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Research Article

Dynamic Nonlinear Connectedness between the Financial Inclusion, Economic Growth, and China's Poverty Alleviation: Evidence from a Panel VAR Analysis

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Whether financial inclusion and economic growth can sustainably release poverty alleviation effects in long term has been the focus of academia and government sector. This article uses provincial panel data from 2004 to 2019 to examine the dynamic nonlinear connectedness between the financial inclusion, economic growth, income inequality, and poverty alleviation; the main objective is to reveal the direction and intensity of the long-term and short-term impact of each factor on poverty alleviation. By building a panel vector autoregression model (PVAR), the comparison analyses of national, eastern, central, and western sample groups verify the existence of dynamic nonlinear connectedness among the four variables. The study found that there is complex bidirectional causality between these variables, financial inclusion has the long-term impact on promoting poverty alleviation in China, the impact of economic growth is relatively weak, and income inequality has weakened the positive impact of financial inclusion on poverty alleviation. Through the analysis of impulse response function, variance decomposition, and time-varying nonparametric estimates in different economic regions, we find that the impact of financial inclusion on poverty alleviation presents a U-shaped characteristic, and the contribution of financial inclusion to poverty alleviation in western regions is significant, but poverty reduction in eastern and central region mainly depends on economic growth. For policymakers, financial inclusion can be an effective way to alleviate relative poverty, but the poverty governance should focus more on reducing income inequality in China.

1. Introduction

Poverty alleviation is the most important indicator in the Sustainable Development Goals (SDGs), which emphasize the need for a reduction of inequality and the eradication of global poverty in all forms by 2030 [1, 2]. As one of the most dynamic economies in the world, China has not only achieved sustained economic growth, but also achieved world-renowned achievements in poverty eradication. At the end of 2020, China successfully completed the arduous task of eliminating absolute poverty, and 98.99 million rural poor people were lifted out of poverty as scheduled, marking a comprehensive victory in the battle against poverty [3].

However, eradicating absolute poverty does not mean the end of antipoverty work. The relative poverty problem in China will still exist for a long time [4], and accidental factors from the economy, society, and family may also lead to the return of poverty-stricken people [5]. Therefore, consolidating existing achievements in poverty alleviation, especially establishing a long-term mechanism for poverty alleviation, has become the focus of theoretical circles and policymakers.

The scholars have put forward many opinions about the reasons for poverty alleviation, and many studies attribute it to sustained economic growth [6]. Some scholars regard financial development and economic growth as an

important way to eliminate poverty in developing countries based on neoclassical economics and development economics theory [7–10]. In terms of the impact mechanisms of financial development and economic growth on poverty alleviation, there are two representative views in the existing research. First, financial development has a "hematopoietic function." By providing financial support to production factors, the financial sector stimulates the actual output of production activities, and ultimately achieves increased employment opportunities and poverty alleviation [11]. Second, there is a "trickle-down effect" in economic growth. Economic growth can spontaneously increase the income of poor groups, and financial development narrows the income gap through the "trickle-down effect" of economic growth [12]; as such, the problem of poverty will eventually be eliminated with economic growth. Under the above-mentioned mechanism, financial poverty alleviation has become an important support for China's poverty alleviation strategy. After China's State Council's "Government Work Report" in 2015 proposed to vigorously develop financial inclusion [13], this financial poverty alleviation method has been advocated by research and practice [14, 15]. However, it is puzzling that some studies have found that in countries or regions with rapid financial development, income gaps and poverty are further aggravated [16, 17]. Some studies have also pointed out that when income gaps increase to offset the poverty alleviation effect of economic growth, economic growth will aggravate the degree of poverty, namely, the problem of "poverty growth" [18, 19]. In general, the poverty alleviation effect of financial inclusion and economic growth has not reached a conclusion, and it is not clear whether they can effectively and continuously promote poverty alleviation in the long term. How about the effect of financial inclusion and economic growth on poverty alleviation in China? What is the long-term and short-term dynamic evolution relationship between the development of financial inclusion, economic growth, and poverty alleviation? Furthermore, is the the dynamic impact consistent across different regions in China? In this context, an empirical analysis of the above issues is necessary, and the conclusions have important significance for the policy formulation of China's relative poverty. We use provincial panel data to build the PVAR model and examine the dynamic nonlinear impact of financial inclusion development and economic growth on poverty alleviation from the perspective of regional heterogeneity.

