

## Article

# Has Digital Financial Inclusion Narrowed the Urban-Rural Income Gap: The Role of Entrepreneurship in China

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**Abstract:** The combination of digital technology and finance has brought about a new development model for financial inclusion. What impact will it have on the current imbalance in the distribution of financial resources and the urban-rural income gap in China? To answer this question, this paper uses relevant data from 2014–2018 to study the impact of digital inclusive finance on the urban-rural income gap from the theory of financial exclusion, and analyzes the transmission of digital inclusive finance through alleviating financial exclusion, widening financing channels and helping residents with entrepreneurial spirit to start their own businesses, thus increasing jobs, raising the income of rural residents and reducing the urban-rural income gap. The conclusions are as follows: (1) digital inclusive finance can significantly converge the urban-rural income gap; (2) among the dimensions of digital inclusive finance, only the breadth of coverage can significantly reduce the urban-rural income gap, while the effects of depth of use and digitalization are not significant; (3) digital inclusive finance can alleviate the urban-rural income gap through the transmission mechanism of promoting residents' entrepreneurship; (4) the worse the regional economic development and education, the better the effect of digital inclusive finance on the urban-rural income gap. This paper combines the above results to propose corresponding policy recommendations.

**Keywords:** digital inclusive finance; urban-rural income gap; entrepreneurship; fintech

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## 1. Introduction

In 2017, the richest 1% of the world's population held about 82% of the world's wealth [1]. In contrast, in 2019, there will still be 1.3 billion people living in "multidimensional poverty". Income gap not only weakens residents' happiness through "relative deprivation effect" and "comparison effect", but also generates a negative impact on economic development and social and political stability [2,3]. Therefore, income gap has become one of the most important issues for governments, organizations and academic circles.

Since 2000, China's Gini coefficient has been consistently higher than the internationally recognized 0.4 "warning line" [4]. This huge income gap has become an important reason that restricts the economic development of China [5]. Researchers generally believe that the expansion of income gap in China mainly stems from the expansion of income gap between urban and rural areas [6]. For example, Chen et al. found that the urban-rural income gap accounted for 58% of the total income gap by separating the Gini coefficient of China from 2005 to 2012 [7], although this result was slightly different from the 70–80% obtained by Wan in 2007 [8]. However, this error, caused by differences in methods and data, does not undermine the conclusion of research, that China's urban-rural income gap is so wide. According to the National Bureau of Statistics, in 2019, the per capita disposable income in cities was 42,356 yuan, more than the 16,021 yuan in rural

areas, and the trend is going to expand. If the difference between urban and rural welfare is taken into account, this gap will be even more prominent. China has become one of the countries with the largest income gap between urban and rural areas in the world [9], and how to reduce the income gap between urban and rural areas has become an important problem facing China.

Robert Shiller pointed out that the unbalanced status of economic and social structure (the gap between the rich and the poor, etc.) is rooted in the unbalanced financial structure [10]. Influenced by China's urban-rural dual economy, the financial system absorbs deposits from rural residents and supplies them to urban areas, which seriously consumes the funds needed for rural development [11]. It is difficult to obtain loans from banks and other credit institutions when rural residents need to loan [12]. At the same time, low-income people in urban areas are excluded from the formal financial system. As of 2019, there are still 460 million natural persons in China without credit records, that is, these people cannot obtain funds in the traditional financial market through credit information, and the poor are easily trapped in the "poverty trap" due to the "Matthew Effect" [13].

In the promotion of the International Year of Microfinance in 2005, the United Nations formally put forward the concept of "financial inclusion" and pointed out that financial inclusion is a financial system that can effectively, comprehensively and conveniently provide services to all sectors and groups of society. It is generally believed that inclusive finance can help individuals, especially poor people, alleviate poverty by increasing their access to and use of financial services, in order to narrow the urban-rural income gap [14]. However, inclusive finance faces many problems during the processing practice. On the one hand, China has a vast land, the distribution of poor people is particularly dispersed, and the operating cost of branches is high. Meanwhile, traditional inclusive finance is still not rid of the disadvantages of benefit orientation, and insufficient support for the poor population [15]. On the other hand, the interest rate of some subprime loans is too high, which aggravates the burden of poor families [16]. The development and application of the Internet and digital technology provide a new way to solve these difficulties.

Combining digital technology with financial services and using digital technologies such as big data and cloud computing can reasonably portray the credit image of customers and improve the information asymmetry of financial lending. Moreover, the application of digital technology breaks through the limitation of geographical space, solves the "last kilometer" problem of financial services, saves the service cost and expands the service group [17]. In addition, the development of the Internet and mobile terminals in China also provides practical support for the combination of digital technology and financial services. In 2020, China's Internet penetration rate as high as 65% (904 million), 76% (649 million) for urban residents and 46% (255 million) for rural residents. The number of mobile phone users in China is about 64% (897 million), and in which the number of mobile Internet users is 99.3%. The popularity of smartphones facilitates the application of more functions [18].

Digital financial inclusion has not only developed in B2C, but also made achievements in B2B. In addition to providing effective financial support to consumers and individuals, digital financial inclusion can also reach the enterprise level. Digital operation has greatly reduced transaction costs, and the digital information footprint can be tracked so that the flow of credit funds can be controlled. The digitization of inclusive finance has made financial services such as supply chain finance, microfinance, and leasing more operational, effectively alleviating financing constraints at the enterprise level, and providing financial support for small and micro enterprises. The full bloom of digital financial inclusion has provided rural residents with financial support, helping them in their consumption, investment, entrepreneurship, and risk prevention. It is expected that the combination of digital technology and financial services will help promote the development of inclusive finance, improve the availability and inclusion of financial services, and narrow the urban-rural gap.

