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Can digital finance development improve balanced regional investment allocations in developing countries? — The evidence from China

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ABSTRACT

This paper studies the effects of digital finance development on cross-regional capital movement and the directions of capital flows using Chinese provincial data from 2011 to 2020. The results show that digital finance development breaks the "spatial barrel effect" of savings and investment allocation in the traditional finance system, thus improving cross-regional capital mobility. We identify two opposite effects of digital finance development on the direction of capital flows. The "endogenous capital return effect" draws the capital from less-developed areas to developed areas due to the higher return of capital in developed areas. The "credit market quality improvement effect" leads the capital to flow in the opposite direction because digital finance improves the credit market quality in less-developed regions. The former dominates the latter, thus worsening the imbalanced regional investment allocations. The results remain in various robustness checks. It implies that, although digital finance development in China is inclusive and has independent impacts on capital allocation outside the traditional financial system, it cannot wholly solve the existing structural problems that institutional reforms should further address.

1. Introduction

Imbalanced allocation of savings and investments is one of the main factors that lead to the severe imbalance of regional development in developing economies, where a few affluent areas coexist with many poor areas. Spatial heterogeneity in investment return and high inequality hinder further economic growth. Schumpeter (1934) believed that investment heterogeneity in an economy was due to the impacts of technological innovation and was an inevitable "creative destruction". However, McKinnon (1973) and Shaw (1973) pointed out that the main reason for investment heterogeneity in developing countries was financial market fragmentation and financial repression. Therefore, addressing the imbalanced regional investment allocation through financial development is one of the essential strategies for developing countries to achieve balanced regional growth and reduce inequality.

Financial development encourages domestic savings and attracts external capital, contributing to capital accumulation and economic growth. Institutional reforms, such as financial liberalization, are believed to be an essential driving force of financial

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development. Recently, there have been rapid and extensive applications of digital technology in financial services, known as digital finance (or FinTech). It utilizes modern information technologies, such as big data, cloud computing, and blockchain, to reduce physical transaction costs and implicit costs caused by asymmetric information in the financial market and provide a broader range of financial services (Ozili, 2017; Goldstein et al., 2019). It is considered a new form of financial organization that improves the efficiency of capital allocation. One believed that the revolutionary development of digital finance significantly impacted the traditional financial system and financial structure (Demirguc et al., 2018). Hence, based on shared beliefs that digital finance provides more financial services at lower costs, we wonder how digital finance development affects the cross-regional capital movement, thus changing the imbalanced investment allocation. More specifically, the primary issue for developing countries is not simply providing more investment funds and stimulating regional growth. Spatial structural problems and regional gaps are more critical problems that hinder economic growth. Therefore, a natural question arises: does digital finance development cause the fund to flow from less-developed regions to developed regions of the country or the other way round? The former may worsen the regional balance, and the latter can contribute to balanced regional growth.

As one of the largest developing countries in the world, China has prominent characteristics of imbalanced regional growth. It has also experienced rapid development of digital finance in recent years as it is one of the authority's most important strategic development goals. Promoting digital finance development is listed as the primary national development strategy (*The outline of the 14th five-year plan for national economic and social development of the People's Republic of China*, Oct. 2020). With national policy and funding support, state-owned telecom companies have carried out large-scale telecom infrastructure construction all over the country. Various digital finance services, such as third-party payment, money market funds, credit investigation, wealth management, online lending, and insurance, have surged. Despite significant differences in economic growth among China's provinces, digital finance development across provinces was highly balanced (Figs. 1 and 2). Based on these features of regional economic growth and digital finance development, it would be interesting to explore whether inclusive digital finance development can help achieves balanced regional investment allocation in China.

Regarding the mechanisms behind digital finance's effects on the regional capital flow, when there are financial market segmentations due to physical and implicit transaction costs or institutional structure reasons, there would be a “spatial barrel effect” on the regional investment. That is, low funding supplies constrain investment in less-developed regions. Digital finance may solve these problems that originated in the traditional finance system by applying advanced technology and providing new forms of financial services, thus leading to higher cross-regional capital mobility. Hence, it is reasonable to expect that digital finance would improve the financial market quality more in the less-developed regions than in developed regions, thus causing the fund flow from the latter to the former. We address this as the “credit market quality improvement effect”, implying that digital finance development is inclusive. However, the effects of digital finance development could also work in the opposite direction. According to the endogenous growth theory, better human capital and urbanization may form an increasing return to capital in developed areas, leading to a higher marginal return to capital in developed areas than in less-developed areas. Thus, the capital will likely flow out of the less-developed areas and further worsen their growth potential. We name this “endogenous capital return effect”. Therefore, inclusive digital finance development does not necessarily contribute to balanced capital allocations. Then what would be the case in China? Does Chinese digital finance development improve or hinder balanced regional capital allocation? We will try to answer it in this paper.

In this paper, we study the effects of digital finance on cross-regional capital movement and the directions of capital flows using Chinese provincial data from 2011 to 2020. The results show that digital finance development breaks the “spatial barrel effect” of savings and investment allocation in the traditional finance system, thus improving cross-regional capital mobility. Regarding the direction of capital flows, both the “endogenous capital return effect” and “credit market quality improvement effect” of digital finance development exist. The former would draw the capital from less-developed areas to developed areas due to the increasing return of capital in developed areas. The latter would lead the capital to flow in the opposite direction because digital finance improves the

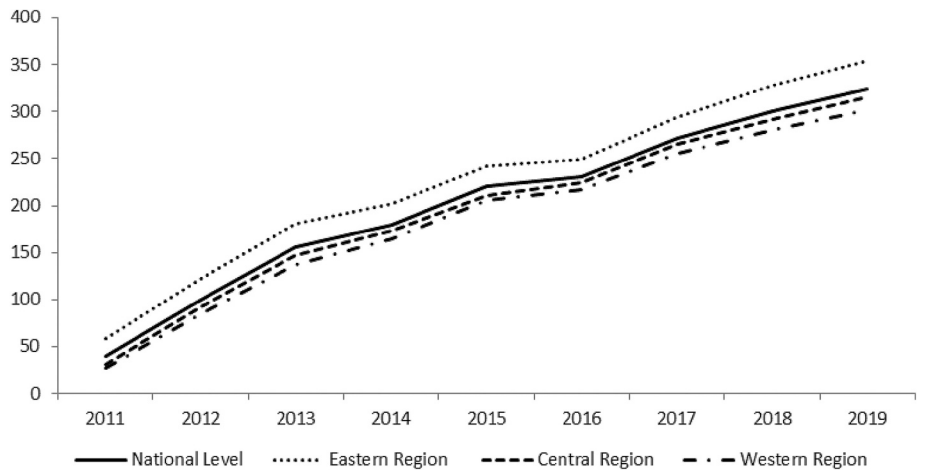

Fig. 1. The Trend of Digital Finance Development in China.

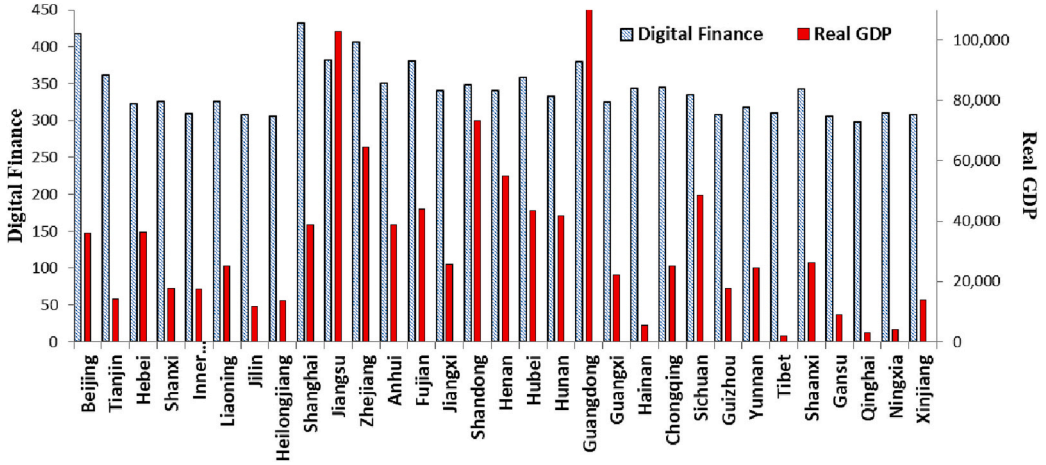

Fig. 2. China's Provincial Digital Finance Index and Real GDP in 2020.

credit market quality in less-developed regions. Overall, the former effect dominates the latter, thus worsening the imbalanced regional investment allocations. Moreover, we further test the robustness of the results with additional control for the effect of traditional financial development on cross-regional capital flow, different types of investments, and different measures of digital finance development. All conclusions remain.

Our study is related to the literature that examines the effects of financial development on capital flow and investment allocation, especially that related to the role of financial liberalization and financial market reform in developing economies. Some studies found that financial liberalization can facilitate portfolio diversification, thus reducing equity investment risk and obtaining higher returns. It would increase foreign capital inflow and private investment (Ahmed, 2016; Zhang and Bezemer, 2016). However, the effects of financial liberalization in developing economies are different from that in developed economies. The reasons lie in the heterogeneity in the level of financial development. Firms in developing countries rely more on the banking system, which has severe market segmentation and financial repression (Agenor and Montiel, 2015). The experience of financial liberalization in Latin America and Southeast Asia showed that: the arbitrage in the financial market and distortions in capital allocation led to undesired results, although financial openness and liberalization attracted significant amounts of foreign capital inflows (Chakraborty and Rawlins, 2004; Lee and Luk, 2018). However, few studies have examined the relationship between financial development and balanced regional capital allocation. According to conditional convergence in growth theory (Solow, 1956; Swan, 1956), when there are significant differences in structural features across regions, they would not converge to the same growth path. Then the imbalanced regional growth would be persistent. Therefore, given distinct differences in regional structural features, it is unclear whether financial development can lead to balanced regional growth in developing economies. More specifically, to our best knowledge, none of the existing studies have explored the effects of digital finance development on the balanced regional allocation of capital and the directions of capital flow. Unlike institutional reform-induced traditional financial development, digital finance development is technology-induced and more inclusively developed. We wonder whether this new form of financial development has different impacts.

Our study's contributions to the literature are multifold. First, we contribute to the literature on the relationship between financial development and balanced growth. We pay specific attention to the unbalanced capital allocation in developing economies. Our results imply that financial development does not necessarily benefit balanced regional growth. The effects depend on to what extent financial development reduces market segmentation, financial repression, and the degree of structural difference between regions. The institutional backgrounds of China's investment formation are essential in explaining how technology-induced financial development, digital finance, affects the regional allocation of capital. The government plays a significant role in investment allocation and has precedence in obtaining funds from the banks; meanwhile, there are remarkable heterogeneities in fund sources for national banks and local commercial banks. Therefore, our study shed light on the importance of institutional features in achieving balanced capital allocation and growth through financial development in developing countries.

