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# Digital Inclusive Finance, Entrepreneurial Activity of Farmers, and Urban–Rural Income Disparity: Evidence from China

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**Abstract.** *In recent years, although the ratio of urban to rural per capita income in China has exhibited a continuous downward trend, the income gap between urban and rural areas remains significantly higher than that of developed countries. Addressing this inequality and achieving common prosperity has become one of the key objectives of national development. Utilizing a sample from mainland China, this paper empirically analyzes the role of digital inclusive finance in narrowing the urban–rural income gap by employing the Theil index to assess this disparity. The findings indicate that digital inclusive finance significantly alleviates the urban–rural income gap; however, its impact varies across different dimensions and regions. Furthermore, threshold effect analysis reveals a non-linear relationship between digital financial inclusion and the urban–rural income gap, with farmers' entrepreneurial activities serving as an important moderating factor in this process. The results of this paper provide new insights into the understanding of urban–rural income distribution issues and offer valuable policy recommendations for addressing imbalances in urban–rural development.*

**Keywords:** *digital inclusive finance, urban-rural income inequality, Theil index, threshold effect, entrepreneurship*

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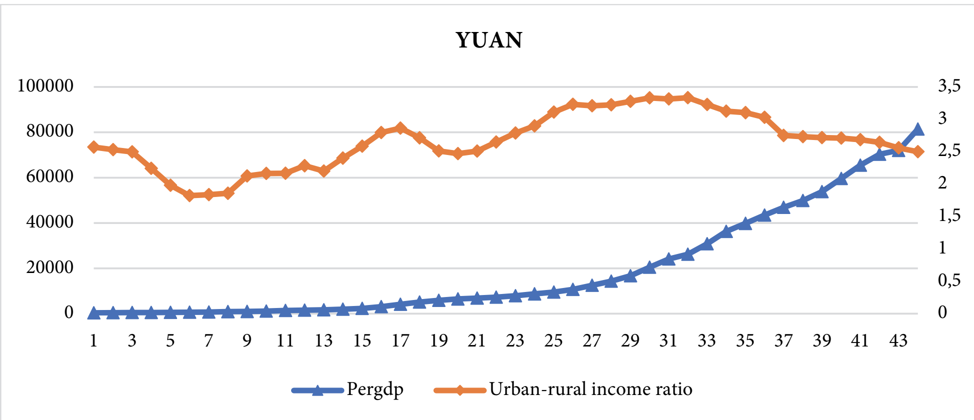
## 1. Introduction

The rural–urban income gap has long been a significant economic and social issue in China, restricting sustainable economic development and profoundly impacting social stability (Li & Du, 2021). As a critical challenge in implementing the Chinese government's rural revitalization strategy, narrowing this income gap is closely linked to the development of the rural economy and the improvement of farmers' living standards. It is also an essential task for promoting the coordinated development of urban and rural areas and achieving common prosperity. Despite remarkable economic achievements in recent decades in China (Zhao & Ruet, 2021), including substantial improvements in national economic output and residents' income levels, the income disparity between urban and rural areas remains pronounced and has not been effectively addressed. Despite the rapid economic development in urban areas, rural areas lag in economic growth, particularly concerning resource allocation, infrastructure development, and social services, resulting in a significant disparity between urban and rural regions.

As illustrated in Figure 1, by 2021, China's per capita gross domestic product (GDP) reached 81,400 yuan, reflecting a 211-fold increase since 1978, which underscores the continuous expansion of China's economy and the significant enhancement of residents' income. However, despite this impressive economic growth, the income gap between urban and rural areas has not seen a substantial reduction. From 1978 to 2021, although the income ratio of urban to rural residents fluctuated, it consistently remained at a high level.

**Figure 1**

*Per Capita GDP and Urban-Rural Income Ratio in China*




*Note.* From the National Bureau of Statistics.

Studies indicate that the formation of the urban–rural income gap is closely linked to the unequal distribution of resources, particularly financial resources, which play a crucial role in this process (Wang et al., 2023). In the contemporary economic system, access to financing is a significant factor in promoting economic activities, enhancing production efficiency, and fostering income growth. For low-income groups, financing can effectively mitigate their initial capital shortages and provide opportunities to escape the poverty trap (Neaime et al., 2018). By securing appropriate financial resources, low-income individuals can more effectively engage in economic activities, thereby improving their productive capacity and income levels. However, evidence shows that traditional financial institutions often allocate a disproportionate number of financial resources to wealthier groups, positioning them more favorably in economic activities (Clarke et al., 2003).

Simultaneously, cities, as hubs of economic and financial activity, attract a substantial number of financial resources and services. Urban residents benefit from easier access to credit, investment, and other forms of financial support (Jia, 2019). Conversely, due to insufficient coverage of financial institutions, limited credit availability, and other factors, rural areas have long been marginalized in terms of financial resources, lacking the same level of support available to urban areas (Liang & Liu, 2019). This spatial imbalance in financial resources creates significant barriers for rural residents in accessing production factors and investment opportunities, thereby constraining their potential for economic development. This situation not only impedes the income growth of rural residents but also exacerbates the income disparity between urban and rural areas, perpetuating a vicious cycle.