Nowadays, China's digital inclusive finance is booming and at the forefront of the world. Research on digital inclusive finance has only emerged in recent years, far behind its development level, and research on the impact and mechanism of digital inclusive finance on the urban-rural income gap is also scarce. In view of this, this paper uses the panel data of 275 prefecture-level cities in China from 2014 to 2018, combined with the digital financial inclusion index released by the Digital Finance Center of Peking University to discuss the impact of digital financial inclusion on the urban-rural income gap and the transmission mechanism, and adopts appropriate instrumental variables to solve the problem of endogeneity. The results showed that: first, digital inclusive finance can significantly reduce the urban-rural income gap; second, different dimensions of digital inclusive finance have different effects on the urban-rural income gap. Only the coverage breadth can significantly reduce the urban-rural income gap, but only when the depth of use and the degree of digitalization has no significant impact on the urban-rural income gap. Third, digital inclusive finance indirectly reduces the urban-rural income gap by affecting residents' entrepreneurship. Fourth, the lower the level of regional economic development and education, the better the effect of digital inclusive finance on reducing the urban-rural income gap, which reflects the nature of digital inclusive finance as a "timely aid".

Possible academic contributions of this study are as follows: first, previous studies are usually at the provincial level or using microdata, and this study uses data at the city level to provide new evidence for the ability of digital inclusive finance to reduce the urban-rural income gap; second, this study discusses the transmission mechanism of digital inclusive finance affecting starting a business and then urban-rural income gap, which enriches relevant literature.

The rest of this paper is listed as follows: In the second part, we sort out the relevant literature on the impact of financial development and digital inclusive finance on the urban-rural income gap. In the third part, we analyze the effect and transmission mechanism of digital inclusive finance on the urban-rural income gap. The fourth part introduces our empirical model and data. The fifth part presents our empirical results. In the sixth part, we put forward corresponding policy suggestions according to the conclusions.

## 2. Literature Review

At present, the importance of financial development to income distribution has attracted increasing attention from scholars [19,20]. The importance of this was first recognized in the 1990s, thanks to the pioneering work of Greenwood and Jovanovic [21]. In their initial investigation, income distribution is independent of the economic growth and financial development, meanwhile, access to financial markets need to pay a fixed fee (the threshold level of wealth), for assuming that, constructs a dynamic model, proves there is a Kuznizian "inverted U-shaped relationship" between financial development and income distribution range, that is: with financial development, the income gap narrowed after expanding [21]. Later, Philippe and Bolton reached the same conclusion when they studied financial development and income distribution by establishing a model of growth and income inequality under the condition of an incomplete capital market [22]. Banerjee et al. and Aghion et al. put forward different views. They believed that financial development could enable more people to enjoy financial services and increase the economic opportunities of low-income people, thus narrowing the income gap [23]. Burgess and Pande observed that the income gap between urban and rural areas decreased significantly, and the poor population also decreased after the Indian government promoted commercial banks to carry out business in rural areas, which provided a practical basis for this conclusion [24]. Townsend et al. is skeptical that financial development can reduce the income gap. They believe that financial development enriches the financial services for the majority of customers who have obtained financial resources, and these customers tend to have higher income, which is more favorable to the high-income peoples and widens the income gap [25].

Based on the special structure of urban and rural dual financial development in China, scholars also hold three different views. Qiao and Chen, from the perspective of financial agglomeration theory, demonstrated an inverted U-shaped nonlinear relationship between financial development and income inequality in combination with China's county cross-section data [26]. Sun believes that easing the urban-rural dual financial structure will help to reduce the urban-rural income gap. That is, the flow of financial resources will determine if the urban-rural income gap will expand or decrease. When financial resources mainly flow into urban areas, the urban-rural income gap will expand; otherwise, the urban-rural income gap will decrease [27]. From the perspective of financial deepening, Kotarski found that, under the influence of the current banking model, household registration system and financial repression, financial development will significantly aggravate income inequality in China [28]. It can be seen that no matter from the perspective of international experience or the present state of China, the impact of financial development on income gap is still controversial. The focus of the controversy is mainly on which part of the population can obtain financial resources and benefit from financial development. That is, there is a consensus that financial resources can increase income, so the allocation of financial resources is the key to reducing income inequality in financial development.

The original intention of the development of inclusive finance is to change the status quo of the unbalanced distribution of financial resources and help the poor people enjoy financial services so as to get rid of poverty. Its influence on income gap can be summarized as direct influence and indirect influence. Direct effects include lowering the threshold effect, exclusion mitigation effect and poverty reduction effect. For example, the research results of Claessens et al. show that the inclusive development of the financial system can promote the balanced distribution of finance, reduce the inequality between different groups of people in accessing the financial system and enjoying financial services, improve the income level of low-income groups, and thus curb the expansion of income gap [29]. Demirguc et al. reported in the United Nations that inclusive finance can help poor people obtain loans or borrow to accumulate assets and build personal credit, so as to have the opportunity to build a more secure future [30]. In terms of indirect influence, Corrado et al. believed that inclusive finance could indirectly improve the income gap by promoting economic growth and using the "trickle-down effect" [31]. When Yin et al. studied the impact of inclusive finance on residents' consumption in Beijing, Tianjin and Hebei, he found that there was a significant income gap between families with inclusive finance and those with non-inclusive finance [32]. However, many scholars hold a cautious attitude towards the development of the current situation of inclusive finance. Arestis et al. pointed out that the current government-led inclusive financial development model is more likely to lead to the misallocation of financial resources and the low efficiency of financial services, thus reducing the income level of poor peasant households [33]. Kaboski et al. emphasized that the change of income level is more likely to come from simple credit expansion when studying the "Million Baht Village Fund Scheme in Thailand" [34]. At the same time, limited by factors such as education level, economic opportunities and financial knowledge, poor peasant households are prone to lack effective demand and low utilization efficiency even if they are provided with sufficient financial resources [35].