The contributions of this article are as follows. Firstly, an important point that has been ignored in previous literature is the lack of systematic consideration when examining the relationship between financial inclusion, economic growth, and poverty alleviation. Therefore, we put these economic variables into a systematic analysis framework based on poverty decomposition theory and focuses on the negative impact of income inequality. We find that increased income inequality offsets the poverty alleviation performance of financial inclusion and the finding can provide a new perspective for related research. Secondly, we analyze the dynamic impact effect between variables from nonlinear perspective, rather than the static impact from linear

perspective in many studies, so that we more clearly understand the dynamic impact and duration of the interaction between variables. Furthermore, the bidirectional causality between economic variables is an unavoidable problem, and the PVAR model can avoid the impact of endogenous problems in the previous literature on the estimation results, which can provide a more accurate basis for policymakers to make poverty reduction policies. Finally, this article emphasizes the correct application of the PVAR analysis. In the last 20 years, the PVAR model has been widely used in economic research; however, there are still many authors who misuse this method. For example, the impulse response function analysis does not consider confidence intervals, and the conclusions also lack robustness check. Therefore, we hope to provide a standardized application case to provide reference for other scholars to use the PVAR model correctly in the future.

The remainder of the article is structured as follows. Section 2 is the literature review. Section 3 sets out the research materials and methods. Section 4 contains the results and discussion. Section 5 discusses the time-varying impact of financial inclusion on poverty alleviation using time-varying nonparametric estimation techniques. Finally, the research conclusions and policy implications of this study are summarized in Section 6.

2. Literature Review

Since the United Nations called for the establishment of a broad financial inclusion system in 2005, the concept of financial inclusion has spread rapidly around the world. Since then, research results on the relationship between financial inclusion, economic growth, and poverty alleviation have become more and more abundant, and both theoretical perspectives and research methods have gradually shown a trend of diversification. Through a literature review, it was found that the existing research on the abovementioned fields can be classified into four categories. The first relates to research on the impact of financial inclusion on poverty alleviation; the second is research on the relationship between economic growth and poverty alleviation; the third is research on the interactive relationship between financial inclusion and economic growth, and the four is the role of income inequality in economic growth and poverty alleviation. The details are as follows.

2.1. The Impact of Financial Inclusion on Poverty Alleviation. The impact of financial inclusion development on poverty alleviation has always been an important issue of concern to the academic community, but the role of financial inclusion development in poverty alleviation is far from reaching a consensus. Institutional factors are an important cause of poverty. Under the market economy system, the profit-seeking nature of capital exacerbates the polarization of income distribution [20]. Marx argued in Das Kapital that the increase of capital concentration puts the ownership and control of capital in the hands of a few people, so poverty and unemployment should be attributed to the capitalist system.

Even Keynesians believe that the shortcomings of the capitalist system include its failure to provide full employment and unequal distribution of wealth and income [21], and they regard monetary policy as an important means of macroeconomic regulation. Therefore, in order to solve the problem of poverty, it is important to consider the rational guidance of capital flow. In this view, financial development is often seen as an effective measure of addressing income inequality and poverty alleviation in developing countries [22]. Since the 1970s, in order to stimulate economic growth and poverty alleviation, governments of various countries have vigorously implemented financial deepening policies, which have generally improved the level of financial development [23]. Among many policies, financial inclusion plays a pivotal role in the process of poverty alleviation due to its advantage of enabling individuals and enterprises in the economy to easily access a wide range of financial services [24]. There has been a significant amount of scholarly research and discussion as to whether the development of financial inclusion can effectively alleviate poverty. On the one hand, there are many research results that support the development of financial inclusion to improve income levels and poverty alleviation. For example, Chibba [25] points out that countries need financial inclusion more urgently than ever before, because financial inclusion is a progressive program to achieve poverty alleviation and inclusive development. Sarma and Pais [26] also believe that financial inclusion includes the characteristics of convenience, availability, and effectiveness, which can help alleviate the poverty of low-income groups. In addition, more and more empirical studies have discussed the causal relationship between the development of financial inclusion and poverty alleviation; many studies have concluded that the development of financial inclusion can help achieve poverty alleviation, and its influencing mechanisms include the indirect effect of developing financial inclusion to stimulate economic growth, thereby narrowing the income gap, and the direct effect of broadening financial service channels [27–32]. On the other hand, there are also many economists who hold a negative attitude towards the poverty alleviation effect of financial inclusion. Critics argue that financial inclusion is nothing more than a "new coat" for microfinance, with questionable effectiveness when it comes to poverty alleviation in developing countries [33–35]. In other words, researchers challenge the traditional assumption of causality between financial inclusion, poverty alleviation, and income inequality. The reason for this is that due to the constraints of income level, professional knowledge and social status, the financial inclusion policy that can benefit most individuals in theory may still benefit high-income groups in practice, which leads to low-income groups being unable to enjoy equal financial service opportunities [36, 37].