The rapid development of digital inclusive finance offers a novel approach to alleviating the urban–rural income gap. Using advanced technologies such as the Internet and big data, digital inclusive finance has significantly expanded the reach of financial services in rural areas through innovative offerings like mobile payments, online credit, and digital banking (Zhou et al., 2020). This financial innovation has not only positively impacted consumption (Zhang et al., 2019), but has also profoundly influenced entrepreneurial activities (Xie et al., 2018) and poverty alleviation efforts (He et al., 2020). As rural digital infrastructure continues to improve, digital financial inclusion is increasingly adopted in these areas and plays a crucial role in eradicating absolute poverty in China (Wang & Ran, 2021). By enhancing the financial accessibility for rural residents, digital financial inclusion not only aids in increasing their incomes but also provides substantial support for fostering entrepreneurial activities and facilitating the transformation and upgrading of the rural economy, ultimately contributing to the reduction of the economic gap between urban and rural regions.

Additionally, existing literature indicates that when enterprises prioritize short-term financial goals, they often undermine their environmental, social, and governance (ESG) performance through real earnings management. This undermining, in turn, negatively impacts their long-term financial performance and sustainability (Habib, 2023).

This research finding offers theoretical support for the present study. Digital financial inclusion should not solely focus on immediate benefits; rather, it should emphasize the promotion of long-term social inclusion and sustainable economic development. By providing ongoing financial support to rural areas, digital financial inclusion can bolster their resilience against economic fluctuations, thereby enhancing their potential for sustainable development (Habib & Mourad, 2024). This financial innovation not only contributes to reducing the urban–rural income gap but also establishes a robust foundation for sustainable economic and social development in rural regions.

Although research on the relationship between digital financial inclusion and income inequality has made significant progress in recent years (see Table 1), there remains a substantial gap in understanding the heterogeneous impact of digital financial inclusion on income inequality. Furthermore, most existing studies primarily focus on the linear relationship between digital financial inclusion and income inequality, neglecting the more complex interaction mechanisms between the two. For instance, the dynamic regulatory effect of digital inclusive finance on income distribution, influenced by farmers' entrepreneurial activities, has not received adequate attention and discussion in the literature. As a crucial driver of economic development and social mobility, entrepreneurial activities may exert varying effects through digital inclusive finance at different stages of entrepreneurial development, leading to a non-linear impact on the urban–rural income gap. Existing studies have yet to engage in comprehensive discussions regarding this complex mechanism, which remains a topic requiring further investigation. As the largest developing country in the world, China experiences a particularly pronounced urban–rural income gap, which not only undermines the inclusiveness of economic growth but also hampers the sustainable development of society. Therefore, an in-depth examination of the role of digital financial inclusion in narrowing China's urban–rural income gap holds significant practical importance for the country in achieving its sustainable development goals.

**Table 1**

*The Key Literature Related to this Topic*

| Year | Author | Variable | Findings |
|---|---|---|---|
| 2021 | Zheng | Digital financial inclusion, income disparity | Digital financial inclusion has narrowed the income gap between urban and rural areas. |
| 2022 | Demir et al. | Financial inclusion, fintech, income inequality | Financial inclusion is the main channel through which fintech can reduce income inequality. |
| 2023 | Das and Chatterjee | Digital finance, inequality | Digital finance help reduces poverty in both rural and urban areas. |
| 2023 | Liu and Guo | Digital financial inclusion, income inequality | Digital financial inclusion significantly reduces relative household poverty. |

| Year | Author | Variable | Findings |
|---|---|---|---|
| 2024 | Takmaz et al. | Digital financial inclusion, income disparity | Financial inclusion is positively correlated with income inequality. However, unemployment inhibits it. |
| 2024 | Zhang et al. | Digital financial inclusion, income disparity | Digital financial inclusion plays a constructive role in narrowing the urban-rural income gap by promoting agricultural technological innovation. |
| 2024 | Sun et al. | Digital financial inclusion, income inequality | Digital financial inclusion mitigates the impact of asset status on income inequality. |
| 2024 | Pei et al. | Digital financial inclusion, relative rural poverty | The development of digital financial inclusion has a significant inhibitory effect on rural relative poverty. |

In light of this, this current paper utilizes data from mainland China to calculate the Theil index for evaluating the urban–rural income gap and analyze the relationship between digital financial inclusion and this income disparity. Additionally, it explores the varying roles of these factors across different regions and dimensions, while also revealing their non-linear relationship. This research enriches the existing literature on digital financial inclusion and provides a new foundation for optimizing urban–rural financial policies, ultimately promoting balanced urban–rural development.

The current paper contributes to the existing knowledge in two ways. First, this work investigates the impact of digital financial inclusion on the urban–rural income gap, revealing its heterogeneous effects across different regions and dimensions. Notably, in the economically developed eastern region, the influence of digital financial inclusion on reducing the urban–rural income gap is particularly pronounced. In contrast, while the overall impact in the economically disadvantaged western region is lower, its marginal benefits are greater. However, the effect of digital financial inclusion on the urban–rural income gap in the central region, situated between the two aforementioned areas, is not statistically significant. This regional disparity offers a robust theoretical foundation for policymakers in developing regional digital financial inclusion strategies. Second, this investigation innovatively uncovers the nonlinear relationship between digital financial inclusion and the urban–rural income gap. Unlike the linear effects discussed in prior research, this paper employs the entrepreneurial activities of farmers as a threshold variable, constructs a nonlinear threshold model, and examines the mechanisms through which digital inclusive finance influences the urban–rural income gap at varying levels of entrepreneurial activity. The results indicate that digital inclusive finance positively affects the narrowing of the urban–rural income gap when entrepreneurial activity is low; however, once entrepreneurial activity surpasses a certain threshold, digital inclusive finance may exacerbate the urban–rural income gap. These findings not only enhance theoretical understanding of urban–rural income distribution but also provide valuable insights for policymakers on effectively integrating entrepreneurial activity with digital financial development. This contribution addresses a notable gap in the existing literature and holds significant theoretical and practical implications.