The rapid development of digital technology in China has an important impact on inclusive finance [36]. Digital technology can alleviate the service barriers faced by traditional finance, such as information asymmetry, high transaction cost, behavior deviation and lack of competition [37], which is inherently inclusive. At the same time, the combination of digital finance and inclusive finance is beneficial to financial service users, digital financial providers, the government and the economy [38]. Song first focused on the impact of digital financial inclusion on the urban-rural income gap. She analyzed the convergence mechanism of digital financial inclusion on the urban-rural income gap from three aspects: lowering the threshold effect, mitigating the exclusion effect and playing

the poverty reduction effect, and verified this conclusion using the provincial panel data from 2011 to 2015 [39]. Li et al. expanded the data range and constructed provincial panel data from 2011 to 2017. On the basis of Song, they introduced financial exclusion theory and concluded that digital financial inclusion can reduce the urban-rural income gap and show heterogeneity [17]. Zhang et al. used the data of Chinese Family Panel Studies (CFPS) combined with China's digital financial inclusion index to find that digital financial inclusion can significantly improve the income of rural residents, but has no significant impact on the income of urban residents, which indirectly proves that inclusive finance has a convergence effect on the urban-rural income gap [40]. Liu et al. used the microdata of China's household finance survey and reached a similar conclusion [18]. On the contrary, Liu et al. believe that digital inclusive finance can increase the income of all families, but this effect is more obvious in rural families, thus reducing the urban-rural income gap. At the same time, it also points out that digital inclusive finance exacerbates the inequality within Chinese rural and urban areas [18].

From the above analysis, it can be seen that digital inclusive finance can effectively make up for the shortcomings of traditional finance and has an important impact on the income gap between urban and rural areas in China. However, previous studies mainly focus on the provincial level or use microdata, and rarely focus on the urban level. At the same time, most studies focus on the direct impact of digital inclusive finance on the urban-rural income gap without an in-depth analysis of its mechanism. Therefore, this study tries to make the following innovations. Firstly, it studies the impact of digital financial inclusion on the urban-rural income gap by using relevant data at the city level. Secondly, it explores the impact of various dimensions of digital inclusive finance on the urban-rural income gap and the regional characteristics of the impact of digital inclusive finance on the urban-rural income gap. Finally, it analyzes the transmission mechanism of digital financial inclusion through influencing starting businesses and then reducing the urban-rural income gap.

### 3. Theoretical Analysis

#### 3.1. Digital Financial Inclusion and Urban-Rural Income Gap

It is generally believed that financial development can influence the urban-rural income gap through threshold effect, poverty alleviation effect and disequilibrium effect [41]. In essence, the threshold effect and disequilibrium effect are manifestations of financial exclusion, and the poverty alleviation effect is the inevitable result of alleviating financial exclusion. There are various reasons for financial exclusion. For example, due to the lack of collateral, low-income level and ambiguous credit rating of low-income families, financial institutions will charge higher loan interest, thus making low-income families prone to fall into the "financial service trap" [42]. In developing countries, due to artificial barriers, the proportion of vulnerable families and small enterprises obtaining credit from banks is too low, which also leads to the imbalance of income distribution [43]. Financial exclusion is more likely to occur in rural areas with backward economic development, low-income level and remote geography [44]. A large amount of evidence shows that alleviating financial exclusion in rural areas can effectively reduce poverty and reduce the urban-rural income gap [45–47].

Sarma systematically summarizes various types of financial exclusion and classifies financial exclusion into five categories: opportunity exclusion, price exclusion, conditional exclusion, market exclusion and self-exclusion [48]. With tens of millions or even hundreds of millions of mobile terminals built on Internet platforms, such as Taobao and WeChat, which are glued to the scene, digital inclusive finance can effectively alleviate financial exclusion [49]. First of all, all financial services in digital inclusive finance can be operated in cyberspace, which greatly alleviates the insufficient supply of financial resources caused by geographical factors, enables rural households in remote areas to enjoy financial services, and alleviates opportunity exclusion [17]. Secondly, digital inclusive

finance replaces the physical network and human services of traditional finance, and the transaction cost is much lower than the physical network and human services, which greatly reduces the price of financial services [50]. Taking Alipay as an example, in 2013, the average cost of information system per transaction of Alipay was about 0.02 yuan, much lower than that of traditional financial institutions and showing a declining trend [39]. This has made financial services more affordable for more people, and has reduced price exclusion. At the same time, digital inclusive finance relies on big data, artificial intelligence and other technologies, combined with Taobao, WeChat and other scenarios, in-depth mining and analysis of users' social media and online shopping platform data, obtain a large amount of valuable soft information to assess risks, make up for the lack of rural users' credit records, thereby alleviating information asymmetry and reducing the access threshold of financial services which alleviated condition exclusion [51]. Further, different from the "Pareto principle" pursued by traditional finance, digital inclusive finance targets groups in the "market of long end" ignored by the traditional financial market, so as to alleviate market exclusion [52]. Moreover, with the development of e-commerce, digital inclusive finance stimulates the promotion of new rural demands, expands more consumption means and service modes, and generates a large number of new service demands [53], alleviating self-exclusion. Accordingly, we propose Hypothesis 1.

**Hypothesis 1.** *The development of digital inclusive finance can narrow the urban-rural income gap.*

### 3.2. Various Dimensions of Digital Financial Inclusion and Urban-Rural Income Gap

Regan and Paxton pointed out that the role of finance actually involves the breadth and depth of the development of the financial system, and these two dimensions will produce different effects [54]. As a combination of traditional finance and digital technology, the essence of digital inclusive finance is still financing, and digital technology is the means to provide financial services. Therefore, digital inclusive finance covers both the breadth and depth of financial development and the degree of digitalization. Therefore, the analysis of the breadth and depth of financial development is still applicable to digital financial inclusion, which also includes digital features.