Second, our study provides additional theoretical explanations about the relationship between financial development and the direction of capital flow. We illustrate the theoretical mechanism that explains why financial development leads to two opposite directions of cross-regional capital movements, which further explains why financial development's effect on regional balance growth may be inconclusive. McKinnon (1973) and Shaw (1973) noted considerable differences in internal investment accumulation in developing countries. They believed market segmentation is the main reason for the gap in internal capital accumulation in developing countries, which can be effectively eliminated by financial deepening. However, our research shows that when the development of digital finance leads to financial deepening, the “credit market quality improvement effect” does help to eliminate the difference in regional capital accumulation. Still, in the meantime, the “endogenous capital return effect” could amplify the differences. Because digital finance not only helps reduce the fixed physical transaction cost leading to the financial market spatial segmentation, but also has an asymmetric impact on the quality of the financial market in different regions. Therefore, developing economies should pay more attention to the direction of capital flow induced by financial development than simply removing financial market segmentation.

Third, our finding adds to the emerging literature that studies the effects of digital finance on the real economy. Many studies provided evidence of the positive effects of digital finance on the Chinese real economy through various channels. For instance, Ji et al. (2022) found that digital finance improved the firm's information transparency, thus mitigating their financial leverage and reducing bankruptcy risk. Jiang et al. (2022) found that internet finance increases corporate investment through the demand-driven channel, promoting household consumption and firm performance. Ding et al. (2022) found fintech development help to intensify bank loan competition and thus positively affects corporate innovation. However, few studies have discussed the negative impact of digital finance on the real economy. Although digital finance development in China is considered inclusive as it is balanced across the country, our study reveals the potential channels that digital finance may lead to undesired regional capital distribution. Financial inclusiveness does not necessarily lead to balanced fund allocations and reduce regional inequality.

Finally, our studies provide substantial policy implications for the institutional reform of the Chinese financial system. Market-oriented financial reform was regarded as the most important driving force for financial development in developing countries (Shaikh et al., 2017). But in recent years, institutional reform in China has stagnated, and the authority has resorted to applying new technologies to improve the degree of economic marketization (Cho and Chen, 2021). By comparing the differences between the impacts of traditional finance and digital finance developments, we found digital finance plays an independent role relative to the traditional finance system. However, although technology-induced financial development may mitigate some problems caused by institutional problems, it cannot completely replace the effect of institutional reform on financial development.

The rest of the paper is organized as follows: Section 2 describes the institutional background of China's investment allocation and raises two hypotheses on digital finance development's effects on regional capital flow. Section 3 illustrates the empirical designs and data description. Section 4 presents and discusses the empirical results and robustness tests. And Section 5 concludes.

2. Institutional background and hypotheses development

2.1. Institutional background

In order to better understand the spatial features of regional investments in China and the marginal impacts of digital finance, we depict the institutional backgrounds regarding investment allocation, fund financing, and digital finance development.

First, regarding investment allocation and financing, unlike the market-oriented allocation in developed countries, the Chinese government plays a vital role in providing funds and making investment allocations. The investments are not primarily allocated by the private sector. Fig. 3 shows the share of government, domestic private firms, and foreign firms in Chinese fixed asset investment from 2004 to 2017. As shown in Fig. 3, although the share of private investment showed an apparent upward trend while the public investment decreased over time, the public investment share is always higher than that of private investment. Moreover, the government investment share has been trending upward since 2015. At the same time, the growth of private investment has slowed down. The existing studies (Eckaus, 2003; Chen and Chen, 2014) explained the high share of public investment through the strong incentive for local officials to make public investments, as GDP growth is one of the most important criteria in assessing their achievements.

Many studies investigated interregional capital mobility in China and found serious segmentation among the regional markets, which also explore how institutional factors affect Chinese provincial capital mobility (Chan et al., 2011; Lai et al., 2013; Deng and Wang, 2016; Wang, 2016). Chan et al. (2011) tested the regional capital mobility from 1978 to 2006 using Feldstein and Horioda (hereafter FH) (Feldstein and Horioka, 1980) framework and found substantial barriers to provincial capital mobility. They further pointed out that the central and provincial government's fiscal transfer helps to promote capital mobility, while private capital mobility remains highly restricted. Lai et al. (2013) examined the regional capital mobility in China from 1978 to 2008 using a panel time-varying correlation coefficient model. They found moderate improvement in provincial capital mobility in the most and least developed provinces. It may attribute to the government's support of the rapid export-led economic growth and the western development policies that were launched in 2000. However, fiscal redistribution cannot improve private capital mobility. Wang (2016) estimated FH regression using spatial empirical methods and examined the factors that affect provincial capital mobility. They found preferential government policies strongly impact capital mobility mainly through government fiscal spending, interventions on banking lending and government investment project. Deng and Wang (2016) also pointed out the allocation puzzle evidenced by the negative correlation between productivity catchup and capital inflow. They believed that the allocation puzzle resulted from state-own enterprises' preferential access to credit. The above literature indicated the critical role of preferential government policies and government fiscal spending, transfer and investment in affecting the regional capital mobility and capital allocation puzzle. However, capital market frictions resulted from more complicated institutional arrangements than how government policies influence capital allocation. We complement the picture of the institutional background of Chinese investment allocation from the perspective of regional financial market (banking) segmentation. In other words, how state-owned and private firms obtain external financing and how banks obtain the funds crucially explain Chinese credit market segmentation and cross-regional capital mobility.

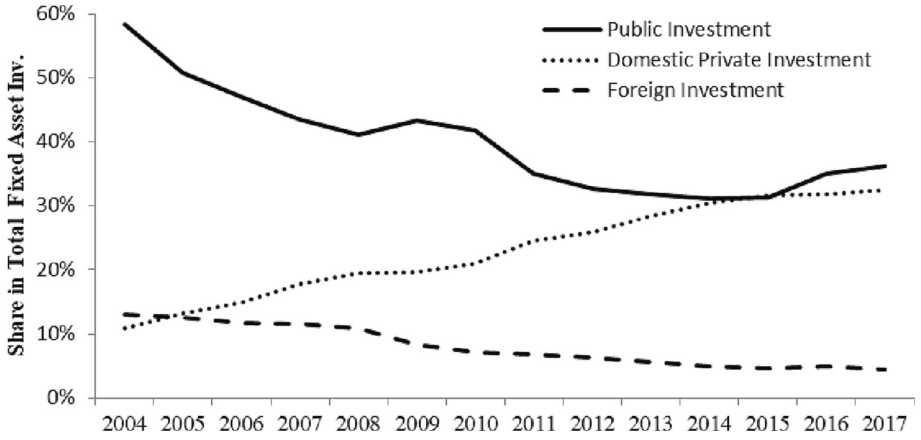

Fig. 3. Three Components of Chinese Fixed Asset Investment.

The local governments invest heavily in various infrastructure constructions through Urban Construction Investment Companies (UCICs).[1] The financing sources of UCICs are local banks and various trust companies. Trust companies are usually a channel for banks to escape supervision and make loans indirectly.[2] Furthermore, local governments were not allowed to issue government bonds freely.[3] Hence, the local governments' actual primary source of investment funding is local banks. For private enterprises, the role of direct financing from the security market is very limited. Around 70% of financing is obtained from banks. The private enterprises also borrow from banks and trust companies within the region. In other words, no matter for the government or private firms, their source of investment financing is mainly local banks.

Second, regarding the fund source and lending allocation of Chinese banking, we need to discuss the structure and operation of China's banking system. There are three types of commercial banks: state-owned commercial banks, joint-stock commercial banks, and local commercial banks. According to the Chinese Commercial Bank Law, state-owned commercial banks and national joint-stock commercial banks can operate nationwide, but local commercial banks are only allowed to operate where they are located. The banks obtain financing mainly through deposits. The equity market is not the main financing source for Chinese commercial banks. Till 2020, the ratio of equity financing to savings in Chinese commercial banks is only 1.3%. For local-operated banks, equity financing is even more limited. Among 133 urban commercial banks and 1539 rural commercial banks (by the end of 2020), only 26 (1.6%) local commercial banks are listed. Hence, the primary funding source for locally operated banks is local savings. For national-operated banks, their local branches are allowed to borrow from the head office and obtain financing from the organization's internal funding pool. However, the branches that borrow from the head office's capital pool are usually considered poorly operated. Local branches of national-operated banks prefer to borrow from other local banks within the region through the interbank market. In other words, although local branches of national-operated banks can obtain funds from other regions' savings through the organization's internal fund pool and the interbank market, their primary financing source is also limited mainly to local savings. Moreover, because local-operated banks mainly originated from the local Rural Credit Cooperatives and the Urban Credit Cooperatives, they have close relationships with local governments,[4] so they prefer to provide financial support to government projects. Therefore, China's regional investments are strongly constrained by its local savings in the banks. The relationships between regional investment and local savings in China are summarized in Fig. 4.

Third, digital finance has developed rapidly in the recent decade. The launch of Yu'ebao (an online sales platform for money market funds established by Alibaba's Ant Financial Services) in June 2013 is typically regarded as the starting point of the rapid development of Internet finance in China (Huang and Huang, 2018; Chen and Zhang, 2021). With the government's strong support, state-owned

[1] The Urban Construction Investment Companies are government financing and investment platforms for major cities in China. They were established gradually starting in 1991. They are special market participants that undertake some government tasks, thus are public institutions or state-owned companies. They do not aim to make profits, but are primarily supported by government subsidies.

[2] The trust companies act as shadow banks in credit expansion. They obtain the funds from the banks and provide the funds to the borrowers. In this way, the banks bypass the supervision and make loans indirectly through the trust companies. This additional credit expansion enlarges the money multiplier.

[3] The Budget Law of the People's Republic of China enforced in 1995 clearly stipulates that local governments in China cannot issue local government bonds. But there are actually three implicit forms of local government bonds that exist: (1) the ministry of finance can issue central government bond and lend the obtained fund to the local government. (2) The central government can issue the government bond on behalf of the local government. (3) Local governments can issue government bonds that are particularly authorized by the central government. All three ways may lead to unclear obligations for the local government to repay the debt. Hence, the law was revised in 2014. But the issuance of local government bonds is still limited, infrequent and with relatively limited amounts.

[4] The chairman of the board and CEO of urban commercial banks and rural commercial banks in each region of China are appointed by local governments.

