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ON THE ACCESSIBILITY OF FINANCIAL SERVICES AND INCOME INEQUALITY: AN INTERNATIONAL PERSPECTIVE

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Abstract. Income inequality has long been an important issue in development economics. Applying international data from 119 countries between 2004 and 2018, this study discusses the relationship between the accessibility of financial services and income inequality. Using the density of the bank branch network to represent the accessibility of financial services, we discover that income inequality is negatively related to the accessibility of financial services, especially in less developed countries and regions. In this nexus, the poverty ratio serves as an intermediary variable. The significance of the nexus is weaker in countries where fintech is more popularized, indicating the substitution effect between fintech and traditional banking services. Nevertheless, the substitution effect is limited, and bank branches will keep playing an important role in delivering financial services. For countries with inadequate banking services, bank branches should be increased to encourage residents to participate in the financial system, while it is no longer necessary to add a large number of branches in countries where fintech has been popularized. Faced with the trend of financial digitalization and the economic shock caused by the COVID-19 pandemic, banks should launch more online services and increase intelligent machines in the branches. By doing so, financial services are more resilient to social changes, so as to alleviate the inequality of income distribution in the long term.

Keywords: financial services, income inequality, bank branches, fintech, inclusive finance, COVID-19.

JEL Classification: C58, D63, G21, O15, O16.

Introduction

In recent decades, with the growth of the global economy, income inequality has become a more and more important issue (Jaumotte et al., 2013). From 1970 to 2021, the share of income of the top 1% in the US increased from 10.7% to 19.0%, indicating an increase in inequality (World Wealth and Income Database, 2022). In developing countries, income inequality is even more serious, causing a lot of social problems.

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From 2020 onwards, not only did the outbreak of COVID-19 impact consumption and investment, but it also exacerbated the inequality of income distribution (Compaoré, 2022). According to a survey in China during the first quarter of 2020, 47% of families with an annual income of fewer than 30,000 yuan were expected to face a 30% reduction in their income in 2020. For families with an annual income of more than 200,000 yuan, the proportion is 19.5% (Gan, 2020). In the United States, COVID-19 has caused more than 50 million Americans to be unemployed. However, the wealth of 643 American billionaires increased sharply during the epidemic (Alcorn, 2020).

Till now, there have been a lot of studies about the negative outcomes of income inequality. A high level of inequality hurts the efficiency of the economy and generates firms to move to countries or regions where income is more equally distributed (Behzadan & Chisik, 2022). This can be explained by the economic law of diminishing marginal propensity of consumption (Wan et al., 2022). Income inequality is often regarded as an important cause of crimes (Choe, 2008; Enamorado et al., 2016; Ramos & Melo, 2022). Moreover, evidence shows that income inequality is also associated with health problems of the poor, such as heart failure (Dewan et al., 2019). Considering these social problems, as well as the global economic shock caused by the COVID-19 pandemic, alleviating income inequality is an urgent issue for policymakers around the world.

Domestic income inequality is affected by various social and economic factors. Besides education, trade, taxes, and transfer payments, the relationship between financial development and income inequality has also aroused attention. As an important part of the financial system, commercial banks are the main providers of financial services. In some developing countries, it is difficult for the poor to obtain basic financial services, causing a lack of opportunity to improve their living conditions, so the level of income inequality remains high. Based on the situation above, this paper applies the data of bank branches and fintech in each country, to show that improving the accessibility of financial services enables more people to participate in the financial system, which reduces the level of income inequality.

Although existing literature generally agrees that improving financial accessibility can help alleviate income inequality, three aspects are worthy to be further discussed.

First, does the nexus exist in countries of various income levels? Due to the differences in economic and social conditions among countries, when conducting cross-country studies, it is also meaningful to focus on the heterogeneity of conclusions and policy implications, which is seldom mentioned in previous studies.

Second, what are the mechanisms between the accessibility of financial services and income inequality? From the authors' perspective, the intermediary effects serve as guidance for the government to turn the policy into greater social welfare.

Lastly, we are also interested in the popularization of fintech, and the potential changes it may bring to the banking industry. For example, to what extent can fintech replace the traditional form of financial services? Do we still need more bank branches around the nation, to promote the accessibility of financial services and social welfare? Since the outbreak of the COVID-19 pandemic, the process of financial digitalization has been accelerated due to lockdowns (Fu & Mishra, 2022). How should banks react to abnormal conditions such as the COVID-19 pandemic, to guarantee financial accessibility around society? Undoubtedly, these questions are all deserved to be further investigated.

Based on the motivations above, this study aims to make contributions from four aspects.

First, on the economic theory, this study tests the poverty reduction effect of financial services, which serves as the intermediary variable between financial service accessibility and income inequality. The implication is that high accessibility to financial services helps alleviate income inequality through poverty reduction.

Second, on the empirical studies, this study shows the welfare effects of financial services, represented by the network of bank branches. By making the international comparison, we provide policy implications for countries of different income levels. In countries of lower income or lower popularization of fintech, bank branches are more correlated with income distribution than otherwise. Similar empirical analysis focusing on heterogeneity among countries is rarely seen in the existing literature.

Besides, on the general policy implication, we show the substitution effect between fintech and traditional forms of financial services. However, the substitution effect is limited, and bank branches will keep playing an important role in delivering financial services. Considering the trend of the reduction of bank branches in some countries, we encourage the government and banks to minimize the *banking desert* that is still prevalent in rural areas. This is essential for guaranteeing the accessibility of financial services.

Lastly, combining our conclusions with reality, we discuss the acceleration of fintech popularization in recent years. Since more services have to be processed online due to the COVID-19 pandemic, it's crucial for banks to launch more convenient online services, especially for the aged, low-income group, small and medium businesses, and agricultural production, to make financial services more resilient to abnormal conditions.

The relationship between the facts, the motivations of this paper, and its contribution is summarized in Figure 1.

This paper is structured as follows. In Section 1, we carefully review the existing literature and introduce some theories about the effects of inclusive finance. Then will use international data to conduct empirical analysis in Sections 2 to 4, to explore the relationship between the

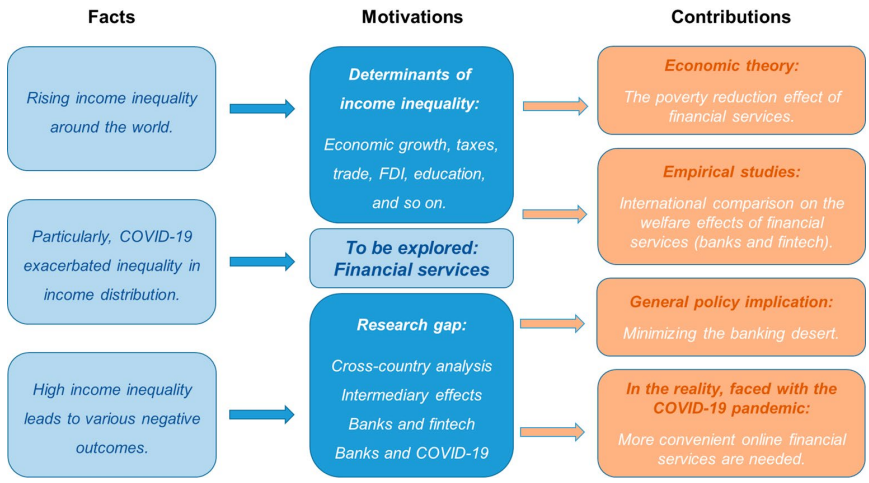

Figure 1. Summary of the Introduction

accessibility of financial services and income inequality in various countries and regions. We will also provide some policy implications corresponding to the results of the empirical analysis.

1. Literature review

1.1. Finance and social welfare: an overview

It is widely agreed that the financial system is the core of the modern economy. Financial services enable people to allocate funds across time, reduce transaction costs, provide risk-sharing mechanisms, and bring more development opportunities to ordinary people (Banerjee & Newman, 1993; Beck et al., 2007). Thus, guaranteeing the accessibility of financial services for the poor can significantly improve their living standards (Sen, 1999). However, due to the threshold of financial services (e.g., credit market imperfections), resources are not equally distributed within the society, making an impact on income distribution (Galor & Zeira, 1993; Dabla-Norris et al., 2015; Hu, 2021).