The development breadth of digital financial inclusion measures the coverage of digital financial services. The greater the development breadth, then, the more people it covers. With the expansion of the development of digital inclusive finance, it can effectively alleviate the financial exclusion in rural areas and increase the availability of financial services for rural residents, thereby increasing the income of rural residents and narrowing the urban-rural income gap [19]. The development depth of digital financial inclusion shows that users use more diversified digital financial inclusion services. We consider the impact of the development depth of digital inclusive finance on the urban-rural income gap from two aspects. On the one hand, the use of more diversified financial services requires more financial knowledge. Rural residents are limited by the local economic conditions and education level, and often have less financial knowledge than urban residents [55]. From this perspective, diversified digital financial services will have better effects on urban users. On the other hand, as the traditional financial industry in urban areas is more developed and provides more abundant financial services, urban residents tend to seek traditional financial services. In rural areas where traditional finance is underdeveloped, diversified digital inclusive financial services provide an effective supplement to the shortage of traditional financial services. Rural residents are more inclined to use digital inclusive finance [56], and diversified digital financial services have a better effect on rural areas. Influenced by the positive two forces, the impact of various digital financial inclusion services on the urban-rural income gap depends on which force is stronger. In terms of the degree of digitalization, compared with urban residents, rural residents have less hardware facilities and fewer understanding of digital technology, so it is difficult for them to operate complex digital inclusive financial services, which is bound to produce a

“digital divide”. With the increasing development of digital technology and the continuous innovation of digital financial services, the digital divide will exacerbate the widening of the urban-rural income gap [57]. Therefore, Hypothesis 2 is proposed in this paper.

**Hypothesis 2.** *Only the development breadth of digital inclusive finance converges the urban-rural income gap.*

### 3.3. Transmission Mechanism: Digital Inclusive Finance and Entrepreneurship

Starting businesses cannot only promote economic development but also provide a large number of jobs [58,59], which plays an important role in narrowing the urban-rural income gap. Based on the theory of entrepreneurship, Banerjee and Newman first established the logical relationship from financial development to entrepreneurship to income distribution, demonstrated the influence of an imperfect financial market on income distribution [23]. They point out that when the level of financial development is low, the financial market is not perfect, because people with higher initial wealth endowment have higher risk capacity, the ability of an individual to borrow funds is affected by the initial wealth endowment, the poor cannot reach the financing threshold of the occupation with a higher level of investment, they can only work for the rich. As a result, supply exceeds demand, it keeps the wages of the poor at a lower level [23]. For the rich, the truth is just the reverse, resulting in a large gap in income. With the gradual improvement of the financial market, some low-income (wealth) people can obtain more financing support, so as to self-employ or become entrepreneurs, which increases the demand for labor, increases the wage level and reduces the income gap. Demirguc et al. further pointed out that when a country’s financial system can provide financing for middle and low-income groups with an entrepreneurial spirit and help some of them become entrepreneurs, the local poverty rate and income gap will be greatly reduced [60].

Small and micro-enterprises are the main form of entrepreneurship of Chinese residents, contributing more than 50% of the national GDP and more than 40% of the tax revenue while absorbing a large number of urban and rural labor [61]. However, small and micro enterprises often lack business records and the information asymmetry is more serious, making it difficult for small and micro enterprises to obtain credit support [62,63]. At the same time, due to the small economic scale of small and micro enterprises, the traditional risk assessment model is difficult to achieve economic cost [64]. Different from traditional financial institutions, digital inclusive finance utilizes digital technologies such as big data and cloud computing to effectively extract useful information from users’ social networks and transaction information. Without hard information such as assets and income, a user’s credit image can be outlined, reducing information asymmetry and expanding transaction possibility sets [65]. This helps small and micro enterprises to obtain financing and lowers the threshold of venture capital constraint, thus promoting entrepreneurship [66]. This view has been confirmed by Xie et al., who found that digital financial inclusion significantly promotes entrepreneurship and has a stronger incentive effect on small and micro enterprises [64]. He et al. also found that the development of digital inclusive finance significantly promoted farmers’ entrepreneurship, especially for farmers with low human capital, material capital and social capital [67]. Accordingly, we propose Hypothesis 3.

**Hypothesis 3.** *Digital inclusive finance promotes entrepreneurship among residents with entrepreneurial spirit, thus narrowing the urban-rural income gap.*

## 4. Empirical Methods and Data Description

### 4.1. Baseline Regress

Firstly, we analyze the relationship between the urban-rural income gap and digital financial inclusion. The concrete empirical model is shown in Formula (1):

$$IG_{it} = \alpha_0 + \alpha_1 \ln(IF_{i,t-1}) + \alpha_2 X_{it} + \theta_i + \rho_t + \mu_{it}, \quad (1)$$

where “i” and “t” respectively represent city and time and  $IG$  represents the urban-rural income gap;  $IF$  represents the development level of local digital financial inclusion;  $X$  represents a series of control variables;  $\theta$  is the individual control effect,  $\rho$  is the year control variable, thus forming the double fixed effect, and  $\mu$  is the random error term.

This paper aims to study whether digital financial inclusion can reduce the urban-rural income gap. Specifically, we use the urban digital financial inclusion index to measure the development level of regional digital financial inclusion and then test whether this index and Theil index are statistically significant, and judge whether digital financial inclusion plays a promoting or reducing role on the urban-rural income gap according to the positive and negative coefficients. In order to achieve our purpose, we also need to deal with two problems: reverse causality and omitted variable problem. In terms of reverse causality, although digital financial inclusion can reduce the urban-rural income gap, regions with a small urban-rural income gap may be more conducive to the development of digital financial inclusion. Our practice is to delay the digital financial inclusion index by one period, so as to weaken the impact of reverse causality. In terms of omitted variables, there are factors that we do not include in the control variables, which have an impact on the urban-rural income gap and are related to the development of digital inclusive finance. Therefore, the fixed effect model is used in all regressions in this paper.

Even with the above efforts, we may not be able to completely solve the problem of endogeneity. Considering that the instrumental variable method is the most effective way to solve the problem of endogeneity, we choose the product of the spherical distance of each city from Hangzhou and the average growth rate of the digital financial inclusion index as the instrumental variable [40]. The logic is as follows: First, geographical distance is a strictly exogenous variable; secondly, the development level of digital inclusive finance is shown as follows: the closer to Hangzhou, the higher the development level, and the farther away, the lower the development level. Moreover, after controlling variables such as regional economic development level, the geographical distance between cities and Hangzhou has no direct correlation channel with the urban-rural income gap. Thirdly, in theory, there is no evidence of the geographical distance between cities and Hangzhou and the urban-rural income gap. Finally, as the geographical distance is a fixed variable, we cannot treat it as a fixed effect, so we use its ratio to the average growth rate of the digital financial inclusion index to construct a new variable, which not only meets the requirements of fixed effect but also shows the real situation of the continuous growth of digital financial inclusion. The specific approach is as follows. Taking 2017 as the baseline (we lag the first phase of the digital financial inclusion index), the instrumental variable of that year = the spherical distance of each city from Hangzhou/(1 + the annual growth rate of the digital financial inclusion index)<sup>(2017-year)</sup>.