The remaining sections of this paper are structured as follows: Section 2 provides a comprehensive review of the existing literature, paying particular attention to the relationship between the key variables. Section 3 discusses the sample, data source, variables, and econometric model. Empirical findings are discussed in Section 4. A discussion of the findings is presented in Section 5. Section 6 provides the conclusion and recommendations of this work.

## 2. Literature Review

Macroeconomic robustness plays a crucial role in fostering the development of financial sector services (Habib, 2024). A well-developed financial sector can provide several comparative advantages to a country, thereby enhancing overall economic performance (Okine et al., 2023). The effective development of the financial sector is regarded as an essential prerequisite for the economic growth of emerging market economies (Hidayat, 2023). In this context, digital financial inclusion is notable for its inclusive and sustainable characteristics, particularly in addressing challenges such as asymmetric information and high transaction costs in rural areas (Yang, 2023). Shahrokhi (2008) depicts digital finance as a unique type of finance that goes beyond traditional financial intermediation and capital markets, signifying a new financial paradigm. DIF alleviates household credit constraints and boosts credit demand in situations where formal finance is inaccessible (Yin & Zhang, 2017). Existing research suggests that DIF plays a key role in developing increased demand for business investment, promotes inclusive economic growth, and expands the farmers' income (Song, 2017; Sehrawat & Giri, 2018; Yin & Peng, 2020; Li et al., 2020). Corrado and Corrado (2017) demonstrated in their research that DIF offers fair and cost-effective financial services to all households, particularly to those belonging to disadvantaged groups. According to Yang et al. (2022), DIF moderates the financial obstacles in rural areas by diversifying the spectrum of customer services. In a study by Zhang and Gao (2023), it was revealed that digital technology extended financial services to households via the Internet, thus effectively eliminating geographical and spatial constraints while reducing the cost of financial services. Consequently, the advancement of DIF has significantly encouraged the financial resources available in rural regions and improved the accessibility of credit for rural inhabitants (Sun et al., 2022). Meanwhile, Bai et al. (2023), and Zhao and Wang (2023) found that DIF enhances the efficiency of financial resource allocation and balances the distribution of financial resources between the city and countryside, effectively addressing asymmetric information in financial industries. Ren et al. (2020) concluded that DIF significantly reduces the level of rural poverty and further found that labor transfer plays a mediating role.

Globally, entrepreneurship is acknowledged as a vital economic activity that generates a significant number of jobs (Mahalakshmi et al., 2023). Past studies suggested that DIF is conducive to farmers' entrepreneurship (Chen & Zhong, 2023). Jiang and Li (2015) stated that DIF offers financial assistance to farmers, thus improving entrepreneurial chances. Wang et al. (2017) observed a bias among investors towards borrowers' identities, with a preference for supporting the working class. However, DIF effectively promotes rural entrepreneurship through information disclosure. According to Yang et al. (2020), DIF boosts rural residents' income by stimulating economic growth and entrepreneurial activities using a mediation effect model. Huang and Zeng (2020) examined the effect of DIF on entrepreneurial activity using a spatial econometric model, while He and Li (2019) discovered that DIF not only alleviates credit constraints for rural residents and enhances information accessibility but also spurs the entrepreneurship of farmers. As a result, the advancement of DIF enhances the entrepreneurial landscape for farmers (Yang & Fu, 2019), and effectively supports migrant workers' entrepreneurship (Zeng et al., 2018), thereby boosting farmers' income.

The existing literature indicates that digital financial technology substantially improves income levels in rural areas by mitigating financial exclusion and enhancing financial efficiency. However, there is lack of studies examining its heterogeneous impact on the urban–rural income gap and the nonlinear relationship between these variables. This article aims to discuss the nonlinear relationship using a threshold regression model that can identify the changes in the size of the relationship between the independent variable and the dependent variable above and below the threshold, thereby making up for the lack of previous research. In addition, the entrepreneurial activity of farmers is also included in the same research framework.

## 3. Methodology

### *3.1 Research Design and Data*

As a significant driver of global economic growth, China has been actively promoting financial inclusion through digital technologies in recent years. However, the urban–rural income gap remains a serious issue. Digital financial inclusion is viewed as a potential solution to this problem, playing a crucial role in alleviating disparities in income distribution between urban and rural areas. Consequently, this current paper seeks to investigate the impact of digital financial inclusion on the urban–rural income gap through empirical analysis. This work employs the Theil Index as an indicator to measure the urban–rural income gap and empirically tests the influence of digital financial inclusion on this gap, as well as its differentiated effects across various dimensions and regions. Furthermore, this paper introduces a threshold effect model to analyze the nonlinear relationship between digital financial inclusion and the urban–rural income gap.

There are 31 provinces in mainland China. Due to the data missing in Tibet province, Tibet is excluded in the sample. As a result, this study selects 30 provincial units in mainland China for the years 2011 to 2021 as the sample. Data about the Digital Financial Inclusion Index are sourced from the Institute of Digital Finance Peking University, and others are from the National Bureau of Statistics, Chinese Statistical Yearbook, and provincial Statistical Yearbook.