In fact, there are some controversies about the relationship between financial development and income inequality. By measuring financial development with monetary indicators (e.g., liquidity), stock market indicators (e.g., market capitalization), and the extent of financial globalization (e.g., FDI), some scholars discovered a non-linear or positive correlation between financial development and inequality (Kim & Lin, 2011; Jaumotte & Papageorgiou, 2013). Another issue is that credit expansion may result in other problems. High-interest rates and deterioration of credit quality will bring potential danger to financial stability and equality, which has been frequently mentioned in existing literature (Karlan & Zinman, 2010; Dabla-Norris et al., 2015; Mehrotra & Yetman, 2015). As a result, heterogeneous analysis becomes quite beneficial when studying this nexus, since the economic and social conditions vary a lot among countries. For countries with a stable economic environment, financial development can reduce income inequality, otherwise, it may enlarge the level of inequality, bringing benefits to the rich while harming the poor (Chiu & Lee, 2019).

According to the authors, the root of the dispute lies in the conceptual difference between the *scale* of financial development and the *accessibility* of financial services for ordinary people. Measures of financial inclusion, such as access to bank accounts, branches, and ATMs, do not influence financial stability and should be promoted extensively (Sahay et al., 2015). Especially, in the background of the global transmission of the COVID-19 pandemic, the problems of income inequality and worsening living standards of the low-income group have become more challenging. As a result, it is worth investigating the way that the financial industry promotes social welfare, which is one of the main motivations of this study.

1.2. Effects of financial services on income distribution

The mechanism between the accessibility of financial services and income inequality has long been an important topic in development economics. Based on former studies by Zhang and Zhan (2006) and Song (2017), we summarize the three effects between financial services and income distribution as follows.

The threshold effect. In reality, financial services are inaccessible to some low-income groups. They have few assets available for the mortgage and weak repaying capability, which may not meet the requirements of credit services provided by commercial banks, resulting in a threshold effect. This phenomenon is prevalent in developing countries. In this case, financial services are less beneficial to those of the low-income group, making them more likely to drop out of school and miss career opportunities, causing income inequality to be more severe (Galor & Zeira, 1993; Hu, 2021).

The exclusion effect. The threshold effect refers to the phenomenon that low-income groups cannot reach the requirements of financial services, while the exclusion effect emphasizes the incentives of financial institutions to keep away from less developed areas. Evidence from Indonesia shows that rural banks operating in urban areas are usually more efficient than otherwise (Fatmawati et al., 2019; Wasiaturrahma et al., 2020). To make more profits, banks tend to set up branches in more prosperous regions, which is a typical example of the exclusion effect. Zhang and Zhan (2006) called this phenomenon *the unbalanced effect of financial development*, leading to capital outflow from rural areas, and further widening the income gap between urban and rural areas.

The effect of poverty reduction. The accessibility of financial services is found to have a positive effect on household income and consumption, leading to lower poverty rates (Jalilian & Kirkpatrick, 2002; Burgess & Pande, 2005; Kiendrebeogo & Minea, 2013; Zhang & Posso, 2019; Coulibaly & Yogo, 2020). From the 20th century onwards, with the development of the finance industry, the types of financial services are expanding. Taking student loans as an example, students from poor families who complete their studies with student loans have more opportunities to obtain higher income, thus improving their family's economic situation in the future (De Gregorio, 1996). In addition, inclusive finance can also play a role in poverty reduction by encouraging business creation and promoting economic growth (Dollar & Kraay, 2002; Banerjee et al., 2010; Demirguc-Kunt et al., 2015; Fareed et al., 2017). In Mongolia, accessibility to loans can increase the chances of owning an enterprise by 10% (Attanasio et al., 2011). The effect of poverty reduction can promote social mobility, alleviate *Matthew's effect* caused by class solidification, and help reduce income inequality. However, due to the differences among countries, the extent of this effect may be different, which will be discussed further in later sections.

The relationship between the three effects is shown in Figure 2. The threshold effect and exclusion effect worsen income inequality, while the poverty reduction effect promotes the

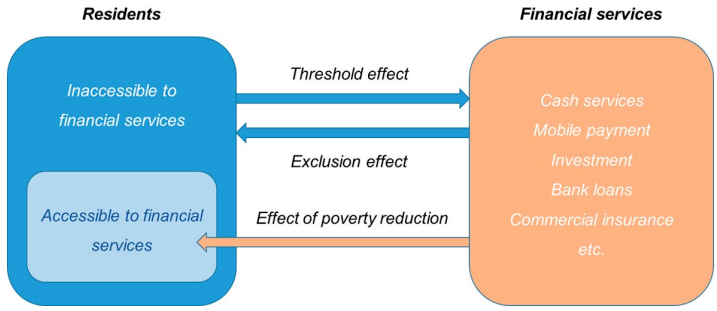

Figure 2. The three effects of financial services on income distribution

income distribution to be more equal. Improving the accessibility of financial services for ordinary people can reduce the threshold effect and exclusion effect, and strengthen the effect of poverty reduction, so as to alleviate income inequality.

1.3. Financial technology and banking services

Traditionally, financial services are delivered by banks, which are still an essential channel to promote inclusive finance. Evidence shows that improving banks' outreach through additional branches will reduce the number of poor workers in developing countries (Mookerjee & Kalipioni, 2010; Coulibaly & Yogo, 2020). Compared to traditional financial services, some believe that fintech can make the services more inclusive. For example, thanks to mobile payment and online banking, the geographical barrier can be overcome on many occasions, and people in rural areas can obtain financial services more conveniently. This provides an important opportunity to increase the income of the poor, narrowing the income gap between urban and rural areas (Song, 2017).

Not only can fintech affect income distribution by empowering the poor, but also by improving the operating performances of commercial banks. International studies show that a higher level of fintech-based financial inclusion can strengthen the risk control capabilities of banks (Banna et al., 2021; Yang et al., 2021). Evidence from China shows that fintech development improved banks' management efficiency (Zhao et al., 2022). It is also shown that a higher share of mobile device transactions is related to a higher growth rate of cost productivity, so banks are capable to provide incremental services to the low-income group (Cho & Chen, 2021).

For certain types of services, fintech has a substitution effect. For example, due to the convenience of mobile payment, cash is seldom used in daily transactions in China and some other countries. However, in other fields, fintech is just a supplement, leading to better operating performance of banks. It's unlikely for fintech to entirely replace banks since banks are developing their platforms and working with start-ups in the fintech industry (Bellardini et al., 2022; Murinde et al., 2022). Fintech is also proven to be beneficial for banks to improve their capability of risk management and reduce credit risks (Cheng & Qu, 2020; Li et al., 2022). The evidence above reflects the existence of a supplementary effect between banks and fintech.

Nowadays, to adapt to the development of fintech, commercial banks in China are changing their branches into *smart banks*. Using machines and AI to run the process, the quality and efficiency of banking services can be improved, leading to a higher level of customer satisfaction (Chen et al., 2021; Lee et al., 2021).

1.4. Other factors related to income inequality

Before we conduct empirical analysis, it's also important to review the possible influential factors of income inequality, some of which will be chosen as the controlled variables of the econometric model. Here, we provide a short literature summary about the impact of economic growth, taxes, education, trade, FDI, and energy security among others on income inequality.

Firstly, developing countries with rapid and unbalanced economic growth are generally facing a high level of income inequality. This is consistent with the classical concept of the Kuznets curve (Kuznets, 1955). Secondly, as a major source of transfer payment, there should be a negative correlation between the amount of tax and income inequality. In addition, population structure and education are also important factors affecting income inequality. In Iran, a negative correlation between the average level of education and income inequality has been found (Shahpari & Davoudi, 2014). However, a recent study from the United States shows a different result. Due to skill-biased technical change, a rising college education may widen income inequality (Kotschy, 2022). In China and South Korea, there exists a relationship between population aging and the inequality of income distribution (Zhan et al., 2021; Hwang et al., 2021).

International trade also has an impact on income distribution within a country, but the mechanism is fairly controversial (Huang et al., 2022). Since 1990, studies have found that inequality has increased in developing countries with major trade reforms, which is not consistent with the classical Heckscher-Ohlin Model (Hanson & Harrison, 1999; Goldberg & Pavcnik, 2007; Mehta & Hasan, 2012). According to a recent study, a non-linear relationship is observed between export diversification and income inequality. In countries with a moderate level of inequality, export diversification may exacerbate income inequality (Lee et al., 2022e).

Other factors related to globalization, such as FDI and the global value chain, have also gained more and more attention when studying income inequality, but the conclusions are also controversial. In India, the process of globalization has led to higher income inequality (Sethi et al., 2021). However, other international studies present that the global value chain can alleviate inequality in developing countries in the long run (Carpa & Martínez-Zarzoso, 2022). In terms of FDI, some scholars have found that an increase in FDI inflows can raise domestic income inequality (Song et al., 2021). In contrast, a recent study shows that the effect of FDI on income inequality is not statistically significant, indicating heterogeneity among countries (Kábrt & Brůna, 2022).