### 4.2. Transmission Mechanism: Digital Inclusive Finance and Entrepreneurship

In order to verify the guiding mechanism that digital inclusive finance can reduce the urban-rural income gap by promoting residents' entrepreneurship and increasing employment opportunities, the empirical model adopted in this paper is shown in Formula (2):



$$\ln(\text{Entrep}_{it}) = \alpha_0 + \alpha_1 \ln(IF_{i,t-1}) + \alpha_2 X_{it} + \theta_i + \rho_t + \mu_{it}, \quad (2)$$

where  $\text{Entrep}_{it}$  represent for entrepreneurship, other variables are consistent with Formula (1). In order to solve the problem of endogeneity, the ratio of the spherical distance of each city from Hangzhou to the average growth rate of the digital inclusive finance index is still adopted as the instrumental variable.

#### 4.3. Transmission Mechanism: Digital Inclusive Finance and Entrepreneurship

The data used in this paper are from two sources, they were *China City Statistical Yearbook* and *Peking University Digital Financial Inclusion Index* released by the Digital Finance Research Center of Peking University. Some missing data are supplemented by local statistical yearbooks or gazettes.

**Urban-rural income gap:** There are two main indicators to measure the urban-rural income gap: the ratio of urban per capita disposable income to rural per capita net income (disposable income) and the Theil index. Among them, the ratio of per capita disposable income of the urban residents and net income of rural residents (disposable income) is simple, easy to obtain and more intuitive, and is often used in early studies. However, it ignores the proportion of urban and rural population, so it cannot reflect the change of urban and rural population mobility, thereby, it cannot accurately reflect the situation of the income gap between urban and rural residents in China. The Theil index comprehensively considers the proportion of urban and rural population, which can better measure the urban-rural income gap. At the same time, the Theil index is more sensitive to income changes at both ends. Considering that the urban-rural income gap in China is mainly reflected at two terminals [68], this paper uses Theil index to measure the urban-rural income gap. The ratio of the per capita disposable income of urban residents to the net income of rural residents (disposable income) will be used for the robustness test in the following paper.

**Digital Inclusive Finance:** This paper adopts the “Digital Inclusive Finance Index” compiled by the Digital Finance Research Center of Peking University, and takes the natural logarithm. The index makes up for the shortcomings of previous indexes, such as single financial services and insufficient attention to new digital financial services. At the same time, hundreds of millions of micro-transaction data of Ant Group are used to ensure the representativeness and reliability of the index data [69]. In general, the digital financial inclusion index includes three dimensions, including coverage breadth, usage depth and digitalization degree, with a total of 33 specific indicators. The index not only includes banking services (mainly credit) but also payment, investment, insurance, money fund, credit services and other business forms, reflecting the multi-level and diversification of digital financial inclusion services. Moreover, the index takes into account both vertical and horizontal comparability. With the release of subsequent indexes, it will be helpful for subsequent studies to compare and discuss with current ones on the basis of unified data. The index, which has been released in two issues, covers 31 provinces, 337 cities at and above the prefectural level and about 2800 counties on the Chinese mainland from 2011 to 2018.

**Entrepreneurship:** There is no unified standard in academic circles for the measurement of entrepreneurship at the city level. Considering digital financial inclusion mainly for small and medium-sized enterprises with low income, the cost restriction is often in the form of many people at stake in founding, and for low income and low entrepreneurial, more business is in the form of individual businesses, so just using private enterprise numbers will underestimate regional entrepreneurship. Moreover, the agglomeration of economy and population in urban areas provides a good business environment for entrepreneurs, and people with entrepreneurial spirit often start businesses in urban areas. Therefore, this paper uses the number of new urban private enterprises and individual employees to measure entrepreneurship and takes the natural logarithm processing.

**Economic development:** According to the development law of Kuznitz's "inverted U-shaped", in the early stage, economic development will widen the income gap, but as the economy develops to a certain extent, economic development will narrow the income gap. However, it is still unclear whether China has passed the peak now, so this paper only uses per capita GDP to measure economic development and do natural logarithm processing.

**Urbanization rate:** Factors of production going to move, when factor compensation is not equal. Influenced by the "urban-rural dual" economic structure, China's labor mobility is not sufficient. With the advancement of China's urbanization process, labor mobility is gradually strengthened, thus promoting the equalization of labor remuneration. However, the effect of China's urbanization on the urban-rural income gap is still controversial [70,71]. Therefore, we use the proportion of permanent residents in the total permanent population at the end of the year to measure the urbanization rate.

**Education level:** education can improve the human capital of residents and increase their income. High quality education resources have been concentrated in urban areas, and the imbalance of education resources between urban and rural areas will promote the widening of the income gap between urban and rural areas. We take the number of students in higher education per 10,000 people to measure education level and do logarithmic processing.

**Industrial structure:** The increase in the proportion of non-agricultural industries indicates the improvement of production efficiency and the tilt of resources to urban areas. Considering that the flow of urban and rural labor force is not sufficient, the production efficiency of the agricultural industry lags behind that of non-agricultural industry, and the failure of population transfer with industry is bound to enlarge the urban-rural income gap. This paper uses the ratio of the GDP of the secondary and tertiary industries to the GDP of the region to measure the industrial structure.

**Traditional finance:** The development of digital inclusive finance is influenced by traditional finance. In order to eliminate the interference of traditional finance and avoid biased estimation, we add traditional finance into the control variable. This paper uses the ratio of the balance of deposits and loans of financial institutions to the gross regional product at the end of the year to measure the development degree of traditional finance.