### *3.2 Research Variables*

#### *3.2.1 Urban–Rural Income Gap (GAP)*

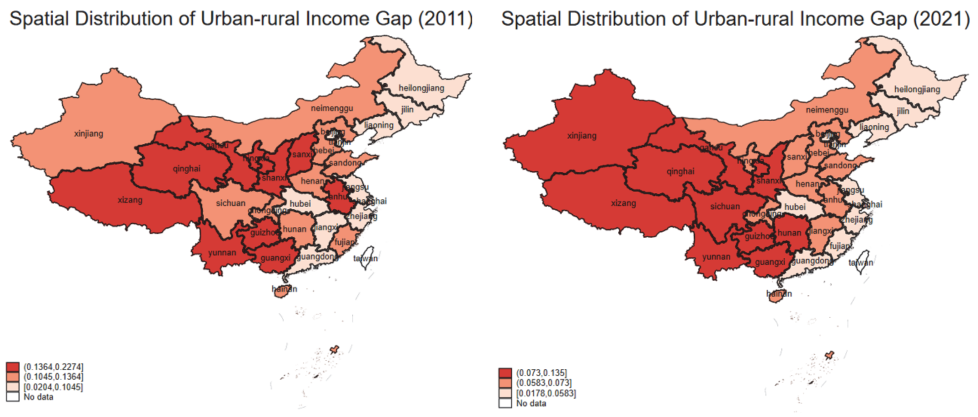
The Gini coefficient, urban–rural per capita income ratio, urban–rural per capita consumption ratio, and the Theil index are generally used to assess GAP in existing literature. The Theil index is more sensitive to income polarization because it accounts for both urban and rural demographic characteristics (Wang & Liu, 2023). Hence, we measure GAP using the Theil index, as shown in Equation (1).

$$TH_{it} = \sum_{j=1}^{2} \left(\frac{I_{jit}}{I_{it}}\right) ln \left[\left(\frac{I_{jit}}{I_{it}}\right) / \left(\frac{P_{jit}}{P_{it}}\right)\right] \tag{1}$$

where $i$ is the provincial unit; $t$ is the time dimension; $j$ represents the urban or rural area; $TH$ is the Theil index, which represents $GAP$; $I_{it}$ is the total income of residents, both urban and rural; $I_{jit}$ is the income earned specifically by individuals residing in either an urban or rural area; $P_{it}$ is the total population; $P_{jit}$ is the population in urban or rural areas. The Theil index is an inverse indicator, where a higher value signifies a wider

**Figure 2**

*The Distribution of The Urban–Rural Income Divide, 2011, 2021*




*Note.* The intensity of the color reflects the magnitude of the income gap, with darker shades denoting a wider gap and lighter shades signifying a narrower gap.

income gap. We take the reciprocal of the Theil index in our empirical analysis. To investigate the spatial character of GAP, this study plots the distribution for the years 2011 and 2021 based on the Theil index (see Figure 2). Findings show that GAP in China varies significantly in different provinces. Regions characterized by smaller urban–rural income disparities predominantly align with the eastern coast, whereas most of those with larger gaps are situated in the western area.

#### *3.2.2 Digital Inclusive Finance*

Referring to the research by Guo et al. (2020), we assess DIF using the Digital Inclusive Finance Index developed by *the Digital Finance Research Center at Peking University*, which includes three dimensions: breadth of coverage (COV), depth of usage (USE), and degree of digitalization (DIG). COV indicates the reach of DIF to customers, while USE reflects the actual utilization of DIF. DIG measures the convenience of DIF.

#### *3.2.3 Entrepreneurial Activity of Farmers (FEA)*

Drawing on the research methods employed by Huang et al. (2023) and Xu et al. (2022), the current study uses the ratio of rural private sector employment to the total rural population as a metric for evaluating the entrepreneurial activity of farmers.

#### *3.2.4 Control variables*

To alleviate the impact of omitted variables, following the research of Wang et al. (2020), Sun and Jiao (2017), Li and Zhang (2022), and Tian and Cai (2023), this study selects four factors as control variables, including industrial structure upgrading measured by the proportion of output value of tertiary industry to that of secondary industry, human capital measured by years of schooling per capita, urbanization measured by the proportion of urban population in the total population, scientific and technological development measured by the ratio of R&D expenditure to GDP.

### ***3.3 Econometric Model***

#### *3.3.1 Baseline Model*

As DIF may have an influence on GAP, we construct the benchmark model, as displayed in Equation (2)

$$GAP_{it} = \beta_0 + \beta_1 DIF_{it} + \theta X_{it} + \varepsilon_{it} \tag{2}$$

where $i$ and $t$ are province and time, respectively. $X$ is a series of control variables. $\varepsilon_{it}$ is the random disturbance term.

*3.3.2 Threshold Model*

As the effect of DIF on GAP may be nonlinear, referring to the method proposed by Hansen (1999), we build the threshold model on the basis of the baseline model as follows:

$$GAP_{i,t} = \beta_0 + \beta_1 DIF_{i,t}(q \le \gamma_1) + \beta_2 DIF_{i,t}(\gamma_1 < q \le \gamma_2) + \dots + \beta_n DIF_{i,t}(\gamma_\mathrm{n} < \mathrm{q} \le \gamma_{\mathrm{n}+1}) + \beta_{n+1} DIF_{i,t}(q > \gamma_{n+1}) + \theta X_{it} + \varepsilon_{it} \quad (3)$$

where $q$ is the threshold variable; $\gamma$ is the threshold value.