Besides the factors mentioned above, there are certainly other determinants of income inequality, such as the level of energy security. Lee et al. (2022d) discovered an inverted U-shape relationship between energy security and inequality, which is similar to the Kuznets curve (Kuznets, 1955). From the authors' perspective, it certainly deserves more attention in the background of the energy crisis caused by international political issues.

1.5. Various effects of financial inclusion

The importance of promoting financial inclusion is not limited to alleviating income inequality. In fact, this policy can have various economic and social effects.

On the economic effects of financial inclusion, international studies have shown the functions of financial inclusion in alleviating the uncertainty of economic performance (Lee et al., 2022b). Correspondingly, on the firm level, financial inclusion has a positive effect on the sales growth of firms (Lee et al., 2020). In countries where Internet finance is widely accepted, the traditional form of credit history may not be effective to reflect one's credit record. An inclusive financial platform that records every user's transaction behavior can solve this problem effectively (Saxena & Punekar, 2020).

Furthermore, the social and ecological effects of financial inclusion should not be neglected. In developing countries, financial inclusion has an important outcome in empowering women and narrowing gender inequality (Ashraf et al., 2010). In Ghana, access to financial services can improve people's living standards, and encourage the consumption of clean energy, bringing significant ecological effects (Addai et al., 2022). Similarly, evidence from China shows that digital financial inclusion can help reduce carbon intensity by increasing disposable income per capita (Lee et al., 2022c).

To promote financial inclusion, this paper focuses on the accessibility of financial services for ordinary people. Also, there are many other factors affecting the level of financial inclusion, such as financial digitalization and financial aid (Song, 2017; Lee et al., 2022a).

1.6. Research gap

Based on the literature above, this paper aims to fill the research gap from three aspects.

First, we adopt a new perspective to study income inequality, making international comparisons on the welfare effects of banking services. Income inequality has long been an important topic in the field of economics, and the topic has gained even more attention since the outbreak of the COVID-19 pandemic. However, speaking of concrete policies, there is still a lack of studies focusing on the effects of promoting financial service accessibility for ordinary people. Furthermore, in countries with different levels of development, the welfare effects of increasing banking services are also different, which is rarely discussed in the existing literature. According to the authors, this topic is especially meaningful for developing countries, where people are more vulnerable to external uncertainties. As a result, this study uses an international data set to reveal how financial inclusion can make a significant difference in social equality.

Second, not only does this study show the relationship between financial service accessibility and income inequality, but also proves the existence of the poverty reduction effect using empirical methods. According to the author, this intermediary effect is worth special attention because poverty is still prevalent in many developing countries, and poverty reduction is one of the chief goals of economic policies. Our study proves that more access to financial services helps alleviate income inequality through poverty reduction, which is a highly recommended policy.

Besides, we raise several new questions regarding the trend of fintech, as well as the relationship between fintech and financial inclusion. For example, to what extent can fintech replace the traditional form of financial services? Do we still need more bank branches in the future, to promote the accessibility of financial services and social welfare? In many countries, due to the economic shock and the trend of financial digitalization, it is reported that the number of bank branches is declining in recent years (Kreiss, 2021; Ndichu, 2021). Increasing the accessibility of financial services, especially for those living in rural areas, is crucial to prevent income inequality from being wider in the future. In this background, how should the government and banks react to the uncertainties like the COVID-19 pandemic, to guarantee financial accessibility around society? It's a pity that these questions are hardly mentioned in the existing literature. So, this study aims to fill the gaps and make innovations in related fields.

2. Model and data

2.1. Model

To illustrate the relationship between the accessibility of financial services and income distribution within a country, we set up the econometric model below. Taking income inequality as the explained variable and the accessibility of financial services as the explanatory variable, the following two-way fixed effect model is constructed, to be the equation of benchmark regression of this paper.

$$Inequality_{it} = \beta_0 + \beta_1 \ln Service_{it} + \beta_2 X_{it} + \alpha_i + \lambda_t + \varepsilon_{it}, \quad (1)$$

where X_{it} represents the controlled variables of the model. α_i and λ_t are individual (regional) fixed effect and time fixed effect, respectively. ε_{it} indicates the stochastic error term. The structure of the equation is inspired by Zhang et al. (2020), who used a similar econometric model to study the nexus between financial openness and income inequality, controlling the individual fixed effect and time fixed effect. Their study focuses on the inverted U-shape relationship between financial openness and income inequality, so the authors introduced the quadratic form of the independent variable. In our paper, the linear form of the equation is used, since the nexus between financial service accessibility and income inequality is more direct and easier to express. In a recent study, a similar method is used to investigate the nexus between FDI and income inequality (Kábrt & Brůna, 2022). According to the authors, this type of setting is versatile enough to be applied in various international research, not limited to one specific topic.

Later, the method of the instrumental variable will be used to solve the endogenous problem. Inspired by existing literature, this paper also tries to reveal the mechanism using the method of stepwise regression based on Eq. (1), to identify the effect of the possible intermediary variable (Baron & Kenny, 1986).

$$M_{it} = \beta_0 + \beta_1 \ln Service_{it} + \beta_2 X_{it} + \alpha_i + \lambda_t + \varepsilon_{it}; \quad (2)$$

$$Inequality_{it} = \beta_0 + \beta_1 \ln Service_{it} + \beta_2 M_{it} + \beta_3 X_{it} + \alpha_i + \lambda_t + \varepsilon_{it}. \quad (3)$$

In Eq. (1) and (2), M_{it} is the intermediary variable to be tested. As the first step of stepwise regression, we get the regression result of Eq. (1). Next, we estimate Eq. (2) to examine the relationship between domestic income inequality and the intermediary variable. Finally, the intermediary variable will be treated as an explanatory variable of Eq. (3), to test whether the intermediary effect exists. The choice of intermediary variables will be explained in detail in Section 3.4.

2.2. Choice of variables

Now we focus on the choice of explained variables. As a basic indicator of income inequality, the Gini coefficient has been widely used in studies of income distribution. At the same time, most countries also provide more statistics, such as the income share of high-income groups (highest 10% or 20%). This paper takes the Gini coefficient, the share of the highest 10% group, and the share of the highest 20% group as the explained variables, to verify the conclusion of this paper.

This paper focuses on the accessibility of financial services, requiring a specific index to measure. Traditionally, most countries use the density of bank branch networks as an indicator to reflect the popularization of financial services. Since 2018, The People's Bank of China releases the *Analysis Report of Inclusive Financial Indicators in China* every year. In terms of the accessibility of financial services, the reports mention several indicators, including the accessibility of bank branches, non-financial institutions with financing functions, ATM and POS machines, etc. (People's Bank of China, 2018) Due to the differences in the classification standards of banking systems and financial institutions in various countries, to ensure the international comparability of data, we choose the density of bank branch network (the number of commercial bank branches per 100,000 adults) as the proxy variable of the accessibility of financial services.

2.3. Data

Every year, *The Development Research Bureau* of the *World Bank Group* collects data on the income distribution of each country. Since the updating frequency varies from country to country, and many countries do not update the data every year, the data set is an unbalanced panel. Due to the requirements of accuracy, we do NOT fill in the missing data. Note that, there are multiple sources of data on the Gini coefficient and other indicators of inequality, which may be different from one another. To ensure the authority and international comparability of the data, this paper uses the data from the World Bank Group in benchmark regression, while we also use the data from the Standardized World Income Inequality Database (SWIID) when conducting robustness tests.

By integrating the data on income distribution and each explanatory variable, an unbalanced panel ranging from 2004 to 2018 is formed as the sample of empirical research, including 119 countries and 830 observations. The World Bank Database also contains some data on inequality before 2003, but most countries did not submit the data to the World Bank at that time, so there are a large number of missing data. Similarly, there exists a time lag when the World Bank Database updates the data. Data in recent years (2019–2021) are also incomplete and not suitable to use. As a result, the sample we use begins in 2004 and ends in 2018. Descriptive statistics of the sample are shown in Table 1, and the full list of the countries is shown in the appendix (Table A1).

3. Empirical results

This section uses the data set to conduct empirical research, beginning with the benchmark regression. To explore the data further, we will do various robustness tests based on the benchmark regression. After that, we will also discuss the endogenous issue and analyze the intermediary effect, to reveal the mechanism of the accessibility of financial services on domestic income inequality.