**Opening to the outside world:** Since the reform and opening up, international trade has brought China advanced technology and management experience and played a huge role in the progress of China's manufacturing and service industries. Since the enterprises engaged in international trade are mainly concentrated in urban areas, it is more favorable to the growth of urban residents' income. In this paper, the ratio of total import and export volume to gross regional product is selected to measure the degree of opening up.

**Government behavior:** China's local governments play an important role in economic development. They can not only redistribute income but also play a significant role in primary distribution. Driven by economic growth, the fiscal expenditure has an obvious tendency of towns; the expenditure of the local governments of gross domestic production is higher, the easier it is to expand the income gap between urban and rural areas [72]. This paper uses the ratio of fiscal expenditure to gross regional production to measure government behavior.

The statistical characteristics of each variable are shown in Table 1.

**Table 1.** Variable statistical description.

Variable	Sample Size	Mean	Standard Deviation	Min	Max
Thayer index	1375	0.0727	0.0366	0.0045	0.252
Digital financial inclusion index	1375	5.247	0.198	4.660	5.667
Coverage	1375	5.054	0.242	4.213	5.578
Depth	1375	5.082	0.293	4.254	5.689
Degree of digitization	1375	5.367	0.228	4.560	6.365
Entrepreneurship	1316	12.75	0.818	7.404	14.18
Per capita GDP	1375	10.75	0.519	9.227	12.33
The industrial structure	1375	0.881	0.0762	0.495	0.997
Education level	1375	4.651	1.0425	0.893	7.044
Traditional financial	1375	2.515	1.235	0.717	13.53
Urbanization rate	1375	0.561	0.133	0.116	0.971
Opening up	1375	0.172	0.433	$1.44 \times 10^{-5}$	10.61
State action	1375	0.209	0.119	0.0439	2.060

## 5. The Empirical Results

### 5.1. Digital Financial Inclusion and the Urban-Rural Income Gap: Baseline Regress

In order to determine whether the model should use a fixed-effect model or a random-effect model, we first performed the Hausman test, and the results showed that we should use a fixed-effect model, and then we added individual and time dual control effects. To avoid endogeneity, we use the product of the spherical distance from each prefecture-level city to Hangzhou and the average growth rate of the digital financial inclusion index as an instrumental variable. Table 2 shows the first-stage regression results of the instrumental variables. It can be seen that the instrumental variable has a significant correlation with the index of the previous year, and the Wald-F statistic is 30.492, which strongly rejects the hypothesis of weak instrumental variable, indicating that this instrumental variable is a reasonable instrumental variable.

We first only considered the univariate relationship between digital financial inclusion and urban-rural income gap, then added control variables for regression, and finally used instrumental variables to do two-stage OLS, as shown in Table 2. The results show that in both the benchmark model and the instrumental variable model, the coefficient of digital financial inclusion is negative and significant at the 1% level. This shows that the development of digital inclusive finance helps to reduce the urban-rural income gap, which also confirms our previous analysis. At the same time, Table 2 also shows that economic development has a good effect on reducing the urban-rural income gap, which is consistent with the previously observed result that the urban-rural income gap is smaller in areas with good economic development. This indirectly confirms the effect of the “trickle-down effect”, but the effect has a small impact. Moreover, the impact of traditional finance on the urban-rural income gap is not significant, which indicates that the importance of digital inclusive finance cannot be replaced by traditional finance.

In terms of economic significance, for every 1% increase in the digital financial inclusion index, the Thiel index decreases 0.0004 (fixed effect) or 0.0019 (fixed effect +IV). From 2014 to 2018, the average value of the digital financial inclusion index increased from 144.93 to 232.80, and almost 61% increase, while the average value of the Thiel Index ranged between 0.067 to 0.080, from 2014 to 2018. It can be seen that the effect of this reduction is considerable.

**Table 2.** The impact of digital financial inclusion on the urban-rural income gap.

	Index of the Previous Year	Theil Index		
		Fixed Effects	Fixed Effects	Fixed Effects + IV
Index of last year		−0.061 *** (−4.925)	−0.041 *** (−3.573)	−0.190 *** (−4.667)
Instrumental variable	−1.340 *** (−5.53)			
Per capita GDP	0.069 *** (4.12)		−0.008 ** (−2.142)	0.001 (0.231)
The industrial structure	0.281 *** (2.69)		−0.012 (−0.851)	0.033 (1.545)
Urbanization ratio	0.241 ** (2.37)		−0.088 (−1.480)	−0.051 (−1.280)
Education	0.006 (1.50)		−0.002 * (−1.853)	−0.001 (−0.622)
Traditional finance	0.002 (0.41)		−0.001 * (−1.764)	−0.001 (−0.807)
Opening up	−0.000 (−0.07)		0.000 (0.776)	0.000 (0.344)
Government actions	0.064 *** (4.42)		0.000 (0.174)	0.010 *** (2.901)
Fixed time	Yes	Yes	Yes	Yes
Fixed individuals	Yes	Yes	Yes	Yes
Sample size	1375	1375	1375	1375
Regulation R <sup>2</sup>		0.416	0.416	0.215
Wald-F statistics	30.492			30.614

Note. T statistics or Z statistics in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . The test critical values of Wald-F are 16.38 (10%), 8.96 (15%), 6.66 (20%), 5.53 (25%).

### 5.2. Robustness Test

In order to further verify the reliability of the research results, three methods are adopted in this paper. The first method is to use the ratio of urban and rural disposable income to measure the urban-rural income gap. The second method is to remove the sample in 2016. The third method is to remove the remote areas of the city. All three methods use fixed effects model and instrumental variable method. The results are shown in Table 3. It can be seen that no matter which method be used, the coefficient of digital financial inclusion converges the urban-rural income gap at a significant level of 1%, which indicates that the results of this paper are robust.