## 4. Results

### *4.1 Descriptive Statistics*

Table 2 reports the descriptive statistics of variables. The sample comprises 330 observations. The mean and the median of variables exhibit a high degree of proximity, suggesting a symmetrical distribution and consistent concentration trend within the dataset. The GAP ranges from 0.017 to 0.227, with a mean of 0.091. The DIF ranges from 18.33 to 459, with an average of 231.5, reflecting a broad variation across regions. The COV has a mean of 213, ranging between 1.96 and 433.4. The variation in coverage underscores the uneven reach of digital financial services across different areas. The USE variable shows a mean of 226.8, with a range between 6.76 and 510.7, pointing to a wide disparity in the extent to which financial services are used in different regions. The DIG has an average value of 301 and ranges from 7.58 to 462.2, indicating a substantial difference in digital infrastructure across regions, with some areas lagging behind in terms of technology access.

**Table 2**

*Descriptive Statistics*

| Variable | Observation | Minimum | Mean | P50 | Maximum | Std. |
|---|---|---|---|---|---|---|
| GAP | 330 | 0.017 | 0.091 | 0.084 | 0.227 | 0.043 |
| DIF | 330 | 18.330 | 231.500 | 238.500 | 459.000 | 103.300 |
| COV | 330 | 1.960 | 213.000 | 215.800 | 433.400 | 103.700 |
| USE | 330 | 6.760 | 226.800 | 228.700 | 510.700 | 105.800 |
| DIG | 330 | 7.580 | 301.000 | 333.200 | 462.200 | 117.400 |
| ISU | 330 | 0.527 | 1.342 | 1.187 | 5.244 | 0.732 |
| HR | 330 | 7.679 | 9.347 | 9.251 | 12.70 | 0.883 |
| URB | 330 | 0.350 | 6.479 | 0.577 | 89.31 | 18.89 |
| TECH | 330 | 0.001 | 0.011 | 0.009 | 0.032 | 0.006 |

*Note.* P50 is the median. Std. is the standard deviation.

### 4.2 Baseline Regression

Table 3 presents the results of pooled ordinary least squares (POLS), random effects method (RE), and fixed effects method (FE). The coefficients of DIF are 0.0684, 0.1052, and 0.1404 respectively, and are statistically significant at the level of 1% in the three methods, indicating that DIF significantly alleviates GAP. However, the results of the Hausman test show that the FE method is preferred over POLS and the RE. Thus, we use the FE method in the subsequent analyses.

**Table 3**

*The Results of Baseline Regression*

| | (1) | (2) | (3) |
|---|---|---|---|
| | POLS | RE | FE |
| DIF | 0.0684*** | 0.1052*** | 0.1404*** |
| | (0.0226) | (0.0150) | (0.0229) |
| ISU | 0.0714** | 0.0014 | -0.0264 |
| | (0.0361) | (0.0712) | (0.0974) |
| HR | 3.7237*** | 3.0802*** | 2.1542*** |
| | (0.3219) | (0.5321) | (0.3706) |
| URB | 0.0010 | 0.0012*** | 0.0017*** |
| | (0.0009) | (0.0004) | (0.0003) |
| TECH | 29.1222*** | 12.4458*** | 7.6589* |
| | (3.2862) | (4.6927) | (4.3780) |
| Constant | -6.5654*** | -5.0495*** | -3.0834*** |
| | (0.6481) | (1.0512) | (0.7610) |
| Observations | 330 | 330 | 330 |
| $R^2$ | 0.7828 | 0.8054 | 0.8063 |
| F | 191.6993*** | - | 199.6885*** |
| Hausman | | 20.1200(p=0.0026) | |

*Note.* The dependent variable is GAP measured by the Theil index. Standard errors are in parentheses. *** =p<0.01, **= p<0.05, *= p<0.1. "-" means that there is no data.

A robustness test is conducted by running a sensitivity analysis using the following methods. First, we assess GAP using the urban–rural consumption ratio. Second, we measure GAP using the urban–rural per capita income ratio. Finally, to address any issue with endogeneity, we use the Generalized Method of Moments (GMM) to estimate Equation (2) instead of the FE method. GMM consists of the Difference Generalized Method of Moments (DIF-GMM) and the System Generalized Method of Moments (SYS-GMM). Compared with DIF-GMM, SYS-GMM significantly improves the estimation efficiency and solves the problem of weak instrumental variables (Blundell & Bond, 1998). Therefore, we choose SYS-GMM in our analysis. The results of the robustness check are reported in Table 4. The sign and significance of the coefficients of DIF are consistent with the results of baseline regression, indicating the reliability of the results.