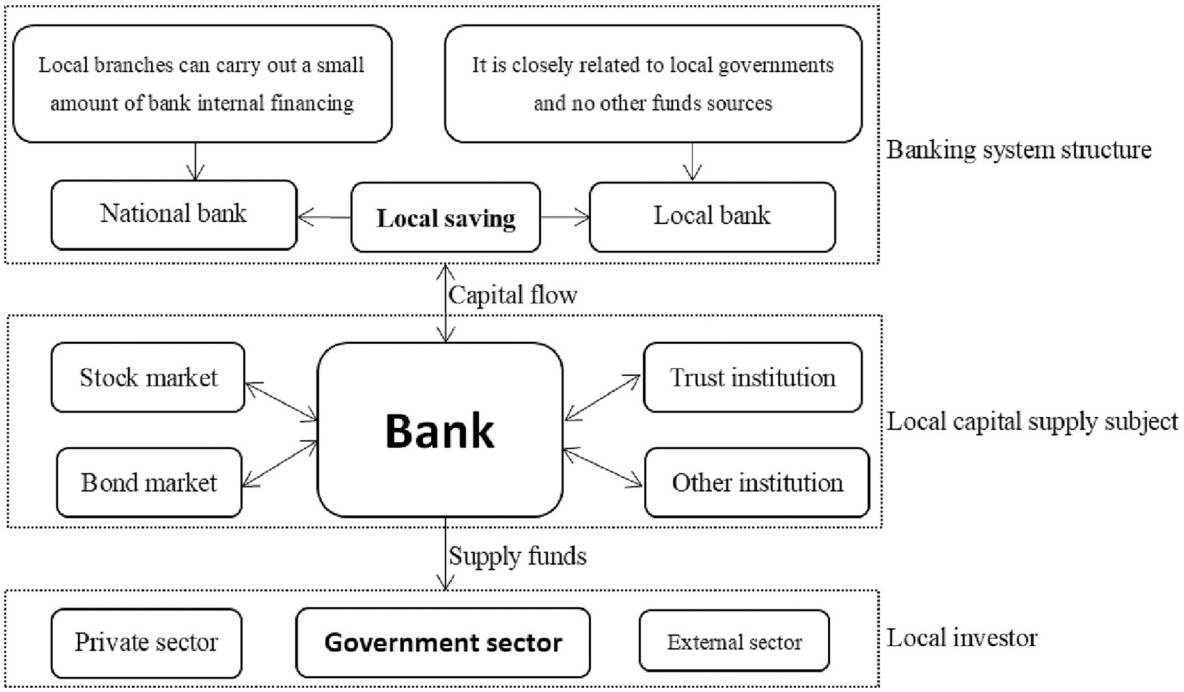

Fig. 4. The Institutional Structure of Regional Investment Financing in China.

companies such as China Telecom and China Mobile have made many communication infrastructure investments. Therefore, China has established a nationwide digital finance system with regionally balanced developments by 2020, which covers the developed areas and most of the under-developed areas and rural areas. The development of Digital finance lowers transaction costs and provides additional choices for households' saving portfolios. Namely, the household can access wealth management and financial investment services through digital finance platforms. There is no limit on the cross-regional flow of funds when saving and investing through digital finance platforms. Take the digital-finance product Yu'ebao as an example. It is a money market fund product integrated with the third-party platform Alipay. It can be easily accessed by households and thus absorbs savings funds. It provides funds to other financial institutions in the money market. Moreover, digital finance intermediaries also cooperated with commercial banks, lending the funds they obtained from commercial banks to online merchants who registered on their platforms. It enables local commercial banks to bypass the regulatory limitation on cross-regional lending. In sum, digital finance affects the cross-regional allocation of funds through three channels: obtaining saving across regions, enhancing the allocation of traditional banking, and providing funds across regions through the money market.

If digital finance improves the flow of funds, it will reduce the correlation between regional savings and investments. Fig. 5 depicts the relationship between the investment-savings correlation and the development of digital finance.[5] By eyeballing Fig. 5, we cannot conclude a clear correlation between the saving-investment correlation coefficient and the development of digital finance. Nearly two-thirds of observations show a positive correlation between saving and investment, and it seems to be trending upward. Still, more than one-third of observations show negative correlations and seemingly trending downward. There could be three possible reasons for the inconclusive relationship: (1) there is indeed no correlation between them; (2) there is a correlation between them, but there are also other influences on the saving-investment correlation not controlled; (3) digital finance influenced the saving-investment correlation through two channels in opposite directions. Therefore, we explore further the possible channels through which digital finance impacts the flow of funds and their spatial allocations.

2.2. Theoretical analysis and hypotheses

2.2.1. Spatial barrel effect and the relax of cross-regional capital flow restrictions

The Neoclassical growth theory assumes no real frictions in the capital market, and the market clears by equaling saving to investment. The steady-state growth rate depends on the savings rate, population growth rate, and technological progress (Bajo-Rubio, 2000; Durlauf et al., 2001). In comparison, the theory of Big-push in the field of economic development (Rosenstein-Rodan, 1961; Thiemann, 2015) focused more on the problem of insufficient investment caused by insufficient saving supply (Flinn, 1990; Esso and

[5] For the correlation between investment and savings in Fig. 5, we use the provincial investment to GDP ratio (investment / GDP) and savings rate (savings / GDP) data to calculate their correlation coefficient in each year.

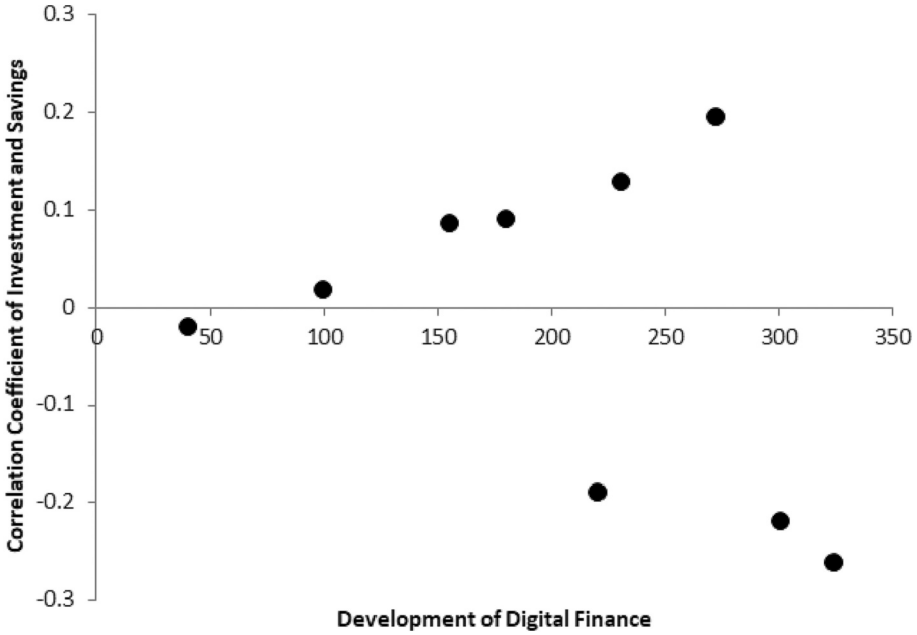

Fig. 5. The XY-plot of Investment-Saving Correlation and Digital Finance Development.

Keho, 2010). Increasing the domestic savings rate and attracting foreign capital are essential for growth. The reality is more complicated for large developing countries with substantial regional differences like China. It is necessary to consider market segmentation when exploring saving and investment allocation. Namely, sufficient savings may be supplied nationally, but it is not allocated balanced across regions because of market segmentation and regional differences. However, the existing research seldom considers spatial structural differences when studying saving and investment allocation, which is essential for large developing countries with less-developed financial markets.

The characteristics of the traditional banking system, including regulatory limitation, geographical segmentation, and the "Guanxi" lending, limit the flow of funds across regions. It causes the spatial barrel effect of saving allocation in China. Compared to the fund allocation through the traditional financial system, digital finance has altered the spatial allocation of China's savings funds. It utilizes big data technology to mitigate the impediments of asymmetric information and promotes the cooperation of online platforms and offline bank branches. It breaks the geographic segmentation of saving allocations and improves the flow of funds nationwide. Therefore, we raise Hypothesis 1 as follows:

Hypothesis 1. Digital finance breaks the "spatial barrel effect of savings allocation" caused by traditional finance and promotes the flow of funds and a balanced capital allocation across the country.

2.2.2. Two opposite effects on the direction of capital flow

There are two effects of digital finance on cross-regional capital movements due to the unbalanced development across regions. On the one hand, because digital finance applies big data, cloud computing, blockchain, and other technologies, it can better identify the project risks of small and medium-sized enterprises and better supervise the fund utilization after lending. Thus, digital finance can mitigate the problem of asymmetric information in the imperfect financial market at a lower cost. That is, digital finance improves the quality of the credit market. This "credit market quality improvement effect" is heterogeneous in different regions. It is more substantial in areas with a less developed credit market than with a more advanced one. As for China, the credit market quality is worse in less-developed areas. With more substantial credit market quality enhancement in these areas, the relative marginal return of capital there will increase. Thus, the balanced digital finance development across the country may cause the capital to flow from developed to less-developed areas. On the other hand, more developed areas may have a higher marginal return of capital due to specialization, high-quality labor, and higher efficiency in organization and production (Bai et al., 2006). The increasing returns to scale may exist according to the endogenous growth theory. Then when digital finance breaks the "spatial barrel effect of savings allocation", the fund would flow from less-developed areas to developed areas, which we named the "endogenous capital return effect". This effect would be enhanced even more when there is an increasing marginal return of capital in developed areas. Therefore, we propose the following Hypothesis 2.

Hypothesis 2. Digital finance influences the direction of cross-regional capital flows through the "credit market quality improvement effect" and "endogenous capital return effect". The former causes the capital to flow from less-developed to developed areas. The latter causes the capital to flow in the opposite direction. Hence, the total effects depend on their relative sizes.