**Table 3.** Robustness test of the model.

	Fixed Effects	Fixed Effects +IV	Fixed Effects	Fixed Effects +IV	Fixed Effects	Fixed Effects +IV
	Dependent Variable: Urban-Rural Disposable Income ratio		Removed in 2016 Dependent Variable: Theil index		Removes Some Remote Areas Dependent Variable: Theil index	
Index of last year	−0.492 *** (−3.916)	−2.111 *** (−4.400)	−0.044 *** (−3.444)	−2.089 *** (−4.592)	−0.048 *** (−3.754)	−0.194 *** (−5.454)
Controlled variable	Yes	Yes	Yes	Yes	Yes	Yes
Fixed time	Yes	Yes	Yes	Yes	Yes	Yes

Fixed individual	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	1375	1375	1100	1100	1285	1285
Regulation R <sup>2</sup>	0.333	0.085	0.501	0.161	0.496	0.287
Wald-F statistics		30.614		34.745		33.216

Note. T statistics or Z statistics in parentheses. Due to space limitations, the details of control variables are not listed.

### 5.3. Influence Analysis of Various Dimensions of Digital Inclusive Finance

Since the digital financial inclusion index has multiple dimensions, we will further investigate the impact of each dimension on the urban-rural income gap. That is, we want to explore if the increase in the number of people participating in digital finance reduces the urban-rural income gap, or the diversification of digital financial services plays a role, or the improvement of digital financial efficiency plays an impact. It may also be a combination of multiple factors. The results are shown in Table 4. It can be seen that the dimension only covers the breadth of reducing the income gap between urban and rural areas on the 1% significant level. Although the depth of use can reduce the urban-rural income gap, there is no statistically significant difference. Similarly, the degree of digitalization has no significant impact on the urban-rural income gap. This also confirms our Hypothesis 2. This shows that increasing the coverage of digital financial coverage is the main reason for reducing the urban-rural income gap. Compared with providing more diversified digital financial services and improving efficiency, it is more important to expand the number of users of digital finance.

**Table 4.** The influence of each dimension on the urban-rural income gap.

Theil Index		Fixed Effects		
Coverage breadth index of the last year		−0.036 *** (−3.692)		
Use the depth index for last year			−0.004 (−1.145)	
Digitalization degree index for last year				0.001 (0.406)
Controlled variable		Yes	Yes	Yes
Fixed time		Yes	Yes	Yes
Fixed individual		Yes	Yes	Yes
Sample size		1375	1375	1375
Regulation R <sup>2</sup>		0.486	0.463	0.462

As analysis shows, the expansion of the user groups of digital finance enables the groups (mostly rural people) who would otherwise have no access to financial services to enter the financial system, alleviates financial exclusion, and thus increases the income of these groups and reduces the income gap between urban and rural areas. Moreover, for this part of the group, because they used to be outside the financial system, they are more deficient in financial knowledge, and the diversification of financial services has higher requirements for financial knowledge, which is more beneficial to people who were originally in the financial system. Therefore, the depth of digital finance use has no obvious impact on the urban-rural income gap. For similar reasons, the impact of higher digital financial efficiency on this segment of the population is weak due to the existence of the “digital divide”.

### 5.4. Transmission Mechanism: Digital Financial Inclusion and Entrepreneurship

If digital financial inclusion can narrow the urban-rural income gap by promoting entrepreneurship of residents with entrepreneurial spirit, then we can see that digital financial inclusion has a significant impact on entrepreneurship of residents with entrepreneurial spirit. The regression results are shown in Table 5. It can be seen that when we only use the fixed effect model, the coefficient of digital financial inclusion is positive, but not significant. When we use the instrumental variable method, the coefficient of digital financial inclusion still positive and significant at the 1% level. This shows that our initial model does have the problem of endogeneity, and after using instrumental variables to overcome the problem of endogeneity, the results show that digital financial inclusion can indeed promote entrepreneurship of residents with entrepreneurial spirit. A large number of empirical studies have shown that residents' entrepreneurship has a significant impact on narrowing the urban-rural gap [73,74]. Zhang et al. further concluded that digital inclusive finance has the best effect on rural residents with low social capital and material capital to start their own businesses, which is more helpful for them to increase their income, thus narrowing the urban-rural income gap [40]. This also laterally validates Hypothesis 3.

**Table 5.** The impact of digital inclusive finance on entrepreneurship.

Entrepreneur-Ship	Fixed Effects		Fixed Effects +IV
Index of last year	0.196 (0.499)	0.297 (0.719)	8.232 *** (2.653)
Controlled variable	No	Yes	Yes
Fixed time	Yes	Yes	Yes
Fixed individual	Yes	Yes	Yes
Sample size	1316	1316	1316
Regulation R <sup>2</sup>	0.323	0.325	0.166
Wald-F statistics			30.926

### 5.5. Further Analysis

#### 5.5.1. Analysis of the Impact of Digital Inclusive Finance in Different Regions on the Urban-Rural Income Gap

In order to further investigate if the effects of digital inclusive finance on the urban-rural income gap are the same in different regions, this paper divides the total samples into three sub-samples: eastern, midland and western regions. Digital inclusive finance and Theil index are used for regression respectively. The results are shown in Table 6. It can be seen that for each region, both the fixed effect and the instrumental variable method show that digital inclusive finance can significantly reduce the urban-rural income gap, but the coefficient is slightly different, which indicates that the impact of digital inclusive finance on the urban-rural income gap may be different in different regions. Then we used the Fischer combination test based on Bootstrap theory to verify if the difference of their coefficients was statistically significant [75]. The results are shown in Table 7 (for simplicity, we only reported the difference of digital financial inclusion coefficients). It can be seen that the empirical results do not reject the hypothesis that there is no difference between the coefficients. That is, in different regions, digital financial inclusion has the same effect on the urban-rural income gap. If we judge the effect of digital financial inclusion on the urban-rural income gap only according to the size of the coefficient at the beginning, and the effect is different in different regions, we will arrive at the wrong conclusions.