3.1. Benchmark regression

Regarding *High_10th*, *High_20th*, and *Gini* as explained variables, the results are shown in Table 2. All the observations are included in Models (1)–(3). To avoid the influence of the

Table 1. Descriptive Statistics (2004–2018)

Variable	Explanation	Obs.	Mean	Std. Dev.	Min.	Max.
High_10th	The income share of the high-income group (highest 10%)	830	28.246	6.088	19.500	54.200
High_20th	The income share of the high-income group (highest 20%)	830	43.481	6.679	33.800	71.000
Gini	Gini coefficient (World Bank)	830	36.114	8.141	23.700	64.800
Bank	Number of commercial bank branches per 100,000 adults	830	25.469	18.734	0.430	110.940
ATM	Number of ATMs per 100,000 adults	792	66.533	42.980	0.020	288.450
Credit	Domestic credit to private sector / GDP (%)	830	74.132	49.378	0.186	308.978
Poverty	Poverty ratio (%) *	818	3.914	10.255	0.000	78.800
dGDP	Growth of GDP per capita (%)	830	2.293	3.471	–14.379	23.986
dPop	Growth of population (%)	830	0.708	0.949	–2.258	5.205
Education	Expected years of education	830	14.868	2.280	5.800	20.400
Tax	Tax / GDP (%)	830	18.632	6.576	0.059	62.800
Trade	Commodity trade volume / GDP (%)	830	72.496	36.476	18.193	182.085

Notes: * Proportion of people living on fewer than 1.90 USD (2011 PPP). Data on expected years of education are obtained from *Human Development Report*. Other data are obtained from the database of the World Bank Group (updated in 2021).

Table 2. Results of benchmark regression

Variables	Full sample			Excluding the outliers of *Bank* (5% each at the top and the bottom)		
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
	High_10th	*High_20th*	*Gini*	*High_10th*	*High_20th*	*Gini*
ln *Bank*	–1.216** (–2.555)	–1.224** (–2.459)	–1.391** (–2.201)	–1.792*** (–2.778)	–1.884*** (–2.892)	–2.253*** (–2.840)
dGDP	0.054** (2.151)	0.052** (2.026)	0.058* (1.801)	0.059** (2.028)	0.051* (1.735)	0.050 (1.387)
dPop	0.366 (1.482)	0.340 (1.341)	0.370 (1.142)	0.277 (1.208)	0.236 (1.011)	0.243 (0.798)
Education	0.271 (1.192)	0.247 (1.054)	0.223 (0.792)	0.258 (1.071)	0.218 (0.879)	0.190 (0.643)
Tax	–0.064** (–2.179)	–0.059* (–1.882)	–0.050 (–1.258)	–0.063*** (–2.781)	–0.062*** (–2.655)	–0.057** (–1.990)
Trade	0.011 (1.208)	0.010 (1.030)	0.012 (0.856)	0.016* (1.721)	0.016 (1.643)	0.020 (1.619)
Constant	28.773*** (7.897)	44.406*** (11.608)	37.656*** (7.950)	30.727*** (7.464)	46.903*** (11.077)	40.965*** (8.145)
Obs.	830	830	830	746	746	746
R-squared	0.185	0.190	0.159	0.228	0.242	0.222

Note: Heteroskedasticity-robust *t*-statistics in parentheses. *** $p \leq 0.01$. ** $0.01 < p \leq 0.05$. * $0.05 < p \leq 0.1$.

extreme values of density of bank branch networks in some countries, this paper also shows the results of benchmark regression after eliminating 5% of data both at the top and the bottom, which are shown in Models (4)–(6). Compared with the results using a full sample, the significance of regression after excluding outliers seems to be higher. No matter which explained variable is chosen, the main explanatory variable *Bank* has reached the significance level of 1%. From 2004 to 2018, if the density of bank branch network in a country increased by 1%, the income shares of the top 10% and top 20% groups will decrease by 0.018% and 0.019% on average, and the Gini coefficient (ranging from 0 to 100) will decrease by 0.023.

The results above are consistent with our intuition, also supported by the early study by Mookerjee and Kalipioni (2010). The customer groups of bank branches are not only enterprises and institutions, but also ordinary consumers. Not only does a dense network of bank branches provide convenient financial services for residents, but also helps to form a competitive market environment and reduce the cost of financial services.

3.2. Robustness test

3.2.1. ATMs: Another proxy for financial accessibility

In benchmark regression, we use the density of bank branches to represent the accessibility of financial services. For most of the time between 2004 and 2018, mobile payment has not been popularized in most countries. Instead, automatic teller machines (ATMs) were an important channel for people to obtain financial services, whose function is highly similar to bank branches. However, in the sample of this study, the correlation between variables *Bank* and *ATM* is not strong, and the correlation coefficient is only 0.406, as shown in Figure 3.

Substitution of variables is a method that is widely used for robustness tests. If there does exist a relationship between the accessibility of financial services and income distribution, no matter which proxy variable is used, a similar conclusion should be drawn. Let the density of the ATM network (the number of ATMs per 100,000 people) represent the accessibility of financial services, the results are shown in Table 3. Using any one of the three income

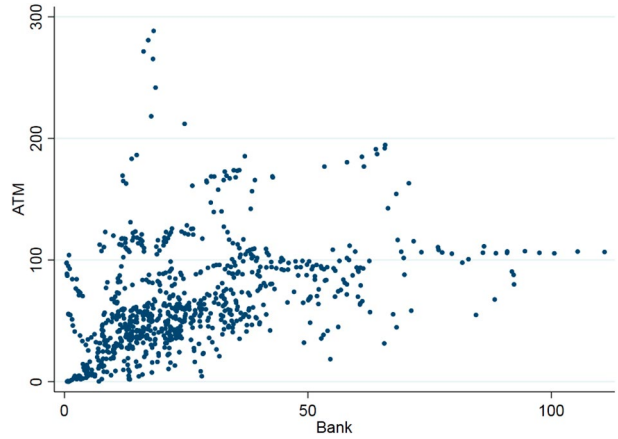

Figure 3. The density of bank branches and ATMs in various countries (2004–2018)

inequality indicators as the explained variable, the density of ATMs has reached the significance level of 1%, which is consistent with the conclusion in Section 3.1.

Note that the explanatory variable in Models (7)–(9) is more significant than that in Models (1)–(3). In reality, bank branches not only provide inclusive financial services but also focus on corporate business and services for wealthy people. As described in the theoretical analysis in Section 1.2, these services have a high threshold effect, which is difficult to benefit ordinary people. Compared to bank branches, all cardholders are users of ATMs, so their services cover a wider customer group, giving a reasonable explanation for its higher significance level in Models (7)–(9).

Table 3. Results of the robustness test (*Bank* replaced by *ATM*)

Variables	Model (7)	Model (8)	Model (9)
	High_10th	*High_20th*	*Gini*
ln *ATM*	–1.107*** (–3.419)	–1.260*** (–3.881)	–1.643*** (–4.098)
dGDP	0.037 (1.595)	0.032 (1.389)	0.030 (1.093)
dPop	0.442* (1.816)	0.430* (1.763)	0.479 (1.583)
Education	0.301 (1.361)	0.284 (1.274)	0.262 (1.000)
Tax	–0.060** (–2.099)	–0.056* (–1.879)	–0.046 (–1.272)
Trade	0.006 (0.626)	0.004 (0.394)	0.002 (0.193)
Constant	28.887*** (7.925)	44.989*** (12.204)	39.199*** (8.942)
Obs.	792	792	792
R-squared	0.191	0.216	0.205

Note: Heteroskedasticity-robust *t*-statistics in parentheses. *** $p \leq 0.01$. ** $0.01 < p \leq 0.05$. * $0.05 < p \leq 0.1$.

3.2.2. Gini coefficient from SWIID

As mentioned earlier, there are various sources of data on the Gini coefficient, which are more or less different from one another. To test the robustness of the results in benchmark regression further, it's natural for us to consider replacing the original World Bank data with another source.

Besides the World Bank Database, the Standardized World Income Inequality Database (SWIID) also provides data on the income inequality of each country or region (Solt, 2020). There are two reasons why we choose the data from SWIID. For one thing, the data are relatively more complete than that from the World Bank Database, having fewer missing values. For another, SWIID contains the Gini coefficient based on both disposable income (notated by *Gini_swiid_disp*) and market income (notated by *Gini_swiid_mkt*), providing more possibilities for us to conduct a robustness test.