3. Empirical designs and methodologies

3.1. Empirical design of Hypothesis 1

Two kinds of empirical methods can be applied to identify cross-regional capital movement in the existing literature: the FH method and the spatial econometrics method. First, the FH framework (Feldstein and Horioka, 1980; Hwang and Kim, 2018) was developed to evaluate the degree of cross-country capital mobility by estimating the correlation between saving and investment. Under financial autarky, a country's investment must be financed by domestic savings. Thus, the correlation between saving and investment is equal to 1. If capital mobility is high, savings will be invested in the country with the highest capital return, resulting in a low correlation between national savings and investments. Regional saving and investment would be highly correlated if cross-regional capital movements were limited. Many studies also adapted the FH framework to evaluate capital mobility across regions within a country. Sinn (1992), Bayoumi and Rose (1993), and Iwamoto and Wincoop (2000) have measured the cross-regional capital mobility for US, UK, and Japan, respectively. Li (2010) and Chan et al. (2011) have estimated the correlation between saving and investment in China, both of which found a low correlation that indicates low capital mobility in China. Second, the application of the spatial method depends on the existence of spatial autocorrelation. We calculate Moran's *I* index using regional investment growth rate and find no significant spatial autocorrelation. Therefore, we choose to apply the FH framework. Different from previous studies, we extend the model in several dimensions: first, to account for the dynamic adjustment of investment by including the lag term of the dependent variable. Second, several control variables are included to account for the regional economic characteristics. Third, digital finance development and its interaction term with investment to GDP ratio are included in the model to account for the impact of digital finance development. Hence, the model is specified as follows:

$$(I/Y)_{it} = c + \beta_0 (I/Y)_{it-1} + \beta_1 (S/Y)_{it} + \beta_2 DF_{it} + \beta_3 DF_{it} * (S/Y)_{it} + \delta_k Z_{it}^k + \gamma_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where *I/Y* is the investment to GDP ratio at the provincial level. *S/Y* is the saving to GDP ratio, measured by total deposit to GDP. *DF* is the digital finance development measured using the "Chinese Digital Financial Inclusion Index" published by Peking University (Guo et al., 2020). Z^k is a vector of control variables that contains various regional economic characteristics, including labor cost (*LC*), regional income size (*RE*), regional income volatility (*EF*), regional fiscal support (*LG*), and sectoral structure (*ES*). *LC* is measured as the average wage of urban employed labor. *RE* is measured as the provincial GDP to national GDP ratio. *EF* is measured by the HP-filtered cycle term of GDP. *LG* is measured as the local government's fiscal expenditure to GDP ratio. *ES* is measured as the ratio of the tertiary industry's value-added to GDP. γ_i and γ_t is the provincial fixed effect and time effect, respectively. ε_{it} is the error term.

The coefficient β_1 in the regression model (1) captures the correlation between regional saving and investment. The larger estimates of the coefficient, the weaker the cross-regional capital movement. The coefficient of the interaction term *DF*(S/Y)* reflects the impact of digital financial development on cross-regional capital flow, which would be negative under *Hypothesis 1*.

3.2. Empirical design of Hypothesis 2

3.2.1. The impact of digital finance on the direction of cross-region capital flow

To test Hypothesis 2, we need to test the direction of cross-regional capital flow. However, it is difficult to directly identify the direction of regional capital flow. Therefore, we indirectly test the direction of cross-regional capital flow by examining the convergence of capital allocation according to Dowrick and Rogers (2002). The empirical model is specified as follows:

$$\Delta i_{it} = c + \beta_0 \Delta i_{i,t-1} + \beta_1 lni_{i,0} + \beta_2 DF_{it} + \beta_3 DF_{it} * lni_{i,0} + \delta_k Z_{it}^k + \gamma_i + \gamma_t + \varepsilon_{it} \quad (2)$$

where Δi is the per capita investment growth rate. $lni_{i,0}$ is the logarithm of the initial investment per capita. The lag terms of the dependent variable are included in the model to reflect the dynamic adjustment of per capita investment. The definitions of other variables are the same as in the regression model (1). If the coefficient of lni_0 is negative, it indicates that the per capita investment growth rate is low when one region's initial per capita investment is high, then the cross-regional capital movement contributes to regional convergence of investment allocation. Namely, the capital flow from developed areas to less-developed areas. Vice versa. The coefficient of the interactive term $DF*lni_0$ reflects the impact of digital financial development on regional convergence of investment allocation. If its coefficient is negative, it indicates that digital finance contributes to regional investment convergence. On the contrary, if the coefficient is positive, then digital finance weakens the convergence, and it causes capital to flow from less-developed to developed areas.

3.2.2. Two effects of digital finance on the direction of regional capital flow

To test two opposite effects of digital finance on regional capital flow stated in *Hypothesis 2*, namely "credit market quality improvement effect" and "*endogenous capital return effect*", the empirical model is constructed as follows:

$$RI_{it} = c + \beta_0 RI_{it-1} + \beta_1 DF_{it} + \beta_2 DF_{it} * D + \beta_3 CMQ_{it} + \beta_4 DF_{it} * CMQ_{it} + \beta_5 DF_{it} * CMQ_{it} * D + \delta_k Z_{it}^k + \gamma_i + \gamma_t + \varepsilon_{it} \quad (3)$$

where *RI* is the investment return rate measured following Bai et al. (2006).[6] The lagged dependent variable reflects the dynamic of the investment return rate. *CMQ* is the quality of the credit market. It is measured using the credit fund allocation index, a sub-index of China's marketization index. *D* is the regional development dummy variable, $D = 1$ if the region is developed, $D = 0$ otherwise. Other variables are defined the same as before. The estimated coefficient of the interaction term *DF*D* reflects the existence of the "endogenous capital return effect". If the coefficient is positive and statistically significant, it means that digital finance has a more substantial effect on improving the investment return rate in developed areas than in less-developed areas. The coefficient of *DF*CMQ* reflects how digital finance affects investment return through its effects on credit market quality. The estimated coefficient of the interaction term *DF*CMQ*D* tests the existence of the "credit market quality improvement effect". If the sign of this estimate is opposite to that of the estimates for the coefficient of *DF*CMQ*, it indicates that digital finance can better improve the credit market quality in less-developed regions, thus raising the investment return of less-developed regions more than developed regions.

3.3. Controlling the impacts of the development of traditional finance

The development of traditional finance can also weaken financial frictions. Thus, it may have similar effects as digital finance development on cross-region capital movements. Therefore, does digital finance development affect the regional capital flow independently? Or does it simply substitute part of the functions of traditional finance? Intuitively, digital finance is more than a new form of the traditional financial system. It is also a new technology and platform for the financial market's information processing and operations. Thus, digital finance is very likely to have an independent effect. Hence, we further control the effects of traditional finance development and explore the independent impacts of digital finance development. Based on baseline equations about hypotheses 1 and 2, we construct the following empirical model:

$$\left(\frac{I}{Y}\right)_{it} = c + \beta_1\left(\frac{S}{Y}\right)_{it} + \beta_2 DF_{it} + \beta_3 DF_{it}*\left(\frac{S}{Y}\right)_{it} + \beta_4 TF_t + \beta_5 TF_t*\left(\frac{S}{Y}\right)_{it} + \delta_k Z_{it}^k + \gamma_i + \varepsilon_{it} \tag{4}$$

$$\Delta i_{it} = c + \beta_0 \Delta i_{i,t-1} + \beta_1 lni_{i,0} + \beta_2 DF_{it} + \beta_3 DF_{it}*lni_{i,0} + \beta_4 TF_t + \beta_5 TF_t*lni_{i,0} + \delta_k Z_{it}^k + \gamma_i + \varepsilon_{it} \tag{5}$$

where *TF* is the development of traditional finance. There are three types of proxies for traditional finance development: financial depth, financial width, and financial structure (Goldsmith, 1969; Levine, 1997; Levine, 2002; Ma and Lin, 2016). Following the existing studies, we define three proxies as follows: financial depth (*TFD*) = M2/GDP, financial width (*TFW*) = private sector credit / total social financing, and financial structure (*TFS*) = (equity financing + bond financing) / bank loan. However, note that these three proxies reflect the development of traditional finance and are also possibly influenced by the development of digital finance (Zhong and Jiang, 2021). It brings difficulties to the identification of the independent effect of digital finance. To solve this problem, we identify according to the following logic: we rank the three proxies by the magnitude of digital finance's impacts as $TFD > TFW > TFS$. The justification is that digital finance has the most significant impact on payment and people's preference for holding money, affecting money creation and, thus, money supply. Besides its considerable impact on money creation, digital finance also dramatically impacts the credit supply for medium, small and micro enterprises, thus raising private credit. Its impact on direct financing is relatively small (Huang and Huang, 2018). Based on this ranking, when using *TFD*, *TFW,* and *TFS,* respectively, for traditional finance (*TF*) in regressions of Eqs. (4) and (5), the marginal effect of digital finance (absolute value for the estimates of β_3) that identified should be increasing, which indicates that digital finance has independent impacts other than the development of traditional finance.

3.4. Empirical methodologies and the data

In order to account for both common shock and the idiosyncratic shocks that affect the accurate estimation of the correlation between saving and investment, Li (2010) applied several estimation methods, including pooled OLS, fixed effects estimation, mean group estimation, and common correlated effects estimations, and Chan et al. (2011) applied panel dynamic OLS and canonical cointegration regressions. In our extended framework, the accurate and effective estimations for Eqs. (1) to (5) may encounter three problems: first, the inertia and adjustment cost characteristics for investment may lead to the correlation between the error term and the lag term of the dependent variable. Second, the autocorrelation of the investment may cause the autocorrelation in the error term. For these two problems, we control for the cross-sectional fixed effect, and use the within-group estimation and the System GMM method. Third, the heteroskedasticity of the disturbance term may exist due to the variation in provincial investment. Controlling for other factors that influence provincial investment can well mitigate this problem.

Our sample is panel data at the provincial level and annual frequency, including 31 Chinese provinces (excluding Hong Kong, Macao, and Taiwan) ranging from 2011 to 2020. The Data is obtained from the Chinese Statistical Yearbook, provincial statistical yearbooks, China marketization index, and Wind databases. The Data for digital finance is obtained from the Institute of Digital Finance of Peking University. Table 1 provides the descriptive statistics of key variables.

[6] Bai et al. (2006) introduced the process for measuring China's provincial investment return rate in great detail.

Table 1
Descriptive Statistics.

	Variable	Obs	Mean	SD	Min	Max
Dependent variable	*I/Y*	310	0.81	0.26	0.21	1.51
	SI/Y	310	0.24	0.17	0.04	1.14
	PI/Y	310	0.50	0.18	0.08	0.89
	OI/Y	310	0.03	0.02	0.00	0.09
	Δi	310	0.11	0.12	−0.62	0.40
Key Explanatory variables	*RI*	310	0.13	0.09	−0.12	0.45
	S/Y	310	0.19	0.14	−0.10	1.24
	DF	310	2.02	0.92	0.16	4.10
	CO	310	1.82	0.90	0.02	3.85
	DE	310	1.97	0.91	0.07	4.40
	DI	310	2.78	1.17	0.08	4.62
	CMQ	310	5.28	2.60	−0.33	10.35
	D	310	0.35	0.48	0	1
	TFD	310	7.41	0.54	6.44	8.00
	TFW	310	0.24	0.07	0.16	0.36
	TFS	310	0.63	0.28	0.30	1.09
Control variables	*LC*	310	10.99	0.32	10.35	12.02
	RE	310	0.03	0.03	0.00	0.10
	EF	310	0.00	0.04	−0.17	0.16
	LG	310	0.28	0.21	0.11	1.38
	ES	310	0.05	0.03	−0.18	0.16

4. Results and discussions

4.1. Results of Hypothesis 1

Table 2 reports the estimation results for Eq. (1). The results of the Hansen test, AR (1) and AR (2) tests indicate that the effectiveness of instrument variables and the estimation results of the system GMM method is reliable.