**Table 4**

*Robustness Test*

| | (1) | (2) | (3) |
|---|---|---|---|
| | Consumption Ratio | Income Ratio | SYS-GMM |
| DIF | 0.0385*** | 0.0100*** | 0.0430** |
| | (0.0072) | (0.0014) | (0.0195) |
| ISU | 0.0478* | 0.0112* | -0.0295 |
| | (0.0266) | (0.0063) | (0.0480) |
| HR | 0.3536*** | 0.1593*** | 1.0488 |
| | (0.1267) | (0.0299) | (1.1678) |
| URB | 0.0009*** | 0.0003*** | 0.0001 |
| | (0.0002) | (0.0000) | (0.0003) |
| TECH | 6.0308*** | 0.4831 | 3.0570 |
| | (1.1963) | (0.3696) | (4.6128) |
| L.GAP | - | - | 0.7674*** |
| | - | - | (0.1799) |
| Constant | -0.6536** | -0.0327 | -1.9305 |
| | (0.2653) | (0.0625) | (2.1942) |
| Observations | 330 | 330 | 300 |
| $R^2$ | 0.7922 | 0.8134 | 0.7664 |
| F | 40.9611*** | 85.9570*** | 406.6920*** |
| AR (1) | - | - | p=0.2370 |
| AR (2) | - | - | p=0.3030 |
| Hansen | - | - | p=0.2800 |

### *4.3 Heterogeneity Test*

#### *4.3.1 Dimensional Heterogeneity*

To examine the impact of dimensional heterogeneity, we conducted an empirical analysis with COV, USE, and DIG as dependent variables, respectively. The outcomes are presented in Table 5. The coefficient of COV is found to be significantly positive at the 1% level in column (1), with consistent results in columns (2) and (3). These findings suggest that COV, USE, and DIG have contributed to narrowing the income divide between farmers and townspeople. The impact of USE is the greatest, followed by COV and DIG.

**Table 5**
*Dimensional Heterogeneity*

| | (1) | (2) | (3) |
|---|---|---|---|
| | COV | USE | DIG |
| COV | 0.1051*** | - | - |
| | (0.0217) | - | - |
| USE | - | 0.1185*** | - |
| | - | (0.0267) | - |
| DIG | - | - | 0.0778*** |
| | - | - | (0.0158) |
| ISU | 0.0021 | 0.0162 | 0.0331 |
| | (0.0982) | (0.1035) | (0.0957) |
| HR | 2.2951*** | 2.3440*** | 2.9655*** |
| | (0.3698) | (0.3811) | (0.4436) |
| URB | 0.0017*** | 0.0016*** | 0.0017*** |
| | (0.0003) | (0.0003) | (0.0003) |
| TECH | 8.4212* | 10.4498* | 9.0766* |
| | (4.8255) | (5.1123) | (4.8225) |
| Constant | -3.2433*** | -3.4761*** | -4.6788*** |
| | (0.7658) | (0.7735) | (0.8682) |
| Observations | 330 | 330 | 330 |
| $R^2$ | 0.8015 | 0.8188 | 0.7781 |
| F | 118.2333*** | 180.1645*** | 121.9827*** |

### *4.3.2 Regional Heterogeneity*

The influence of DIF on GAP may vary by region due to disparities in resource availability and levels of economic development. Hence, this study categorizes the full sample into three sub-samples: the eastern, central, and western regions. The eastern region is predominantly composed of well-developed provinces, while the western region is mainly comprised of less-developed provinces. As shown in Table 6, disparities across regions are evident in the impact of DIF on GAP. It is observed that DIF significantly affects GAP in both the eastern and western regions. However, the influence is less pronounced in the central region. Specifically, the regression coefficient for the eastern region is 0.2340, surpassing that of the entire sample (0.1404) and the western region (0.1046). This suggests that the effectiveness of DIF in diminishing GAP primarily stems from the eastern region. This may be because the eastern part of China is characterized by advanced economic and financial development. Digital finance generates obvious dividends. The western region, although economically behind, offers more employment opportunities. Once the financial exclusion among rural residents is reduced, farmers can more easily access entrepreneurial and investment prospects, ultimately increasing their incomes. Conversely, the central region is in a dilemma, with constraints on economic development and less room for local development, hindering the potential impact of digital financial inclusion initiatives.

**Table 6**

*Regional Heterogeneity*

| | (1) | (2) | (3) |
|---|---|---|---|
| | Eastern Region | Central Region | Western Region |
| DIF | 0.2340*** | 0.0656 | 0.1046*** |
| | (0.0440) | (0.0361) | (0.0112) |
| ISU | -0.1751 | 0.1201 | 0.1929 |
| | (0.1584) | (0.0760) | (0.1106) |
| HR | 1.3455 | 2.2856* | 2.1474*** |
| | (1.0285) | (1.1351) | (0.4405) |
| URB | 0.0016** | 0.0019** | 0.0019*** |
| | (0.0007) | (0.0006) | (0.0005) |
| TECH | 1.6127 | 18.2904 | 16.8272 |
| | (4.1123) | (10.1944) | (13.4117) |
| Constant | -1.1353 | -3.2714 | -3.4588*** |
| | (2.1128) | (2.3702) | (0.8621) |
| Observations | 121 | 88 | 121 |
| $R^2$ | 0.6243 | 0.5430 | 0.5539 |
| F | 66.1442*** | 48.4912*** | 84.2577*** |

### *4.4 Threshold Effect*

To explore the nonlinear effect of DIF on GAP, we take entrepreneurial activity of farmers (FEA) as the threshold variable. Before determining a specific panel threshold model, it is necessary to conduct an examination to confirm the existence of the threshold effect. This article uses the method of Bootstrap introduced by Hansen (2000) to assess the threshold effects, with the outcomes detailed in Table 7. The analysis reveals that FEA rejects the triple-threshold test but passes the double-threshold test at the level of 5%. The threshold values for FEA are 0.361 and 0.715 (see Table 8).