Using the data of the Gini coefficient from SWIID, the results are shown in Table 4. Models (10)–(11) are the results using the same observations as the benchmark regression, while Models (12)–(13) are the results using all the possible observations here. Models (10) and (12) use the data of the Gini coefficient based on disposable income, and Models (11) and (13) use the data based on market income. It is shown that the variable *Bank* in all four models reaches the significance level of 5%, which is similar to the results in benchmark regression.

Table 4. Results of the robustness test (using the Gini coefficient from SWIID)

	Model (10)	Model (11)	Model (12)	Model (13)
	Gini_swiid_disp	*Gini_swiid_mkt*	*Gini_swiid_disp*	*Gini_swiid_mkt*
ln *Bank*	–1.258** (–2.609)	–1.538*** (–2.635)	–0.863** (–2.459)	–1.306*** (–2.951)
dGDP	0.038* (1.758)	0.042* (1.836)	0.021 (1.513)	0.016 (1.089)
dPop	0.201 (0.993)	–0.267 (–0.937)	0.067 (0.592)	–0.134 (–0.932)
Education	0.128 (0.682)	0.176 (0.829)	0.106 (0.890)	0.158 (1.127)
Tax	–0.037* (–1.789)	–0.027 (–1.365)	–0.022* (–1.949)	–0.020* (–1.937)
Trade	0.012 (1.109)	0.007 (0.597)	0.007 (1.078)	0.008 (0.999)
Constant	37.139*** (11.470)	48.846*** (13.330)	38.555*** (21.217)	47.828*** (23.424)
Obs.	830	830	1259	1259
R-squared	0.191	0.132	0.150	0.125

Note: Heteroskedasticity-robust *t*-statistics in parentheses. *** $p \leq 0.01$. ** $0.01 < p \leq 0.05$. * $0.05 < p \leq 0.1$.

One of the reasons why we choose the World Bank Gini coefficient data in benchmark regressions is the consistency of sources among various indicators. In this study, data on most indicators are obtained from the World Bank Database, a useful, comprehensive, and widely acknowledged database that is commonly used in international economic studies. From the authors' perspective, the consistency of data sources can minimize the differences in statistical measures of each variable, enabling us to provide more credible and precise results as possible. Moreover, data from the World Bank Database are more detailed, including the shares of income from the highest 10%, 20%, and so on. As a result, we are still using data from the World Bank in the rest parts of the paper.

3.2.3. Division of periods

Now we apply another method to show the robustness of the model. Note that the time span of the sample is as long as 15 years. In order to verify whether the conclusions are limited to a certain time period, we divide the sample into two parts. Taking the 2007–2009 economic

recession as the split point, we obtain two sub-samples whose time spans are 2004–2009 (before and during the recession) and 2010–2018 (post-recession), respectively. This method has also been used in other international economic studies (Zhang et al., 2020). The regression results are shown in Table 5. The variable *Bank* is generally significant in both periods, reaching a higher significant level of 5% since 2010.

Table 5. Results of the robustness test (sample split into two periods)

Variables	Before & during the recession (2004–2009)			Post-recession (2010–2018)		
	Model (14)	Model (15)	Model (16)	Model (17)	Model (18)	Model (19)
	High_10th	*High_20th*	*Gini*	*High_10th*	*High_20th*	*Gini*
ln *Bank*	−2.021* (−1.723)	−1.840 (−1.603)	−2.314* (−1.699)	−1.540** (−2.521)	−1.504** (−2.472)	−1.618** (−2.114)
dGDP	0.016 (0.514)	0.007 (0.220)	0.010 (0.263)	0.036 (1.345)	0.034 (1.215)	0.037 (1.056)
dPop	0.251 (0.720)	0.306 (0.895)	0.234 (0.562)	0.485* (1.819)	0.466* (1.775)	0.505 (1.473)
Education	−0.028 (−0.068)	−0.019 (−0.046)	−0.074 (−0.161)	0.130 (0.539)	0.100 (0.416)	0.122 (0.427)
Tax	−0.050*** (−3.978)	−0.053*** (−4.632)	−0.057*** (−4.314)	−0.083 (−0.984)	−0.065 (−0.856)	−0.049 (−0.572)
Trade	0.003 (0.133)	0.006 (0.258)	0.007 (0.252)	0.013 (1.054)	0.007 (0.631)	0.004 (0.286)
Constant	35.860*** (5.860)	50.332*** (8.478)	45.286*** (6.808)	31.046*** (7.429)	46.775*** (11.073)	39.407*** (7.651)
Obs.	273	273	273	557	557	557
R-squared	0.191	0.209	0.200	0.122	0.141	0.136

Note: Heteroskedasticity-robust *t*-statistics in parentheses. *** $p \leq 0.01$. ** $0.01 < p \leq 0.05$. * $0.05 < p \leq 0.1$.

3.3. Solution to endogenous issue

Endogeneity issues are mainly caused by reverse causality, measurement error, and missing variables. There is no evidence that the extent of income inequality will affect the accessibility of financial services, so we needn't consider the endogenous problem caused by reverse causality. Due to the two-way fixed effect model, other factors affecting the income distribution can generally be controlled by individual fixed effects and time-fixed effects.

However, it is worth paying attention that the number of bank branches in a country is not constant during the year. This number can be changed at any time, introducing significant measurement errors related to endogenous problems. To solve this problem, we need to find a more measurable index to be the instrumental variable. Here, the ratio of domestic credit to the private sector to GDP may be a suitable instrumental variable. On the one hand, in areas with a higher density of bank branches, credit activities are usually more active, so the ratio of credit to GDP tends to be higher. On the other hand, the amount of bank credit can be added directly and measured accurately in a certain period of time. The regression results after introducing the instrumental variable are shown in Table 6.

Table 6. Results using instrumental variable

Variables	Model (20)	Model (21)	Model (22)
	High_10th	*High_20th*	*Gini*
ln *Bank*	–1.117** (–2.244)	–1.173** (–2.444)	–1.331** (–2.317)
dGDP	0.054*** (2.730)	0.052*** (2.632)	0.058** (2.412)
dPop	0.366** (2.419)	0.340** (2.315)	0.370** (2.076)
Education	0.268** (2.164)	0.245** (2.036)	0.221 (1.562)
Tax	–0.064*** (–3.734)	–0.059*** (–3.470)	–0.051** (–2.448)
Trade	0.011** (2.016)	0.011* (1.854)	0.012 (1.622)
Obs.	805	805	805
Cragg-Donald Wald *F*-statistic	99.767	99.767	99.767
R-squared	0.184	0.190	0.159

Note: Heteroskedasticity-robust *t*-statistics in parentheses. Countries with data of only one year are excluded. Constants are omitted. *** $p \leq 0.01$. ** $0.01 < p \leq 0.05$. * $0.05 < p \leq 0.1$.

After introducing the instrumental variable, the coefficients of the *Bank* are relatively unchanged, reaching the significance level of 5% in all three models. Meanwhile, the Cragg-Donald Wald F-statistics are far larger than 10 in Models (20)–(22), indicating the validity of the instrumental variable. A recent study also presents the relationship between income inequality and credit conditions, especially the number of small business loans, whose conclusions are generally in line with this paper (Contreras et al., 2023).

Note that the controlled variables in Models (20)–(22) become more significant. In fact, factors such as the growth of GDP per capita, tax rate, growth of population, expected years of education, and international trade are all correlated with domestic income inequality. Emerging economies with a high GDP growth rate are generally faced with serious social inequality, which is consistent with the Kuznets Curve (Kuznets, 1955). Similarly, the rapid growth of the population is often related to a high birth rate. Most of these countries are in the early stage of economic growth, facing a high level of income inequality. Evidence from Africa shows that a lower speed of population growth helps improve socioeconomic vulnerability, thus boosting the stability of the economy and reducing income inequality (Ahmadalipour et al., 2019).

The relationship between taxes and income inequality seems to be obvious. Here we observe a larger regression parameter in Model (20) than that in Model (21). It implies that taxes have a stronger effect on income equality in the highest-income group, which is in line with reality.

In terms of education, developing countries generally face severe inequality in educational opportunities, and income inequality is likely to be enlarged while the expected years of education are increasing. Taking China as an example, from 2000 to 2010, the expected years of education increased rapidly from 9.6 years to 12.9 years, but there are large differences in the educational opportunities between urban and rural areas, resulting in a higher level of income inequality (Chen et al., 2010). Later studies also pointed out that education is increasingly leading to a higher inequality of income, showing the tendency of class solidification in society, both in China and the United States (Zhou & Zhao, 2019; Kotschy, 2022).