First, as shown in Table 2, all the coefficient estimates of *S/Y* are positive and at least statistically significant at 5% level. It means that local savings significantly impact local investment, and the capital flow across regions is limited to a certain extent. Second, all the coefficient estimates for *DF*S/Y* are negative and statistically significant at 1% level. That is, *DF* can reduce the correlation between local savings and investment. It indicates that the development of digital finance has weakened the restrictions on allocating savings

Table 2
The Impact of Digital Finance on Cross-regional Capital Flow.

Variables	within-group	within-group	within-group	sys-GMM	sys-GMM	sys-GMM
$(I/Y)_{-1}$	0.7591***	0.7382***	0.6760***	0.7571***	0.7992***	0.6925***
	(0.0538)	(0.0505)	(0.0769)	(0.0707)	(0.0786)	(0.0982)
S/Y	0.6601***	0.4883**	0.2381***	0.5602***	0.4266**	0.3601**
	(0.1482)	(0.2105)	(0.0627)	(0.1137)	(0.1973)	(0.1725)
DF		0.3826*	0.3281**		0.4226**	0.3038*
		(0.2057)	(0.1524)		(0.2013)	(0.1624)
*DF*S/Y*		−0.0716***	−0.0548***		−0.0760***	−0.0489***
		(0.0153)	(0.0116)		(0.0188)	(0.0097)
LC			−0.0505***			−0.0601**
			(0.0127)			(0.0275)
RE			0.1155			0.3124
			(0.0968)			(0.2759)
EF			−0.0641**			−0.0343*
			(0.0305)			(0.0187)
LG			0.0478**			0.0317***
			(0.0215)			(0.0091)
ES			0.0412			0.0334
			(0.0379)			(0.0310)
Individual FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Observation	279	279	279	279	279	279
Adjust-R^2	0.60	0.62	0.68			
AR (1)				0.00	0.00	0.01
AR (2)				0.40	0.54	0.58
Hansen Test				0.28	0.39	0.52

Notes: Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively. AR (1) and AR (2) test lists the P-value of the first- and second-order autocorrelation of the differenced residual, respectively. The Hansen test lists the *P*-value of the over-identification test of instrumental variables.

across regions in traditional finance. The cross-regional capital movements have greatly increased. The results support *Hypothesis* 1 that digital finance development in China has broken the spatial barrel effect of savings allocation and improved cross-regional capital flow and allocation.

4.2. Results of *Hypothesis 2*

Tables 3 and 4 reports the estimation results for Eq. (2) and Eq. (3), respectively.

First, as shown in Table 3, the estimated coefficients for lni_0 are all negative and statistically significant at 1% level. It indicates that the regions with high initial capital stock (more developed regions) have relatively low investment growth rates, which is the conditional convergence of capital allocation. The estimated coefficients for the interaction term $DF*lni_0$ are all positive and statistically significant at 1% level. Namely, *DF* reduces the convergence of capital allocation. It implies that the development of digital finance causes the capital to flow from less-developed regions to developed regions, which hinders the convergence of investment across regions. The results contradict the common expectation that digital finance is more inclusive than traditional finance, improving the balanced regional development in developing countries. On the contrary, digital finance overall hurts the inclusiveness of financial development.

Second, we test both the "credit market quality improvement effect" and the "endogenous capital return effect" of digital finance development on the direction of regional capital flow. For the "endogenous capital return effect", according to the results in Table 4, the estimates of the coefficients for *DF* are all positive and statistically significant at 5% level at least. That is, digital finance development increases the investment return. The coefficient estimates for the interaction term *DF*D* are all positive and statistically significant at 1% level. It implies that digital finance development improves investment return in developed regions more than in less-developed regions. It proves the existence of the "endogenous capital return effect", which causes the capital flow from less-developed regions to developed regions. For the "credit market quality improvement effect", as shown in Table 4, the coefficients of *CMQ* are all estimated to be positive and statistically significant at 5% level. Namely, the credit market quality enhancement can improve the investment return. The estimated coefficients of *DF*CMQ* are all positive and statistically significant at 5% level. That is, digital financial help improve the credit market quality and contribute to higher investment returns. The coefficient estimates of *DF*CMQ*D* are all negative and weak significant at 10% level. It indicates that the "credit market quality improvement effect" of digital finance development is weakly stronger in less-developed areas than in developed areas. Hence, the "credit market quality improvement effect" does exist. Furthermore, according to the magnitudes of the estimated coefficients in column 7 of Table 4, the "endogenous capital return effect" is much larger than the "credit market quality improvement effect".

Therefore, the results verify *Hypothesis 2*. The development of digital finance hinders the convergence of investment. It leads the capital flow from less-developed areas to developed areas. The reason is that the "endogenous capital return effect" dominates the "credit market quality improvement effect". In other words, although digital finance development improves the credit market quality

Table 3
The Overall Impact of Digital Finance on the Direction of Regional Capital Flow.

Variables	within-group	within-group	within-group	sys-GMM	sys-GMM	sys-GMM
$(\Delta i)_{-1}$	0.2072***	0.1661***	0.0908***	0.0986***	0.0357***	0.0249***
	(0.0386)	(0.0257)	(0.0149)	(0.0136)	(0.0085)	(0.0071)
lni_0	−0.5281***	−0.3632***	−0.2801***	−0.2950***	−0.2097***	−0.1628***
	(0.1259)	(0.1037)	(0.0924)	(0.0861)	(0.0672)	(0.0429)
DF		0.2561**	0.1773*		0.2683*	0.1915**
		(0.1138)	(0.0953)		(0.1434)	(0.0912)
$DF*lni_0$		0.0826***	0.0460***		0.0685***	0.0313***
		(0.0241)	(0.0137)		(0.0189)	(0.0105)
LC			−0.0996			−0.0448
			(0.1357)			(0.0729)
RE			0.4030			0.1182
			(0.3844)			(0.1573)
EF			−0.3871**			−0.2908**
			(0.1769)			(0.1419)
LG			0.2153			0.4861
			(0.1862)			(0.3958)
ES			0.0842**			0.1379*
			(0.0401)			(0.0757)
Individual FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Observation	279	279	279	279	279	279
Adjust-R^2	0.45	0.55	0.57			
AR (1)				0.00	0.00	0.01
AR (2)				0.49	0.53	0.60
Hansen Test				0.47	0.59	0.65

Notes: Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively. AR (1) and AR (2) test lists the P-value of the first- and second-order autocorrelation of the differenced residual, respectively. The Hansen test lists the *P*-value of the over-identification test of instrumental variables.

Table 4
The Two Effects of Digital Finance on the Direction of Regional Capital Flow.

Variables	within-group	within-group	within-group	sys-GMM	sys-GMM	sys-GMM
RI$_{-1}$	0.7851***	0.7372***	0.7120**	0.8703***	0.8176***	0.7871***
	(0.0826)	(0.0935)	(0.1058)	(0.1206)	(0.1409)	(0.1638)
DF	0.0711***	0.0639**	0.0602**	0.1525***	0.1127***	0.0860**
	(0.0135)	(0.0301)	(0.0285)	(0.0512)	(0.0320)	(0.0401)
*DF*D*		0.0233***	0.0137***		0.0355***	0.0220***
		(0.0062)	(0.0039)		(0.0104)	(0.0068)
CMQ			0.0253**			0.0387**
			(0.0114)			(0.0172)
*DF*CMQ*			0.0091**			0.0116**
			(0.0042)			(0.0051)
*DF*CMQ*D*			−0.0032*			−0.0024*
			(0.0017)			(0.0013)
LC	−0.0686*	−0.0707*	−0.0764	−0.0388	−0.0173*	−0.0274
	(0.0374)	(0.0388)	(0.0619)	(0.0326)	(0.0095)	(0.0239)
RE	0.2051	0.0980	0.1659	0.1448	0.2729	0.1305
	(0.1862)	(0.0761)	(0.1425)	(0.1159)	(0.2430)	(0.1217)
EF	−0.0727*	−0.0702*	−0.0793	−0.0123	−0.0128	0.0219
	(0.0390)	(0.0385)	(0.0672)	(0.0155)	(0.0146)	(0.0268)
LG	0.0302*	0.0272	0.0504	0.0133	0.0469	0.0651*
	(0.0161)	(0.0249)	(0.0439)	(0.0156)	(0.0418)	(0.0355)
ES	0.0531	0.0537	0.0384	0.0645	0.0318*	0.0776
	(0.0493)	(0.485)	(0.0352)	(0.0518)	(0.0173)	(0.0658)
Individual FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Observation	279	279	279	279	279	279
Adjust-R^2	0.65	0.67	0.70			
AR (1)				0.00	0.00	0.00
AR (2)				0.61	0.65	0.70
Hansen Test				0.36	0.51	0.57

Notes: Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively. AR (1) and AR (2) test lists the P-value of the first- and second-order autocorrelation of the differenced residual, respectively. The Hansen test lists the *P*-value of the over-identification test of instrumental variables.

Table 5
The Impact on Regional Capital Flow (controlling Traditional Finance Development).

Variables	within-group	within-group	within-group	sys-GMM	sys-GMM	sys-GMM
(I/Y)$_{-1}$	0.5892***	0.5416***	0.5279***	0.6013***	0.6138***	0.6310***
	(0.0812)	(0.0920)	(0.1047)	(0.0856)	(0.1159)	(0.1428)
S/Y	0.2159***	0.2037**	0.1930***	0.3273***	0.3429**	0.3510**
	(0.0583)	(0.0892)	(0.0548)	(0.0917)	(0.1583)	(0.1691)
DF	0.3026**	0.2873**	0.2915*	0.2706*	0.2915**	0.3192*
	(0.1405)	(0.1360)	(0.1550)	(0.1447)	(0.1386)	(0.1706)
*DF*S/Y*	−0.0215	−0.0406**	−0.0478***	−0.0199*	−0.0375**	−0.0431***
	(0.0189)	(0.0182)	(0.0120)	(0.0105)	(0.0180)	(0.0118)
TFD	0.1215***			0.0902		
	(0.0413)			(0.0755)		
*TFD*S/Y*	−0.0582**			−0.0809*		
	(0.0269)			(0.0442)		
TFW		0.5301***			0.5635**	
		(0.1027)			(0.2671)	
*TFW*S/Y*		−0.0810**			−0.0631**	
		(0.0392)			(0.0287)	
TFS			0.1168***			0.1269**
			(0.0329)			(0.0591)
*TFS*S/Y*			−0.0304**			−0.0180**
			(0.0138)			(0.0079)
Control	YES	YES	YES	YES	YES	YES
Observation	279	279	279	279	279	279
Adjust-R^2	0.70	0.73	0.74			
AR (1)				0.00	0.00	0.00
AR (2)				0.29	0.41	0.34
Hansen Test				0.58	0.71	0.66

Notes: Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively. AR (1) and AR (2) test lists the P-value of the first- and second-order autocorrelation of the differenced residual, respectively. The Hansen test lists the *P*-value of the over-identification test of instrumental variables.

more in less-developed areas, the growth potential in developed areas is more attractive to financial institutions, thus drawing funds from the less-developed areas.