**Table 7**

*Threshold Effect Test*

| Threshold Variable | Threshold Type | F-statistics | P-value | Bootstrap | Critical Value | | |
|---|---|---|---|---|---|---|---|
| | | | | | 1% | 5% | 10% |
| FEA | Triple | 15.710 | 0.724 | 500 | 63.676 | 52.798 | 43.323 |
| | Double | 19.970 | 0.046 | 500 | 26.665 | 20.509 | 16.430 |

**Table 8**

*Threshold Estimator and Confidence Interval*

| Threshold Variable | Threshold Type | Threshold Value | 95% Confidence Interval |
|---|---|---|---|
| FEA | Single | 0.361 | (0.329, 0.365) |
| | Double | 0.715 | (0.697, 0.761) |

The threshold is the value at which the likelihood ratio (LR) statistically approaches 0 (Hansen, 2000). Based on the results presented in Table 8, we generate likelihood ratio function plots for FEA at a 95% confidence interval using Stata software (see Figure 3). In these plots, the threshold corresponds to the lowest point of the LR statistic. The dashed line represents the critical value of 7.35. As the critical value exceeds the threshold value, it is concluded that the threshold values are valid. Consequently, we establish Equation (4) on the basis of Equation (3).

$$GAP_{i,t} = \beta_0 + \beta_1 DIF_{i,t}(q \leq 0.361) + \beta_2 DIF_{i,t}(0.361 < q \leq 0.715) + \beta_3 DIF_{i,t}(q > 0.715) + \theta X_{it} + \varepsilon_{it} \tag{4}$$

where $q$ is the entrepreneurial activity of farmers.

**Figure 3**

*Likelihood Ratio Function Diagram (FEA)*

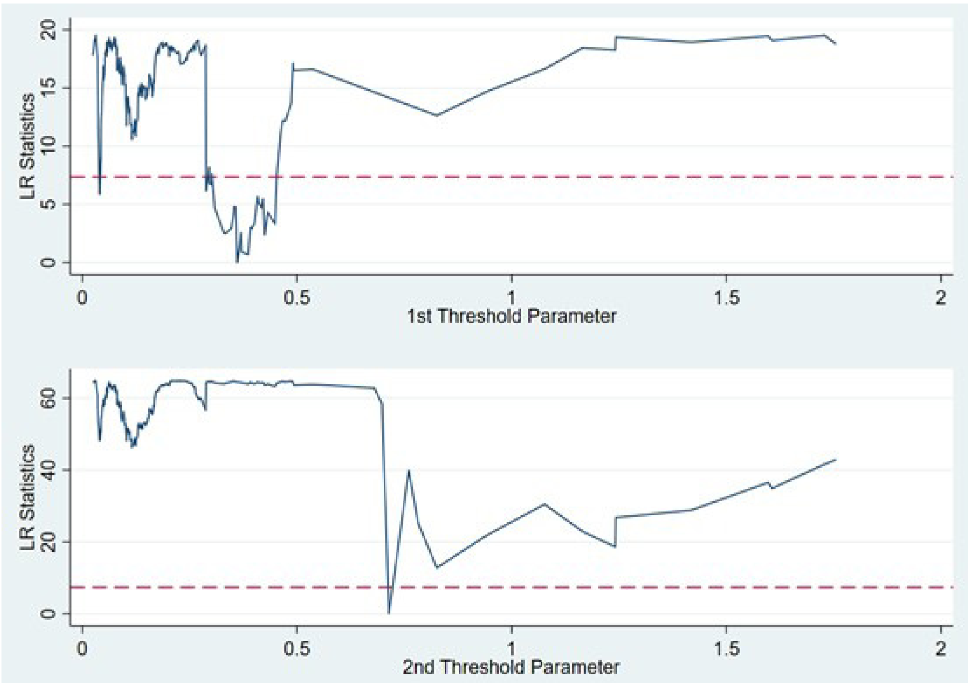


Table 9 lists the results of the threshold effect. When FEA is lower than 0.361, the impact is 0.111 (p=0.0000). Moreover, when the value of FEA is between 0.361 and 0.715, the regression coefficient increases to 0.132 (p=0.0000). However, when the value of FEA is higher than 0.715, the effect of DIF on GAP is now negative with a coefficient of -0.293 (p=0.0000). This shows that the entrepreneurial activity of farmers moderates the nonlinear influence of DIF on GAP, and when the entrepreneurial activity of farmers exceeds 0.715, DIF widens GAP. A reason that may account for this result is that entrepreneurship is a high-risk activity with the potential for increased income if successful, while farmers who do not succeed in entrepreneurship may suffer losses. According to Li (2016) and Xu et al. (2017), factors such as market conditions and the natural environment may impact the entrepreneurial activities of farmers, thus making them more vulnerable to risks and increasing the chances of failure. Hence, a rise in the number of entrepreneurial farmers may lead to a higher likelihood of entrepreneurial failures.

**Table 9**

*Results of Threshold Effect*

| | **Coefficient** | **SE** | **t-statistics** | **p-value** |
|---|---|---|---|---|
| DIF ($q \leq 0.361$) | $0.111^{***}$ | 0.016 | 6.690 | 0.000 |
| DIF ($0.361 < q \leq 0.715$) | $0.132^{***}$ | 0.016 | 8.150 | 0.000 |
| DIF ($q > 0.715$) | $-0.293^{***}$ | 0.060 | -4.910 | 0.000 |
| ISU | $0.100^{**}$ | 0.043 | 2.320 | 0.021 |
| HR | $2.142^{***}$ | 0.373 | 5.750 | 0.000 |
| URB | $0.002^{***}$ | 0.000 | 4.130 | 0.000 |
| TECH | $8.237^{***}$ | 2.884 | 2.860 | 0.005 |
| Constant | $-2.937^{***}$ | 0.775 | -3.790 | .000 |
| Observations | 330 | | | |
| $R^2$ | 0.728 | | | |
| F | $112.080^{***}$ | | | |

*Note.* DIF stands for the dependent variable; FEA represents the threshold variable; SE refers to standard error.

