correlation statistic and the Cragg-Donaldson Wald statistics are distributed as chi-square under the null that the equation is unidentified. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table D4

Robustness check: An alternative measure of internet finance.

	(1)	(2)	(3)	(4)
	$Deposit_{i,t}$	$Deposit_{i,t}$	$\Delta\ln Y_{i,t}$	$\Delta\ln Y_{i,t}$
$FOutreach_{i,t}$	1.128***	1.120***	0.419*	0.421*
	(0.130)	(0.130)	(0.247)	(0.246)
$FOutreach_{i,t}*Internet\_Buy_{i,t}$	-0.046*		-0.040**	
	(0.025)		(0.020)	
$FOutreach*Internet\_Pay_{i,t}$		-0.013*		-0.014**
		(0.007)		(0.007)
$\ln Y_{i,t-1}$			-0.532*	-0.539*
			(0.319)	(0.317)
$Gov_{i,t}$	-2.030	-1.903	-0.486	-0.526
	(1.246)	(1.188)	(0.835)	(0.826)
$FDI_{i,t}$	-0.295	-0.155	-1.422	-1.466
	(2.803)	(2.827)	(2.180)	(2.245)
$Edu_{i,t}$	0.402***	0.402***	0.026	0.024
	(0.030)	(0.030)	(0.037)	(0.029)
$Post\&Tele_{i,t}$	-0.087***	-0.086***	0.015	0.016
	(0.025)	(0.026)	(0.016)	(0.016)
$Road_{i,t}$	-1.076***	-1.082***	-0.438*	-0.443*
	(0.155)	(0.155)	(0.261)	(0.259)
$CPI_{i,t}$	1.199	0.966	-3.056	-2.965
	(3.254)	(3.335)	(2.665)	(2.592)
$SOE_{i,t}$	0.415	0.362	-0.654	-0.684
	(0.642)	(0.657)	(0.535)	(0.538)
City Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	1239	1239	1162	1162
AR(2)	0.965	0.999	0.343	0.339
Hansen p -value	0.425	0.441	0.261	0.318

Notes: All specifications were estimated using the system GMM estimator. Test statistics and standard errors (in parentheses) of all variables in the regressions are asymptotically robust to heteroscedasticity. The subscript i indexes cities, and the subscript t, time, where t = 2006–2011. The dependent variable is the logarithm of bank deposits per capita in columns (1) and (2), and real per capita GRP growth rate in columns (3) and (4). See Appendix A for the detailed definitions of all variables. *AR(2)* is a test for the second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen J test of over-identifying restrictions is distributed as Chi-square under the null of instrument validity. We treat all variables except year dummies as potentially endogenous variables. Levels of these variables dated $t-2$ and further are used as instruments in the first-differenced equations, and the first-differences of these same variables lagged twice are used as additional instruments in the level equations. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

References in the Online Appendices

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