4.3. Results controlling for the development of traditional finance

Tables 5 and 6 reports the estimation results of eqs. (4) and (5), respectively, that control for the possible influence of traditional finance development. As previously mentioned, three different traditional finance development proxies are used to identify the independent influence of digital finance on cross-regional capital flow. According to the results in Table 5, first, when financial depth (*TFD*) and its impacts on the regional capital flow (*TFD*S/Y*) are controlled in the estimation, the effect of digital finance on the regional capital flow (*DF*S/Y*) is not significant (column 1) or weak significant (column 4). Because both digital finance and traditional finance can affect financial depth, the estimated direct impact of digital finance on cross-regional capital flow is dampened when the effect of financial depth is controlled. Second, when financial width (*TFW*) and financial structure (*TFS*) and their impacts on the regional capital flow (*TFW*S/Y* and *TFS*S/Y*) are included in the estimation, the effect of digital finance on the regional capital flow (*DF*S/Y*) are still statistically significant and negative. That is, digital finance has an independent effect on regional capital movements. But the magnitude of the effect identified is smaller than the corresponding estimates in Table 2 without controlling for the effect of traditional finance development. In addition, since digital finance has less impact on financial structure than on financial width, the estimated impact of digital finance is more prominent when a financial structure proxy is used than when financial width proxy is used. Last but not least, as shown in columns 3 and 6, the effect of digital finance on regional capital flow is larger than that of traditional finance. The coefficient estimate of *DF*S/Y* is −0.0431, while the estimate for the coefficient of *TFS*S/Y* is −0.0180.

In sum, the results imply that finance development can overall lead to more cross-regional capital movement. Apart from the effects of traditional finance development, digital finance development has an independent effect on the cross-regional flow of funds. *Hypothesis* 1 remains true when the effect of traditional finance development is controlled.

First, according to the results in Table 6, when traditional financial development proxies and their interaction with lni_0 are introduced into the regression, the coefficients of $DF*lni_0$ are mostly positive and statistically significant. That is, digital finance leads to the divergence of capital allocation. Namely, *Hypothesis* 2 holds after controlling for the possible impact of traditional finance development. Second, the coefficients of interaction terms of traditional financial development with lni_0 are neither statistically significant. Namely, traditional financial development does not significantly affect capital allocation convergence. One possible reason is that the "credit market quality improvement effect" and "endogenous capital return effect" of traditional financial development equals each other, thus offsetting. The other possible reason is that digital finance development and traditional finance development have opposite impacts on the convergence of capital allocation. Thus, the overall impact is ambiguous when the proxies are possibly influenced by digital finance development. Third, when financial depth (*TFD*) is used as a proxy for traditional financial development,

Table 6
The Impact on the Regional Capital Flow Direction (controlling Traditional Finance Development).

Variables	within-group	within-group	within-group	sys-GMM	sys-GMM	sys-GMM
$(\Delta i)_{-1}$	0.0813***	0.0756***	0.0846***	0.0205***	0.0210***	0.0192***
	(0.0138)	(0.0116)	(0.0157)	(0.0062)	(0.0058)	(0.0050)
lni_0	−0.2518***	−0.2632***	−0.2573***	−0.1915***	−0.1536***	−0.1402***
	(0.0653)	(0.0716)	(0.0624)	(0.0520)	(0.0473)	(0.0401)
DF	0.1519**	0.1420*	0.1618*	0.1730**	0.1681*	0.1539**
	(0.0716)	(0.0759)	(0.0869)	(0.0802)	(0.0918)	(0.0713)
$DF*lni_0$	0.0204*	0.0351**	0.0405***	0.0146	0.0250**	0.0281***
	(0.0112)	(0.0163)	(0.0118)	(0.0119)	(0.0113)	(0.0082)
TFD	0.1359*			0.0902*		
	(0.0726)			(0.0487)		
$TFD* lni_0$	−0.0582			−0.0315		
	(0.0491)			(0.0284)		
TFW		0.0530***			0.0592**	
		(0.0126)			(0.0281)	
$TFW* lni_0$		−0.0214			−0.0337	
		(0.0185)			(0.0274)	
TFS			0.1169*			0.1247**
			(0.0638)			(0.0602)
$TFS* lni_0$			−0.0304			−0.0513
			(0.0288)			(0.0460)
Control	YES	YES	YES	YES	YES	YES
Observation	279	279	279	279	279	279
Adjust-R^2	0.59	0.60	0.62			
AR (1)				0.00	0.00	0.00
AR (2)				0.36	0.55	0.69
Hansen Test				0.55	0.52	0.65

Notes: Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively. AR (1) and AR (2) test lists the P-value of the first- and second-order autocorrelation of the differenced residual, respectively. The Hansen test lists the *P*-value of the over-identification test of instrumental variables.

the coefficient estimates for DF^*lni_0 are weakly significant at 10% level (column 1) or insignificant (column 4). When financial width (*TFW*) is used, the coefficient estimates for DF^*lni_0 are significant at 5% level (columns 2 and 5). When financial structure (*TFS*) is used as a proxy, the coefficient estimates for DF^*lni_0 are significant at 1% level (columns 3 and 6). Hence, when the proxies are less affected by digital finance development, the independent effect of digital finance on capital allocation convergence is more clearly identified. Compared with the coefficient estimates without controlling for the impact of traditional finance in Table 3, the magnitude of estimates here is smaller.

We can draw some policy implications from the results: the development of digital finance was mainly due to the application the new information and communication technologies or may bypass some strict regulations on traditional financial institutions, thus further propelling the marketization of the financial market and leading to the higher mobility of cross-regional capital movement. In contrast, the development of traditional finance mainly relied on institutional reforms to achieve further marketization, while the process is advancing slowly. The cross-regional capital movements are limited under the traditional finance system. However, without the institutional reform of the traditional finance system, solely relying on technological advancement to achieve the marketization of the financial market caused the capital flows from the less-developed regions to developed regions. It worsens the imbalanced investment allocation, thus causing further gaps in growth potential and higher income inequality across the regions. If no future institutional reforms address the problem, it will hurt growth inclusiveness in China.

4.4. Robustness checks

4.4.1. Considering investment allocations by different agents

Previously, when exploring the impact of digital finance on cross-regional capital flow and allocation of investment, we considered the investment at the aggregate level. However, the investment decisions made by different agents could lead to different allocation results. That is, the regional allocations of public investment (*SI*), domestic private investment (*PI*), and foreign investment (*OI*) are different. Then how does digital finance affects investment allocations by different agents? Would the impacts on cross-regional capital flow be heterogeneous? Hence, we further explore whether the results of *Hypothesis* 1 hold when using the data of three types of investments, respectively.

Table 7 reports the results using public, private, and foreign investment as the dependent variable in the model (1). As shown in Table 7, first, digital finance does not significantly impact the cross-regional capital movement of public investment. The coefficient estimates of *DF*S/Y* are insignificant in columns 1 and 4. Second, digital finance has a significant impact on the cross-regional capital movement of domestic private investment and foreign investment. For domestic private investment, the coefficient estimates of *DF*S/Y* are statistically significant at 1% level and equal to −0.1244 and − 0.0716 in columns 2 and 5, respectively. For foreign investment, the estimated coefficients of *DF*S/Y* are statistically significant at 5% level and equal to −0.1336 and − 0.0953, respectively. Hence, digital finance substantially impacts the cross-regional capital movement in the private sector more than in the public sector. Intuitively, public investment follows the policies and guidelines of government authorities, whose purposes are to serve the government's development strategies. Most public investments are non-market behaviors. Even if digital finance development breaks the barriers between different regions, it will not affect public investment allocations. On the contrary, both domestic private investment and foreign investment are made by private entities. Their financing and investment behaviors are market-oriented. They would benefit from more sources of financing and more opportunities for investment as digital finance break the barriers in the flow of funds across the regions. The funds in the private sector are keen to flow to the regions with higher returns. Hence, digital finance mainly enhances the cross-regional capital movement in the private sector.

Table 7
The Impact of Digital Finance on Regional Capital Flow (Different Investment Categories).

Variables	*SI*	*PI*	*OI*	*SI*	*PI*	*OI*
$(I/Y)_{-1}$	0.1038***	0.3162***	0.1919***	0.1609***	0.5950***	0.4152***
	(0.0159)	(0.0368)	(0.0251)	(0.0192)	(0.0724)	(0.0580)
S/Y	0.3528**	0.4561**	0.3704**	0.2236**	0.2401***	0.3471***
	(0.1639)	(0.2105)	(0.1792)	(0.1028)	(0.0670)	(0.0982)
DF	0.0396**	0.0647***	0.0130*	0.0157*	0.0258***	0.0332**
	(0.0185)	(0.0203)	(0.0071)	(0.0086)	(0.0062)	(0.0078)
*DF*S/Y*	0.1105	−0.1244***	−0.1336**	0.0989	−0.0716***	−0.0953**
	(0.0826)	(0.0372)	(0.0627)	(0.0715)	(0.0218)	(0.0460)
Control	YES	YES	YES	YES	YES	YES
Observation	279	279	279	279	279	279
Adjust-R^2	0.47	0.49	0.60			
AR (1)				0.00	0.00	0.00
AR (2)				0.26	0.37	0.39
Hansen Test				0.55	0.52	0.49

Notes: Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively. AR (1) and AR (2) test lists the P-value of the first- and second-order autocorrelation of the differenced residual, respectively. The Hansen test lists the *P*-value of the over-identification test of instrumental variables.

4.4.2. Considering different dimensions of digital finance development

We explore further whether the different dimensions of digital finance development have heterogeneous impacts on the regional capital flow and convergence of investment allocation. The development of digital finance can be reflected by the increasing numbers of transaction accounts, the deepening of digital financial services, and the facilitation of financial services. Correspondingly, there are three sub-indexes for digital finance development: coverage index (*CO*), usage depth index (*DE*), and digitization degree index (*DI*). The coverage index reflects the extensive margin, including the number of accounts and the linked bank cards per account. The usage depth index reflects the intensive margin, including the intensity and frequency of digital finance services, such as payment, money market funds, credit guarantee, insurance, loans, and wealth management. The digital degree index reflects usage benefits, including the average loan rate of credit services and the density of using services through mobile phones. Thus, it is interesting and important to study which dimension in digital finance development is the main driven force of the regional capital flow.