Finally, the impact of international trade on income inequality is quite controversial that has been discussed in Section 1.4. Here we observe a positive correlation with a moderate significant level. This is generally consistent with various studies conducted earlier in Mexico (Hanson & Harrison, 1999) and India (Mehta & Hasan, 2012).

As shown above, by introducing instrumental variables, we have generally solved the endogenous problem, strengthening the credibility of the conclusions.

3.4. Analysis of the intermediary effect

After discussing the direct impact of the accessibility of financial services on income distribution, this paper will also test an indirect mechanism. In theory, financial services can relax the budget constraints of intertemporal decision-making, optimize the allocation of financial resources, and promote the growth of consumption and investment (Banerjee & Newman, 1993; Beck et al., 2007; among others). As mentioned in Section 1.2, inclusive finance can promote the growth of agriculture and small firms, and alleviate income inequality while reducing poverty reduction (Jalilian & Kirkpatrick, 2002; among others). To verify this indirect channel, this paper takes the poverty ratio (proportion of people living on fewer than 1.90 USD, 2011 PPP) as the intermediary variable, and adopts the method of stepwise regression (Baron & Kenny, 1986).

The results are shown in Table 7. Models (1)–(3) in Section 3.1 show the first step of stepwise regression, revealing the significance of the *Bank* without the intermediary variable. Model (23) is the second step. In this stage, the intermediary variable is regarded as an explained variable, and the coefficient of the *Bank* reaches the significance level of 1%. Models (24)–(26) are the results of the third step of stepwise regression. The intermediary variables in all three models have reached the significance level of 1%. So far, the intermediary effect of poverty reduction between the accessibility of financial services and income inequality has been verified, contributing to the theories and hypotheses about this issue.

4. Discussion

In this section, we investigate the differences between various countries on the issue of financial services and income inequality. Then we will make further discussion considering the background of COVID-19, and carry out relevant policy implications to deal with the difficult time.

Table 7. Verification of the intermediary effect

Variables	Step 2	Step 3		
	Model (23)	Model (24)	Model (25)	Model (26)
	Poverty	*High_10th*	*High_20th*	*Gini*
ln *Bank*	–3.130*** (–4.324)	–0.449 (–1.049)	–0.383 (–0.874)	–0.323 (–0.586)
Poverty		0.251*** (3.641)	0.271*** (3.851)	0.340*** (3.840)
dGDP	0.028 (1.021)	0.046* (1.911)	0.041* (1.704)	0.043 (1.454)
dPop	0.058 (0.243)	0.346 (1.526)	0.329 (1.428)	0.367 (1.254)
Education	–0.269 (–1.100)	0.336* (1.681)	0.317 (1.564)	0.309 (1.293)
Tax	–0.014 (–0.679)	–0.061** (–2.158)	–0.058* (–1.906)	–0.049 (–1.280)
Trade	0.014 (1.152)	0.008 (0.984)	0.007 (0.760)	0.006 (0.551)
Constant	17.674*** (3.736)	24.395*** (7.391)	39.641*** (11.596)	31.659*** (7.561)
Obs.	818	818	818	818
R-squared	0.334	0.238	0.251	0.227

Note: Heteroskedasticity-robust *t*-statistics in parentheses. *** $p \leq 0.01$. ** $0.01 < p \leq 0.05$. * $0.05 < p \leq 0.1$.

4.1. Different factors affecting inequality: a heterogeneous analysis

According to the criteria of classification given by the United Nations, the sample includes 41 high-income countries, 36 higher-middle-income countries, 31 lower-middle-income countries, and 11 low-income countries. To compare the influential factors of the domestic income inequality in different groups, we do the regression shown in Table 8 (the results of middle-high income countries are omitted). For lower-middle-income countries and low-income countries, the negative correlation between the density of bank branches and income inequality is more significant, reaching a significance level of 1% in Models (30)–(31). For high-income countries, the negative correlation is also observed, but it is weaker and not significant.

Various reasons contribute to this phenomenon. The financial sector of lower-middle-income and low-income countries is relatively underdeveloped. In sub-Saharan African countries, the low institutional quality is an important reason for this phenomenon, harming economic growth (Krause, 2015; Aluko & Ajayi, 2018). Through the empirical results above, the implication is that increasing bank branches can directly promote the popularization of financial services and alleviate income inequality. In contrast, the banking system of high-income countries are more mature, and the vast majority of residents can conveniently obtain financial services. In this case, the income distribution is more dependent on other factors, such as tax and transfer payments, reaching the significance level of 5% in Models (27)–(28).

Table 8. Results of sub-samples classified by levels of economic development

Variables	High-income countries (41)			Lower middle-income and low-income countries (42)		
	Model (27)	Model (28)	Model (29)	Model (30)	Model (31)	Model (32)
	High_10th	*High_20th*	*Gini*	*High_10th*	*High_20th*	*Gini*
ln *Bank*	–0.763 (–0.809)	–0.931 (–0.994)	–1.161 (–1.040)	–1.338*** (–3.534)	–1.216*** (–3.404)	–1.265** (–2.442)
dGDP	0.029 (0.817)	0.018 (0.498)	0.002 (0.057)	–0.019 (–0.395)	–0.010 (–0.239)	0.002 (0.041)
dPop	0.190 (0.663)	0.155 (0.554)	0.105 (0.313)	–0.044 (–0.109)	0.262 (0.575)	0.640 (0.954)
Education	0.014 (0.054)	–0.096 (–0.339)	–0.208 (–0.570)	1.366*** (5.172)	1.412*** (5.116)	1.584*** (4.738)
Tax	–0.066** (–2.132)	–0.063** (–2.033)	–0.058 (–1.573)	–0.141 (–1.591)	–0.109 (–1.526)	–0.097 (–1.199)
Trade	–0.001 (–0.058)	–0.002 (–0.203)	–0.007 (–0.465)	0.019 (0.608)	0.011 (0.386)	0.010 (0.320)
Constant	29.149*** (4.907)	46.479*** (7.531)	41.338*** (5.235)	21.108*** (6.304)	35.479*** (10.364)	25.785*** (5.686)
Obs.	459	459	459	126	126	126
R-squared	0.116	0.114	0.093	0.482	0.521	0.495

Note: Heteroskedasticity-robust *t*-statistics in parentheses. *** $p \leq 0.01$. ** $0.01 < p \leq 0.05$. * $0.05 < p \leq 0.1$.

We now take the United States as an example. As one of the countries with the most developed banking industry, the income inequality in the United States is fairly serious, with a Gini coefficient above 0.4 for a long time. This is partly due to its relatively low taxes and loose financial regulation. In contrast, countries in northern Europe adopt high tax and welfare policies. For example, in Denmark, the tax accounts for more than 30% of GDP, whose income inequality is relatively mild, and the Gini coefficient remains between 0.25 and 0.3. On this issue, it has been found that high-income inequality is related to the scale of the government, measured by the share of government consumption in GDP. This can partly explain the relatively high level of income inequality in the United States (Popov, 2022). Evidence from several European welfare countries also shows that taxes and transfers help reduce gender inequality, which is beneficial for narrowing the income gap in the whole society (Avram & Popova, 2022).

4.2. Financial technology and traditional banking services

In addition to institutional factors, the impact of financial technology should not be ignored. Financial technology, such as online banking and mobile payment, has been widely used in some countries, partly substituting the function of traditional banking services. Therefore, a hypothesis can be made. In countries where fintech is less popularized, the negative correlation between income inequality and accessibility of financial services (reflected by the density of bank branches) is more significant.

The *Global Findex Database* reports statistics on the penetration rate of mobile payment accounts among citizens (age 15+) in each country for the first time in 2017 (so data from previous years are not available), reflecting the popularization of fintech among ordinary people (World Bank, 2017). There is a strong positive correlation between the popularization of mobile payment accounts and GDP per capita, with a high correlation coefficient of 0.751 in 2017 within sample countries. For example, the penetration rate is 60.6% in Germany and 39.8% in China. However, residents in many developed countries are still accustomed to making transactions in cash or by credit card. In Japan, the penetration rate of mobile payments is only 33.3%, and this is even lower in Italy (22.2%). The data of each country in the sample are shown in the Appendix (Table A1).