## 5. Discussion

The empirical results of the current paper indicate that digital financial inclusion plays a significant positive role in narrowing the urban–rural income gap, aligning with the findings of most existing studies (Xie, 2023; Wang et al., 2024; Mo et al., 2024). Specifically, it supports the view that digital financial inclusion can enhance the income distribution structure by increasing financial accessibility in rural areas. However, this paper reveals that the impact of digital financial inclusion on reducing the urban–rural income gap is more pronounced in China's economically developed regions (such as the eastern coastal areas) and economically underdeveloped regions (such as the western inland areas), while its effect is not significant in the central regions. This discrepancy may be attributed to variations in the level of digital infrastructure development across different regions. The eastern region, characterized by a mature digital financial network and high Internet penetration, enables digital financial inclusion to effectively reach both urban and rural populations, thereby realizing its potential to narrow the income gap. Conversely, despite being economically underdeveloped, the western region benefits from the initial construction phase of digital finance, which has also demonstrated a relatively significant impact in this area.

The current paper further analyzes the complex interactive relationship between digital inclusive finance and the urban–rural income gap, particularly in the context of farmers' entrepreneurial activities. The findings indicate that as entrepreneurial activities increase, the impact of digital inclusive finance on the urban–rural income gap exhibits a significant nonlinear change. Specifically, at low levels of entrepreneurial activity, digital inclusive finance positively contributes to narrowing the urban–rural income gap. However, once entrepreneurial activities surpass a certain threshold, the effect of digital financial inclusion reverses, resulting in a widening of the income gap. This observation highlights that digital inclusive finance has a different impact on urban–rural income gap depending on the entrepreneurial environment. This threshold effect has not been thoroughly examined in existing literature. By elucidating this nonlinear relationship, the study offers a novel academic perspective and theoretical foundation for understanding the dynamics between digital inclusive finance and the urban–rural income gap.

## 6. Conclusion and Recommendations

This study makes a significant contribution to the theory of financial inclusion and income distribution. It demonstrates the impact of digital financial inclusion on rural–urban income gap, thereby enhancing the theory of financial inclusion. Moreover, the introduction of a nonlinear threshold effect illustrates that entrepreneurial activity alters the direction of the influence of digital inclusive finance on the urban–rural income gap after reaching a certain threshold, offering a novel theoretical perspective.

Based on the current findings, several policy recommendations are proposed to maximize the positive impact of digital inclusive finance on urban–rural income inequality and address potential challenges. First, the government should boost investment in rural digital infrastructure to improve financial services in rural areas. This would help create the conditions necessary for promoting digital financial inclusion and provide financial support for rural revitalization. Moreover, financial institutions should engage actively with farmers to enhance the digital financial literacy of rural residents and encourage greater farmers' participation in digital financial services. In rural areas with limited resources, various strategies are employed to optimize the financial management of rural enterprises (Habib et al., 2024) and to fully use the resources provided by digital financial inclusion. Second, although DIF has effectively reduced income disparities between urban and rural areas in the eastern and western regions, its impact in the central region remains limited. Therefore, policy efforts should vary across regions. For the eastern and western regions, further enhancing coverage and depth can consolidate the positive impact of DIF. In the central region, foundational infrastructure and service systems need to be established first to reduce the digital financial divide. Finally, the current analysis indicates a non-linear relationship between DIF and urban–rural income inequality, with entrepreneurship acting as a moderating factor. While entrepreneurship can reduce income inequality, excessive entrepreneurial activity beyond a certain threshold may widen the gap. Policymakers should balance encouraging entrepreneurship with measures to prevent the negative effects of over-entrepreneurship. During the entrepreneurial process, relevant departments should actively guide farmers to start businesses, preventing blind entrepreneurship. It is essential to promote intelligent financial services, such as Robo-advisors, which may mitigate the adverse effects of behavioral biases on investment decisions (Lisauskiene et al., 2021) and assist companies in enhancing their financial management and social responsibility. These strategies aim to reduce the risk of financial distress (Habib, 2023) and improve the success rate of farmers' entrepreneurial endeavors.

Although this paper conducted a detailed empirical analysis based on provincial-level data in China, it did not employ data from prefecture-level cities with larger sample sizes due to limited availability. This limitation somewhat hinders a comprehensive understanding of outcomes at a more granular level. Future studies could analyze the specific impact of digital inclusive finance on the urban–rural income gap by incorporating data from prefecture-level cities, thereby enhancing the accuracy of the research. Additionally, previous studies have demonstrated that the organic integration of technology management and knowledge management is a crucial factor in promoting organizational innovation (Suryanarayana, 2023). This theoretical perspective offers significant implications for exploring how to integrate digital financial inclusion with local knowledge systems and digital technologies in rural areas. Future research could further investigate this issue, particularly in underdeveloped rural areas, focusing on how to combine local knowledge resources with digital technology through the platform of digital financial inclusion to foster economic development and enhance innovation capacity.

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