Table 8 shows the estimation results of model 1 using sub-indexes. As shown in Table 8, when using the coverage index (*CO*), the estimated coefficients of *CO*(S/Y)* are all positive but insignificant. When using the usage depth index (*DE*) and digitization degree index (*DI*), the estimated coefficients of *DE*(S/Y)* and *DI*(S/Y)* are all negative and statistically significant. The coefficients of *DE*(S/Y)* are significant at 5% level and equal to −0.0345 (column 2) and − 0.0210 (column 4), respectively. The coefficients of *DI*(S/Y)* are significant at 1% level, and equal to −0.0299 (column 3) and − 0.0452 (column 6). The results using *DE* and *DI* are consistent with the result using the aggregate index. Hence, the usage depth and digitization degree contribute to the cross-regional capital movement, but the coverage does not.

The possible explanations are: the coverage reflects the number of accounts registered, while it does not account for the actual transactions made in these accounts. On the contrary, the usage depth index reflects the number, amount, and frequency of various transactions conducted on digital finance platforms. The digitization degree index reflects the degree of convenience, mobility, and benefits of digital finance platforms (Fig. 6). Thus, the usage depth and the digitization degree reveal more accurately the amount of financing and investment made and the benefits obtained by digital finance, which is related to the cross-regional capital flow.

4.4.3. Robustness check with alternative empirical method

In this subsection, we apply an alternative measure of cross-regional net capital flow and quantile regression to check the robustness of our results. Following Guo and Wang (2003), we construct a proxy for cross-regional net capital flow. Within a country, the flow of goods and services should be opposite to the flow of funds. Thus, we calculate the net flow of goods and services of provinces to proxy the net flow of funds. We subtract the provincial net export from the provincial net outflow of goods and services, thus obtaining the provincial net outflow of goods and services to other provinces. Then we standardize this measure of regional capital flow as a percentage of GDP and denote it as *RCF*. When *RCF* is positive, it indicates net capital inflow from other provinces and vice versa. RCF is positive for most developed areas, which means they have net capital inflows. While for most of the less-developed areas, *RCF* is negative, which implies they have net capital outflows. In order to test the effect of digital finance on cross-regional capital flow, we construct the empirical model as follows:

$$RCF_{it} = c + \beta_1 DF_{it} + \delta_k Z_{it}^k + \gamma_i + \gamma_t + \varepsilon_{it} \tag{6}$$

Because previously, we found digital finance has different effects on the regional capital flow in developed and less-developed regions, we estimate Eq. (6) with bootstrap quantile regression to check the robustness of previous results. Table 10 reports the estimation results. As shown in Table 10, digital finance has statistically significant impacts on the *RCF* under different quantiles. The coefficients of *DF* for the regression of 10%、30%, and 50% quantile of *RCF* are negative, which indicates that digital finance causes more net capital outflow from less-developed areas. The magnitude of the negative impact is the largest and most significant for the 10% quantile of *RCF*. The coefficients of *DF* for the regression of 70% and 90% quantile of *RCF* are positive, which indicates that digital finance leads to more net capital inflow to developed areas. The magnitude of the positive effect is the largest and most significant for the 90% quantile of *RCF*. Therefore, the results imply that digital finance makes regional capital allocation even more imbalanced, which is consistent with the previous findings.

5. Conclusion

We study the effects of digital finance development on cross-regional capital movement and the directions of capital flows using Chinese provincial data from 2011 to 2020. The results show that digital finance development breaks the “spatial barrel effect” of savings and investment allocation in the traditional finance system, thus improving cross-regional capital mobility. Regarding the direction of capital flows, the “endogenous capital return effect” draws the capital from less-developed areas to developed areas due to the higher return of capital in developed areas. The “credit market quality improvement effect” leads the capital to flow in the opposite direction because digital finance improves the credit market quality in less-developed regions. The former dominates the latter, thus worsening the imbalanced regional investment allocations. Moreover, we found that digital finance has independent effects on cross-regional capital movements and their direction after controlling the effect of traditional financial development with various measures. And digital finance mainly influences private and foreign investment made by the private sector but does not impact public investment. Furthermore, applying the sub-indexes of digital finance, we found that digital finance takes effect primarily through the usage depth and the digitization degree.

Our results draw substantial policy implications for the inclusive development of the financial system and balanced regional growth. Because regional imbalanced growth and inequality are essential issues for large developing economies, achieving balanced

Table 8
The Impact of Digital Finance on Regional Capital Flow (Different Dimension of Digital Finance).

Variables	within-group	within-group	within-group	sys-GMM	sys-GMM	sys-GMM
$(I/Y)_{-1}$	0.7631***	0.7582***	0.7491***	0.8349***	0.8892***	0.8660***
	(0.0912)	(0.0883)	(0.0871)	(0.0947)	(0.1035)	(0.1079)
S/Y	0.2628***	0.2016***	0.1738**	0.3791***	0.3469**	0.2658***
	(0.0544)	(0.0518)	(0.0812)	(0.0983)	(0.1625)	(0.0759)
CO	0.0776			0.0377		
	(0.0622)			(0.0325)		
*CO*S/Y*	0.0501			0.0336		
	(0.0429)			(0.0288)		
DE		0.0391**			0.0544*	
		(0.0190)			(0.0292)	
*DE*S/Y*		−0.0345**			−0.0210**	
		(0.0166)			(0.0102)	
DI			0.0236*			0.0857**
			(0.0130)			(0.0406)
*DI*S/Y*			−0.0299***			−0.0452***
			(0.0096)			(0.0124)
Control	YES	YES	YES	YES	YES	YES
Observation	279	279	279	279	279	279
Adjust-R^2	0.61	0.61	0.62			
AR (1)				0.00	0.00	0.01
AR (2)				0.56	0.41	0.68
Hansen Test				0.61	0.50	0.70

Notes: Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively. AR (1) and AR (2) test lists the P-value of the first- and second-order autocorrelation of the differenced residual, respectively. The Hansen test lists the *P*-value of the over-identification test of instrumental variables. Table 9 shows the estimation results of model 2 using sub-indexes. As shown in Table 9, first, similar to the results in Table 8, the coverage index (*CO*) does not significantly impact investment allocation convergence. In comparison, both the usage depth index (*DE*) and digitization degree index (*DI*) have significant impacts on investment allocation. The coefficients of $DE*lni_0$ and $DI*lni_0$ are all positive and statistically significant at 1% level. The results when using *DE* and *DI* are consistent with that using the aggregate index of digital finance. Both usage depth and digitization lead to divergence of capital allocation.

Table 9
The Impact on the Regional Capital Flow Direction (Different Dimensions of Digital Finance).

Variables	within-group	within-group	within-group	sys-GMM	sys-GMM	sys-GMM
$(\Delta i)_{-1}$	0.1608***	0.2170***	0.1951***	0.0310***	0.0452***	0.0366***
	(0.0192)	(0.0258)	(0.0236)	(0.0052)	(0.0071)	(0.0063)
lni_0	−0.2538***	−0.2635***	−0.2951***	−0.1652***	−0.1910***	−0.2053***
	(0.0591)	(0.0620)	(0.0841)	(0.0507)	(0.0538)	(0.0492)
CO	0.1905			0.1703		
	(0.1682)			(0.1416)		
$CO*lni_0$	0.0369			0.0426		
	(0.0325)			(0.0318)		
DE		0.1618**			0.1840**	
		(0.0782)			(0.0813)	
$DE*lni_0$		0.0593***			0.0491***	
		(0.0105)			(0.0112)	
DI			0.1544*			0.1675**
			(0.0830)			(0.0812)
$DI*lni_0$			0.0462***			0.0337***
			(0.0116)			(0.0093)
Control	YES	YES	YES	YES	YES	YES
Observation	279	279	279	279	279	279
Adjust-R^2	0.46	0.48	0.50			
AR (1)				0.00	0.00	0.00
AR (2)				0.37	0.46	0.57
Hansen Test				0.69	0.58	0.42

Notes: Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively. AR (1) and AR (2) test lists the P-value of the first- and second-order autocorrelation of the differenced residual, respectively. The Hansen test lists the *P*-value of the over-identification test of instrumental variables.

regional allocations of saving funds and investment is critical to their economic growth. The fundamental causes for the regional imbalance allocation and considerable differences in investment returns are financial market segmentation and disadvantage for less-developed areas in obtaining investment funding due to severe asymmetric information problems. However, removing financial market segmentation does not necessarily induce the fund flow to less-developed areas. The impact of financial development may be

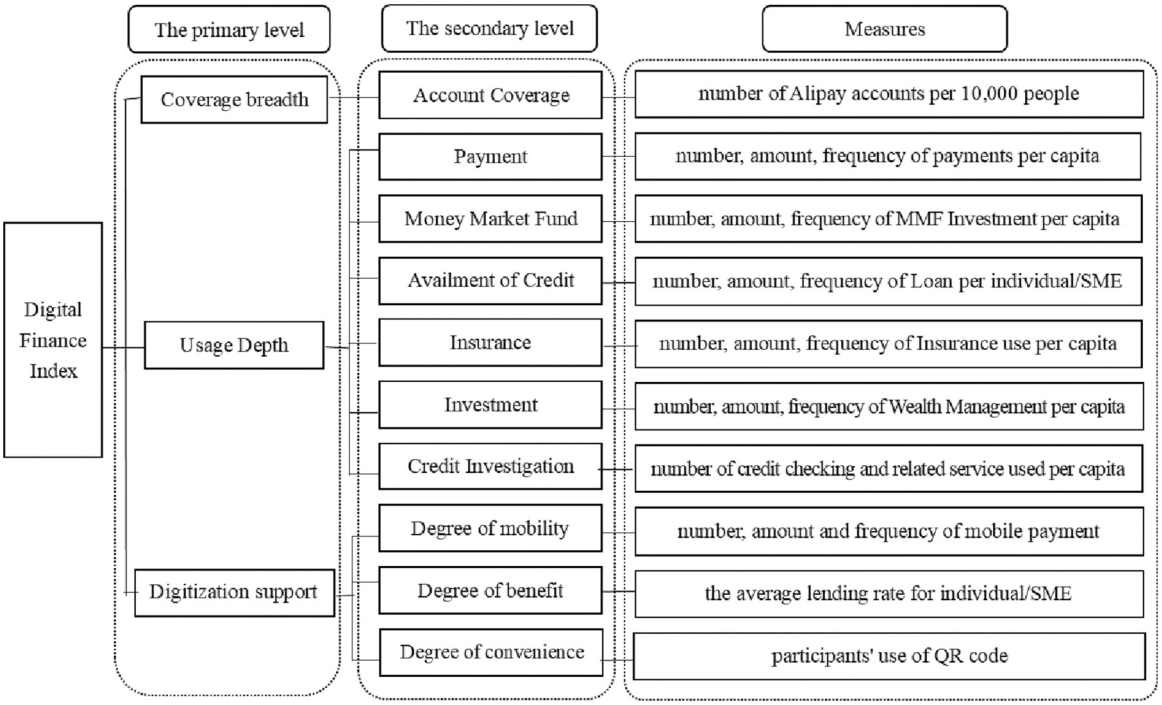

Fig. 6. China's Digital Finance Index Construction Framework.