Now we investigate how the penetration rate of mobile payment account affects the relationship between the density of the bank branch network and income inequality. According to the value of penetration rate, this paper divides the sample into three groups, including 32 countries with high penetration rates (above 40%), 73 countries with low penetration rates (below 40%), and 14 countries missing the required data. The regression results for the first group and the second group are shown in Table 9. For countries with a low penetration rate of mobile payment accounts, there exists a significant negative correlation, while this is not observed in the other group.

The analysis above shows a substitution effect between fintech and traditional banking services. For countries with a high penetration rate of fintech, the correlation between bank branches and income inequality is weak, so it is no longer necessary to continue expanding

Table 9. Results of sub-samples classified by penetration rates of mobile payment accounts

Variables	32 countries with a high penetration rate			73 countries with a low penetration rate		
	Model (33)	Model (34)	Model (35)	Model (36)	Model (37)	Model (38)
	High_10th	*High_20th*	*Gini*	*High_10th*	*High_20th*	*Gini*
ln *Bank*	−0.252 (−0.303)	−0.475 (−0.573)	−0.621 (−0.593)	−1.082** (−2.064)	−0.984* (−1.816)	−1.017 (−1.489)
dGDP	−0.001 (−0.034)	−0.014 (−0.545)	−0.030 (−0.826)	0.066* (1.722)	0.066* (1.777)	0.076 (1.648)
dPop	0.001 (0.009)	−0.013 (−0.080)	−0.020 (−0.092)	−0.131 (−0.294)	−0.231 (−0.486)	−0.362 (−0.549)
Education	0.177 (0.700)	0.089 (0.352)	0.087 (0.268)	0.426 (1.270)	0.432 (1.238)	0.400 (0.979)
Tax	−0.025 (−1.692)	−0.023 (−1.604)	−0.010 (−0.538)	−0.103*** (−2.746)	−0.101** (−2.313)	−0.097 (−1.598)
Trade	−0.010 (−1.191)	−0.013 (−1.432)	−0.020 (−1.517)	0.026* (1.806)	0.028* (1.856)	0.038** (2.036)
Constant	24.089*** (4.665)	41.284*** (7.775)	33.969*** (4.751)	29.675*** (6.538)	44.881*** (9.571)	38.252*** (6.882)
Obs.	325	325	325	473	473	473
R-squared	0.076	0.073	0.070	0.273	0.295	0.267

Note: Heteroskedasticity-robust *t*-statistics in parentheses. *** $p \leq 0.01$. ** $0.01 < p \leq 0.05$. * $0.05 < p \leq 0.1$.

bank branches. However, in many developing countries and regions, due to the difficulty of developing fintech, they can improve the accessibility of financial services for residents by increasing bank branches, in order to alleviate income inequality.

Here we raise another question. Is this substitution effect strong enough, that using the density of bank branches to represent the accessibility of financial services is no longer valid for our study? In 2017, the correlation coefficient between the density of bank branches and the penetration rate of mobile payment accounts in the sample countries was 0.031, indicating an insignificant correlation between the two. As we have mentioned earlier in *Literature Review*, although fintech has been widely accepted in many countries, it is far from being able to replace traditional banking systems (Murinde et al., 2022). At present, both the density of bank branches and the penetration rate of fintech are important indicators reflecting the accessibility of financial services, and both of them are included in the *Analysis Report of Inclusive Financial Indicators in China* issued by the People's Bank of China (People's Bank of China, 2018). Therefore, we believe that it is still reasonable to use the indicators of bank branches to make an international comparison of the accessibility of financial services.

4.3. COVID-19 and banking services

Not only are traditional banking services affected by innovations in fintech, but also affected by the policy of epidemic prevention after the outbreak of COVID-19. Although shocks due to COVID-19 have already been extensively studied (Wang & Liu, 2022; Liu et al., 2022; among others), the new challenges to banking services after the outbreak of COVID-19 and its associated pandemic status are not well examined.

For bank branches, lockdowns, and gathering restrictions result in a lower volume of customers and a decrease in revenue and operating efficiency. Taking the Arabian countries as an example, according to the forecast by Boston Consulting Group, in UAE, Saudi Arabia, and Kuwait, the revenue pool of regional retail banks will approximately recover to the 2019 level only by 2024, indicating a stagnation of market size (Ndichu, 2021).

With the trend of economic shock and financial digitalization, banks in the United Kingdom are closing their branches at high rates during the COVID-19 crisis (Higgs et al., 2022). This is also true in the United States. According to the Federal Reserve, the total number of branches closed in 2020 exceeds the number of branches closed during the most recent recession, reaching the number of 3,700 (Kreiss, 2021). Some of the branches closed resulting in a *banking desert*, with no branch within a 10-mile radius of the center of the track, which is a direct outcome of the exclusion effect (Ergungor & Moulton, 2014; Morgan et al., 2016). By June 2021, there were 1,610 banking deserts containing 5.6 million people, mostly low-income and rural communities. Of those living in a banking desert, approximately 31% are identified as a racial or ethnic minority.

According to the conclusions shown in Section 4.2, due to the substitution effect of fintech and traditional banking services, the popularity of fintech has been growing rapidly since the COVID-19 pandemic. The world has witnessed a markable increase in financial app downloads (Fu & Mishra, 2022). To make financial services more inclusive, it's crucial for commercial banks to launch more convenient online services, especially for the aged, low-income group, small and medium businesses, and agricultural production, to make financial

services more resilient to lockdowns. This would help reduce the uncertainties when people need financial services during a difficult time, such as mortgage loans (Liu, 2023).

Considering the necessity of bank branches in certain cases, to prevent the phenomenon of banking desert in rural areas and minority regions, the government should carry out policies to encourage banks to retain branches in those areas. For example, the state or provincial government can provide a certain amount of subsidy for each branch, guaranteeing the right to obtain financial services for the residents.

4.4. Financial innovation and the upgrading of bank branches

The analysis above focuses on the number of bank branches, but we are always taking an important factor into consideration, which is called financial innovation. With the innovation of the financial system, the mode of banking services is undergoing a historical change. In Section 4.1, we talk about the correlation between the accessibility of financial services (indicated by the density of bank branches) and income inequality in countries with different levels of income per capita. For high-income economies, due to the convenience of fintech, most customers can use online banking to manage their wealth and run businesses, so it is no longer necessary to add a large number of bank branches.

Despite the fact above, bank branches are still very important in the modern financial system. Notice that some highly private procedures, such as the authentication of identity, are exclusively operated in offline branches. A tangible banking environment also helps develop the relationship between banks and customers and maintain the brand image of the bank itself, which is hard to be completely replaced (Nguyen, 2019). That's why we still observe a negative relationship between the density of bank branches and income inequality in Models (27)–(29), regarding the group of high-income countries, though less significant.

Since bank branches are still indispensable, how can they adapt to the era of fintech? What can banks do to reduce operating costs, so the branches can provide more financial services? The answer is to upgrade the branches with more intelligent machines, delivering financial services with less operating costs. This policy implication is consistent with the innovation of *smart banks* in China mentioned in Section 1.3, which is also worth promoting in other countries.

Conclusions

Using the density of bank branches to represent the accessibility of financial services, this study discusses the relationship between the accessibility of financial services and income inequality, applying international data from 2004 to 2018. The negative correlation between the accessibility of financial services and income inequality is confirmed, which is particularly significant in lower-middle-income countries and low-income countries. Considering the substitution effect of fintech on traditional bank branches, we divide the sample according to the penetration rate of mobile payment accounts. In countries where mobile payments are less popularized, the negative correlation between the density of bank branches and income distribution is more significant. Intermediary analysis shows that inclusive financial services can alleviate income inequality through the channel of poverty reduction.

In terms of financial development around the world, especially during the crisis caused by the COVID-19 pandemic, the conclusions have some policy implications. For countries and regions with inadequate banking services, the government and commercial banks should strengthen the financial infrastructure by adding bank branches, to encourage residents to participate in the financial system. Due to the lockdowns and gathering restrictions caused by the COVID-19 pandemic, commercial banks should launch more convenient online services, especially for the aged, low-income group, agricultural production, and small and medium businesses, to make the banking services more resilient to abnormal conditions.

For some countries and regions, due to the convenience of fintech, most customers can use online banking to manage their wealth and run businesses, so it is no longer necessary to increase the number of bank branches. To adapt to the era of fintech, the bank should continue upgrading the branches with intelligent machines, delivering financial services with less operating costs.