**Table 6.** The impact of digital financial inclusion in different regions on the urban-rural income gap.

Theil Index	Fixed Effects			Fixed Effect + VI		
	Eastern	Midland	Western	Eastern	Midland	Western
Index of last year	−0.044 ** (−2.305)	−0.020 * (−1.850)	−0.044 ** (−2.611)	−0.114 *** (−3.942)	−0.193 * (−1.907)	−0.215 ** (−2.161)
Controlled variable	Yes	Yes	Yes	Yes	Yes	Yes
Fixed time	Yes	Yes	Yes	Yes	Yes	Yes
Fixed individual	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	480	500	395	480	500	395
Regulation R <sup>2</sup>	0.476	0.569	0.652	0.424	0.127	0.358
Wald-F statistics				28.094	9.567	6.364

Note. T statistics or Z statistics in parentheses. Due to space limitations, the details of control variables are not listed. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . The test critical values of Wald-F are 16.38 (10%), 8.96 (15%), 6.66 (20%), 5.53 (25%).

**Table 7.** The test Fischer combination.

Differential coeffi- cient	B0-B1(Eastern 1 West- ern 0)	B0-B1(Eastern 1 Mid- dle 0)	B0-B1(Middle 1 West- ern 0)
Index of last year	0 (0.492)	0.023 (0.172)	−0.024 (0.164)

### 5.5.2. Digital Financial Inclusion Helps Underdeveloped Areas

We will further explore if the impact of digital financial inclusion on the urban-rural income gap is different in cities with different economic development. If digital inclusive finance can expand the coverage and influence the urban-rural income gap, then the areas that cannot be reached by traditional finance in the past can enjoy financial services through the development of digital inclusive finance, thus reducing the urban-rural income gap. We call it “timely help”. As traditional finance in developed regions is more widely covered, digital inclusive finance plays a more substitute role, which is called “icing on the cake”. Based on the original model, we introduced the cross term of last year’s index and per capita GDP, as shown in Table 8. The regression results show that the coefficient of the cross term is positive and significant at the 1% level, indicating that in the underdeveloped areas, digital inclusive finance has a better effect in converging the urban-rural income gap. This indicates that digital inclusive finance plays a timely role in providing assistance, and also shows the universality of digital inclusive finance.

### 5.5.3. Digital Financial Inclusion Helps Areas with Low Education Levels

Further, we will consider the role of education level in the impact of digital financial inclusion on the rural-urban income gap. Similar to the last part, we introduced the cross term of last year index and education level based on the original model, as shown in Table 8. The results show that the coefficient of the cross term is positive and significant at the 1% level, indicating that the convergence effect of digital inclusive finance on the urban-rural income gap is better in cities with lower education level. This is consistent with our previous analysis; due to the use of digital financial service having a higher request to the level of education, quality education resources are mainly concentrated in urban areas, high education level of the city urban and rural education gap is bigger, the formation of the “digital divide” bigger, leading to the development of digital inclusion financial impact on the income gap between urban and rural areas. For cities with low education levels, the gap between urban and rural education levels is smaller, and the effect of the “digital divide” is weaker, resulting in the phenomenon we observed. This result is different from the conclusion of Liang et al. [15], which may be caused by the different administrative levels and the difference in the selection of indicators in our study.

**Table 8.** Digital inclusive finance and regional development degree.

Theil Index	Fixed Effects	
Index of last year	−0.145 *** (−4.675)	−0.053 *** (−4.131)
Last year index multiplied by GDP per capita	0.011 *** (4.151)	
Last year index multiplied by education		0.004 *** (3.727)
Controlled variable	Yes	Yes
Fixed time	Yes	Yes
Fixed individual	Yes	Yes
Sample size	1375	1375
Regulation R <sup>2</sup>	0.499	0.499

## 6. Conclusions

The integration of digital technology and financial services provides strong support for resolving financial exclusion and easing financing constraints. Its inclusive development concept will help vulnerable groups to enjoy the financial services they deserve, thus playing a role in poverty reduction and alleviating the urban-rural income gap. Based on the municipal panel data from 2014 to 2018, this paper explores the impact of digital financial inclusion on the urban-rural income gap. This paper found that: (1) Digital inclusive finance can significantly narrow the urban-rural income gap; (2) For all dimensions of digital inclusive finance, only the breadth of coverage can significantly reduce the urban-rural income gap; (3) Digital inclusive finance can narrow the urban-rural income gap by promoting entrepreneurship of residents with entrepreneurial spirit; (4) The convergence effect of digital inclusive finance on the urban-rural income gap is better in cities with lower levels of economic development and education, reflecting its inclusive nature.

Based on the above conclusions, this paper proposes the following policy recommendations: First, we should continue to promote the development of digital inclusive finance. The development of digital inclusive finance in China is relatively late, and its service feature and development mode still need continuous practice and research, and the government should provide room for innovation. Secondly, we should focus on expanding the coverage of digital inclusive finance, give priority to solving the shortcomings of insufficient coverage of financial services, and on this basis, continue to strengthen the depth of its use and the degree of digitalization, to provide more diverse and efficient digital financial services to more people. Then, for underdeveloped areas, the government should provide appropriate financial support, strengthen local Internet infrastructure construction, step up publicity efforts, and promote rural residents to adapt to digital financial services. Next, create a better business environment to strengthen the role of digital financial inclusion in entrepreneurship [76], to alleviating poverty in rural areas and improve income distribution. Digital inclusive finance is a new concept, and there are many blind spots in the original financial supervision system. Lack of supervision can easily lead to the wild growth of digital inclusive finance, which is not conducive to its healthy development.

There are still some shortcomings in this paper, and I hope the follow-up research can make up for them. The digital financial inclusion index used in this paper is compiled by the Digital Finance Research Center of Peking University based on the micro-data of Ant Financial Services Group. Given that Ant Financial Group has many competitors in the field of digital finance, and traditional financial institutions are also gradually opening similar businesses services, the digital financial inclusion index may not fully represent the development of digital financial inclusion, which requires future researchers to use more comprehensive information. At the same time, digital inclusive finance includes a



variety of digital financial services. Due to the limitation of space, this paper does not dig into the impact of various business forms on the urban-rural income gap.

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