Table 10
Robustness Check with alternative dependent variable and bootstrap quantile regression.

Variables	Q = 10%	Q = 30%	Q = 50%	Q = 70%	Q = 90%
DF	−0.0109***	−0.0048**	−0.0011*	0.0127**	0.0185***
	(0.0028)	(0.0022)	(0.0006)	(0.0058)	(0.0042)
Control	YES	YES	YES	YES	YES
Observation	279	279	279	279	279
Pseudo R^2	0.61	0.66	0.63	0.68	0.64

Notes: Q denote for quantile. The estimators are obtained with bootstrap iteration. Robust standard errors of t-statistics are shown in parentheses. ***, **, and * stands for statistically significant at 1%, 5%, and 10% level respectively.

regional asymmetric depending on the direction of capital flow across regions. Financial development may hurt the regionally balanced growth when capital flows from less developed to developed regions more than the other way round. Therefore, it is crucial for developing economies to pay attention to how institutional features of the domestic financial market and characteristics of regional differences shape the directions of capital flow, thus affecting the effects of financial development on regional balanced economic growth.

Our results also provide substantial policy implications for the development of financial technologies. Recently, many countries have promoted the inclusive development of financial technologies and aim to address the distortions in the traditional financial system and improve balanced regional growth. We investigate the case in China, a large developing country with sizeable regional growth gaps and rapid and balanced development of digital finance. Our results suggest that a balanced development of digital finance across the regions does not necessarily lead to a more balanced investment allocation. Although digital finance breaks the constraints on regional capital flow, the funds that flow from less-developed areas are more than inflow. The situation is the opposite for the developed areas. Thus, it does not benefit the balanced regional growth. Digital finance cannot wholly resolve the distortion in the financial system caused by institutional arrangements. Therefore, institutional reforms in the banking system are needed to address capital segmentation that shaped the imbalanced regional growth in the first place, such that institutional factors would eventually not distort the benefit of digital finance. However, policymakers need not necessarily separate institutional reforms from adopting advanced technologies in the digital era. For instance, traditional banking could use financial technology during the reforms to enhance operational efficiencies and risk management, such as to increase regional capital mobility among the branches and banks. It is essential for developing economies to apply Fintech in a suitable way that improves the institutional features of their domestic financial markets and leads to balanced regional growth.

CRediT authorship contribution statement

Minghua Zhan: Conceptualization, Methodology, Investigation, Validation. **Shuai Li:** Methodology, Software, Data curation, Investigation, Validation, Writing – original draft, Writing – review & editing. **Zhouheng Wu:** Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing.

Data availability

I have provide a dataset on Mendeley-Data.

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References

Agenor, P.R., Montiel, P.J., 2015. Development Macroeconomics. Published by Princeton University Press, 41 William Street, Princeton, New Jersey, 08540.
Ahmed, A.D., 2016. Integration of financial markets, financial development and growth: is Africa different? J. Int. Financ. Mark. Inst. Money 42, 43–59.
Bai, C.E., Hsieh, C.T., Qian, Y.Y., 2006. The return to capital in China. Brook. Pap. Econ. Act. 2, 61–68.
Bajo-Rubio, O., 2000. A further generalization of the Solow growth model: the role of the public sector. Econ. Lett. 68 (1), 79–84.
Bayoumi, T., Rose, A., 1993. Domestic savings and intra-national capital flows. Eur. Econ. Rev. 37, 1197–1202.
Chakraborty, C., Rawlins, G., 2004. Financial resource flows, macro policy response, and the socio-economic environment: the experience of Latin America and East Asia. J. Socio-Econ. 33 (4), 469–489.
Chan, K., Dang, V., Lai, J., Yan, I., 2011. Regional capital mobility in China: 1978–2006. J. Int. Money Financ. 30, 1506–1515.
Chen, Z., Chen, S., 2014. Institutional environment, local government investment impulse and soft constraint of financial budget. Econ. Res. J. 49 (03), 76–87.
Chen, S., Zhang, H., 2021. Does digital finance promote manufacturing servitization: micro evidence from China. Int. Rev. Econ. Financ. 76 (11), 856–869.
Cho, T., Chen, Y., 2021. The impact of financial technology on China's banking industry: an application of the meta-frontier cost Malmquist productivity index. North Am. J. Econ. Financ. 57, 101414.
Deng, L., Wang, B., 2016. Regional capital flows and economic regimes: evidence from China. Econ. Lett. 141, 80–83.
Demirguc, K.A., Klapper, L., Singer, D., Ansar, S., Hess, J., 2018. The global findex database 2017: measuring financial inclusion and the Fintech revolution. World Bank Working paper, No.12735.
Ding, N., Gu, L., Peng, Y., 2022. Fintech, financial constraints and innovation: evidence from China. J. Corp. Finan. 73, 102194.
Dowrick, S., Rogers, M., 2002. Classic and technological convergence: beyond the Solow-Swan growth model. Oxf. Econ. Pap. 54, 369–385.
Durlauf, S.N., Kourtellos, A., Minkin, A., 2001. The local Solow growth model. Eur. Econ. Rev. 45 (4–6), 928–940.
Eckaus, R.S., 2003. Some consequences of fiscal reliance on extra budgetary revenues in China. China Econ. Rev. 14 (1), 72–88.
Esso, J.L., Keho, Y., 2010. The savings-investment relationship: Cointegration and causality evidence from Uemoa countries. Int. J. Econ. Financ. 2 (1), 174–181.
Feldstein, M., Horioka, C., 1980. Domestic saving and international capital flows. Econ. J. 90, 314–329.
Flinn, M.G., 1990. On savings and investment dynamics in a small open economy. J. Int. Econ. 29 (1–2), 1–21.
Goldsmith, R.W., 1969. Financial Structure and Development. Yale University Press, New Haven.
Goldstein, I., Jiang, W., Karolyi, G., 2019. To FinTech and beyond. Rev. Financ. Stud. 32 (5), 1647–1661.
Guo, J., Wang, H., 2003. Research on capital flow and economic gap between regions in China. J. Manag. World 7, 45–58.
Guo, F., Wang, J., Wang, F., Kong, T., Zhang, X., Chen, Z., 2020. Measuring the development of digital inclusive finance in China: index compilation and spatial characteristics. China Econ. Q. 19 (04), 1401–1418.
Huang, Y., Huang, Z., 2018. The development of digital finance in China: present and future. China Econ. Q. 17 (04), 1489–1502.
Hwang, S., Kim, Y., 2018. Capital mobility in OECD countries: a multi-level factor approach to saving–investment correlations. Econ. Model. 69 (1), 150–159.
Iwamoto, Y., Wincoop, E., 2000. Do border matter? Evidence from Japanese regional net capital flows. Int. Econ. Rev. 41 (1), 241–269.
Ji, Y., Shi, L., Zhang, S., 2022. Digital finance and corporate bankruptcy risk: evidence from China. Pac. Basin Financ. J. 72, 101731.
Jiang, K., Chen, Z., Rughoo, A., Zhou, M., 2022. Internet finance and corporate investment: evidence from China. J. Int. Financ. Mark. Inst. Money 77, 101535.
Lai, J., McNelis, P., Yan, I., 2013. Regional capital mobility in China: economic reform with limited financial integration. J. Int. Money Financ. 37, 493–503.
Lee, S.S., Luk, P., 2018. The Asian financial crisis and international reserve accumulation: a robust control approach. J. Econ. Dyn. Control. 90, 284–309.
Levine, R., 1997. Financial development and economic growth views and agenda. J. Econ. Lit. 35, 688–726.
Levine, R., 2002. Bank-based or market-based financial systems: which is better. J. Financ. Intermed. 11, 398–428.
Li, C., 2010. Savings, investment, and capital mobility within China. China Econ. Rev. 21, 14–23.
Ma, Y., Lin, X., 2016. Financial development and the effectiveness of monetary policy. J. Bank. Financ. 68, 1–11.
McKinnon, R.I., 1973. Money and Capital in Economic Development. Brooking Institution Press, Washington.
Ozili, P.K., 2017. Impact of digital finance on financial inclusion and stability. Borsa Istanbul Rev. 18 (4), 392–340.
Rosenstein-Rodan, P.N., 1961. Notes on the theory of the 'big push'. In: Economic Development for Latin America. Palgrave Macmillan, London, pp. 57–81.
Schumpeter, J.A., 1934. English translation published in 1934. In: The Theory of Economic Development. Harvard University Press, Cambridge, MA.
Shaikh, A., Glavee, R., Karjaluoto, H., 2017. Exploring the nexus between financial sector reforms and the emergence of digital banking culture – evidences from a developing country. Res. Int. Bus. Financ. 42, 1030–1039.
Shaw, E.S., 1973. Financial Deepening in Economic Development. Oxford University Press, New York.
Sinn, S., 1992. Saving-investment correlations and capital mobility: on the evidence from annual data. Econ. J. 102, 1162–1170.
Solow, R.M., 1956. A contribution to the theory of economic growth. Q. J. Econ. 70 (1), 65–94.
Swan, T.W., 1956. Economic growth and capital accumulation. Econ. Rec. Econ. Soc. Aust. 32 (2), 334–361.
Thiemann, L., 2015. Operationalising food sovereignty through an investment lens: how agro-ecology is putting 'big push theory' back on the table. Third World Q. 36 (3), 544–562.
Wang, S., 2016. China's interregional capital mobility: A spatial econometric estimation. China Econ. Rev. 41, 114–128.
Zhang, L., Bezemer, D., 2016. Finance and growth in China, 1995-2013: more liquidity or more development? Camb. J. Reg. Econ. Soc. 9 (3), 613–631.
Zhong, W., Jiang, T., 2021. Can internet finance alleviate the exclusiveness of traditional finance? -evidence from Chinese P2P lending markets. Financ. Res. Lett. 40 (5), 101731.