In the background of fintech popularization, as well as the impact of the COVID-19 pandemic, the practical implications of this study can be summed up below. Bank branches are an essential form of financial infrastructure that should be improved in various developing countries. Faced with greater competition, the introduction of VTMs is highly recommended for bank branches to reduce costs while providing more efficient financial services. Considering the substitution effect of fintech and traditional banking services, especially in the abnormal conditions in the post-COVID-19 era, online services should also be more inclusive to alleviate income inequality.

Future studies

So far, there remain some limitations in our study, which may bring inspiration for future studies. First, due to the short history and limited practice of digital finance in developing countries, it is still difficult to apply relevant international data at present, which is one of the main limitations of this study.

Second, as an empirical study, we haven't investigated the theoretical mechanism using mathematical derivations on this issue, especially in the background of the popularization of fintech.

Besides, there is a lack of indicators to measure the threshold effect and the exclusion effect of financial services, so it may be not possible to test all the intermediary effects mentioned in Section 1.2 using empirical methods.

Lastly, due to the unbalanced panel data, mainly caused by the missing values of the Gini coefficient, we are not able to verify the unidirectional or bidirectional causality between the variables.

Later, with the development of fintech, future studies can develop theoretical models using mathematic methods, use the data of a longer period to assess the topic, and build more indicators to further investigate the intermediary effects of financial services and income inequality. Meanwhile, due to economic uncertainty caused by the COVID-19 pandemic and global political issues, the question of how to guarantee the accessibility of financial services deserves attention in the long term. We hope that the research directions shown above will bring inspiration for further studies in this field.

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APPENDIX

The list of the 119 countries in the sample, as well as their income levels and mobile payment penetration rates, are shown below.

Table A1. List of sample countries

No.	Code	Country	Income level	Mobile payment penetration rate (2017)
1	ALB	Albania	Upper middle income	4.2%
2	ARG	Argentina	Upper middle income	10.5%
3	ARM	Armenia	Upper middle income	11.3%
4	AUS	Australia	High income	67.7%
5	AUT	Austria	High income	50.7%
6	BGD	Bangladesh	Lower middle income	22.4%
7	BLR	Belarus	Upper middle income	32.4%
8	BEL	Belgium	High income	61.9%
9	BTN	Bhutan	Lower middle income	
10	BOL	Bolivia	Lower middle income	9.5%
11	BIH	Bosnia and Herzegovina	Upper middle income	6.0%
12	BWA	Botswana	Upper middle income	24.7%
13	BRA	Brazil	Upper middle income	12.9%
14	BGR	Bulgaria	Upper middle income	10.7%
15	BFA	Burkina Faso	Low income	29.0%
16	CPV	Cabo Verde	Lower middle income	
17	CMR	Cameroon	Lower middle income	15.6%
18	CAN	Canada	High income	69.6%

Continue of Table A1

No.	Code	Country	Income level	Mobile payment penetration rate (2017)
19	CAF	Central African Republic	Low income	2.2%
20	CHL	Chile	High income	28.0%
21	CHN	China	Upper middle income	39.8%
22	COL	Colombia	Upper middle income	8.5%
23	COG	Congo, Rep.	Lower middle income	5.7%
24	CRI	Costa Rica	Upper middle income	17.7%
25	CIV	Cote d'Ivoire	Lower middle income	33.3%
26	HRV	Croatia	High income	32.9%
27	CYP	Cyprus	High income	32.5%
28	CZE	Czech Republic	High income	52.5%
29	DNK	Denmark	High income	83.0%
30	DOM	Dominican Republic	Upper middle income	8.4%
31	EGY	Egypt, Arab Rep.	Lower middle income	2.2%
32	SLV	El Salvador	Lower middle income	6.3%
33	EST	Estonia	High income	69.5%
34	ETH	Ethiopia	Low income	0.4%
35	FJI	Fiji	Upper middle income	
36	FIN	Finland	High income	80.1%
37	FRA	France	High income	49.1%
38	GEO	Georgia	Upper middle income	9.4%
39	DEU	Germany	High income	60.6%
40	GHA	Ghana	Lower middle income	35.5%
41	GRC	Greece	High income	17.8%
42	GTM	Guatemala	Upper middle income	4.5%
43	HND	Honduras	Lower middle income	8.1%
44	HUN	Hungary	High income	28.5%
45	ISL	Iceland	High income	
46	IND	India	Lower middle income	5.3%
47	IDN	Indonesia	Upper middle income	7.7%
48	IRN	Iran, Islamic Rep.	Upper middle income	45.5%
49	IRL	Ireland	High income	42.0%
50	ISR	Israel	High income	46.8%
51	ITA	Italy	High income	22.2%
52	JAM	Jamaica	Upper middle income	
53	JOR	Jordan	Upper middle income	4.3%
54	KAZ	Kazakhstan	Upper middle income	18.2%
55	KEN	Kenya	Lower middle income	71.8%

Continue of Table A1

No.	Code	Country	Income level	Mobile payment penetration rate (2017)
56	KOR	Korea, Rep.	High income	67.1%
57	KGZ	Kyrgyz Republic	Lower middle income	5.8%
58	LVA	Latvia	High income	55.5%
59	LBN	Lebanon	Upper middle income	5.4%
60	LSO	Lesotho	Lower middle income	26.2%
61	LTU	Lithuania	High income	43.3%
62	LUX	Luxembourg	High income	56.5%
63	MDG	Madagascar	Low income	10.7%
64	MWI	Malawi	Low income	20.1%
65	MYS	Malaysia	Upper middle income	32.6%
66	MDV	Maldives	Upper middle income	
67	MLI	Mali	Low income	23.5%
68	MLT	Malta	High income	43.1%
69	MUS	Mauritius	High income	15.2%
70	MEX	Mexico	Upper middle income	7.4%
71	MDA	Moldova	Lower middle income	10.0%
72	MNG	Mongolia	Lower middle income	38.4%
73	MAR	Morocco	Lower middle income	1.5%
74	MOZ	Mozambique	Low income	22.1%
75	MMR	Myanmar	Lower middle income	1.1%
76	NAM	Namibia	Upper middle income	46.2%
77	NPL	Nepal	Lower middle income	4.0%
78	NLD	Netherlands	High income	75.8%
79	NIC	Nicaragua	Lower middle income	4.5%
80	MKD	North Macedonia	Upper middle income	11.8%
81	NOR	Norway	High income	85.1%
82	PAN	Panama	High income	6.3%
83	PRY	Paraguay	Upper middle income	28.4%
84	PER	Peru	Upper middle income	5.3%
85	PHL	Philippines	Lower middle income	7.0%
86	POL	Poland	High income	52.4%
87	PRT	Portugal	High income	28.0%
88	ROU	Romania	High income	12.3%
89	RUS	Russian Federation	Upper middle income	33.2%
90	RWA	Rwanda	Low income	28.8%
91	WSM	Samoa	Upper middle income	
92	SRB	Serbia	Upper middle income	12.1%

End of Table A1

No.	Code	Country	Income level	Mobile payment penetration rate (2017)
93	SYC	Seychelles	High income	
94	SVK	Slovak Republic	High income	42.8%
95	SVN	Slovenia	High income	44.1%
96	SLB	Solomon Islands	Lower middle income	
97	ZAF	South Africa	Upper middle income	20.6%
98	ESP	Spain	High income	30.3%
99	LKA	Sri Lanka	Lower middle income	7.7%
100	LCA	St. Lucia	Upper middle income	
101	SDN	Sudan	Low income	
102	SWE	Sweden	High income	79.3%
103	CHE	Switzerland	High income	56.0%
104	TZA	Tanzania	Lower middle income	36.5%
105	THA	Thailand	Upper middle income	17.4%
106	TLS	Timor-Leste	Lower middle income	
107	TGO	Togo	Low income	20.7%
108	TON	Tonga	Upper middle income	
109	TUN	Tunisia	Lower middle income	4.1%
110	TUR	Turkiye	Upper middle income	28.0%
111	UGA	Uganda	Low income	47.2%
112	UKR	Ukraine	Lower middle income	18.1%
113	ARE	United Arab Emirates	High income	46.6%
114	GBR	United Kingdom	High income	46.7%
115	USA	United States	High income	67.3%
116	URY	Uruguay	High income	15.8%
117	VUT	Vanuatu	Lower middle income	
118	ZMB	Zambia	Lower middle income	26.2%
119	ZWE	Zimbabwe	Lower middle income	45.5%

Note: The mobile payment penetration rate is defined by the percentage of people (age 15+) who use a mobile phone or the Internet to access an account. Data on mobile payment penetration rates are obtained from *Global Findex Database*, 2017. Income levels are consistent with the classification by the World Bank in March 2021.