2.2. The Relationship between Economic Growth and Poverty Alleviation.

Since the 1990s, economists have paid more and more attention to the relationship between economic growth and poverty alleviation. Many studies show that economic growth helps to alleviate poverty in developing countries and regions, but the existing literature does not reach a consensus on the strength and direction of its impact [38]. From the perspective of the evolution of economic theory, neoclassical economics and the development economics theory constitute two important theoretical cornerstones in this field. On the one hand, based on the theory of diminishing marginal utility, neoclassical economics emphasizes the "trickle-down effect" of economic growth on low-income groups, arguing that economic growth can ultimately promote poverty alleviation in low-income groups in an effective way [38]. On the other hand, development economics suggests that due to the "vicious circle" between resource factors and economic growth, developing countries or regions fall into poverty and backwardness and are hard to get rid of, and the phenomenon of a "poverty trap" aggravates people's confusion in understanding the poverty alleviation effect of economic growth [39]. Therefore, researchers are constantly trying to find new theoretical explanations to reveal the internal mechanism of how economic growth affects poverty alleviation. For example, Zhong [40] explained the connection between economic growth and poverty alleviation from the perspective of resource allocation efficiency and pointed out that poverty alleviation is the result of economic growth, regional development, and targeted poverty alleviation led by the Chinese government. It is worth mentioning that some scholars have tried to explain the poverty alleviation effect of economic growth from the perspective of an economic growth model. Montalvo and Ravallion [41] first proposed the "economic growth model hypothesis," which holds that the sectoral or geographical composition of economic activities is independent, and the economic model will have an impact on the poverty alleviation effect of economic growth. In other words, the hypothesis attempts to answer the question of which model is more conducive to poverty alleviation between the balanced growth model and the nonequilibrium growth model of the economic sector. When discussing the impact of economic growth on poverty alleviation, Li and Bian [19] believe that the income distribution effect is greater than the economic growth effect. In terms of empirical research, although many studies suggest that economic growth has the role of promoting poverty alleviation, there are also critical voices in the existing literature. Based on the "poverty–growth–inequality" framework, proponents have verified that economic growth is the determinant of poverty alleviation [42, 43], and some studies have further explained the poverty alleviation mechanism of economic growth [44]. Some scholars have found that even with different poverty line standards, the economic growth elasticity of poverty alleviation is between −2 and −3, which means that 10% of economic growth will reduce poverty by 20% to 30% [45, 46]. At the same time, critics do not deny the poverty alleviation role of economic growth, but question the "trickle-down effect" of economic growth. Given that the empirical results do not fully support the conclusion that economic growth will benefit members of all income classes, the "trickle-down effect" of economic growth has been extensively criticized in theory and in reality [47]. In

addition, some scholars have put forward different views, suggesting that economic growth is not the only determinant of poverty alleviation [48], and the effectiveness of poverty alleviation may also be affected by the moderating effects of many factors such as policy, society, population, geography, and climate [49].

2.3. The Interactive Relationship between Financial Inclusion and Economic Growth. In the existing literature, it is evident that the interactive relationship between financial inclusion and economic growth has not been fully studied by the academic community. Most traditional financial development theories are based on the perspective of financial deepening, focusing on the comprehensive impact of financial intermediaries and financial markets on economic growth [12]. For example, when Schumpeter and Opie [50] discussed the theory of economic development, they emphasized the key role played by the financial system in the process of economic growth by stimulating innovation and productive financing. Scholars such as Lucas [51] and Miller [52] also agreed with this view; they put forward the theoretical proposition that financial markets contribute to economic growth and believe that if we want to promote economic growth, we should prioritize encouraging the rapid development of the financial sector. At the same time, King and Levine [53] pointed out that the financial sector is a stable capital intermediary system, and its capital availability can bring long-term economic growth and productivity improvement. The above studies all support the interactive relationship between financial development and economic growth. According to research by Siddik et al. [54], the economic growth effect of financial inclusion has received much attention in the last decade and is regarded as a priority policy option by central banks, regulators, and government officials. In this context, some of the literature regards the development of financial inclusion as an important engine and a key strategic component of sustained economic growth [55]. In addition, an increasing number of empirical studies also provide evidence of the interaction between financial inclusion and economic growth, but these studies show that there is not necessarily a positive influence between them. Some studies have confirmed that financial inclusion has a significant economic growth effect. For example, some scholars believe that the development of financial inclusion can help reduce transaction costs of microindividuals, alleviate the phenomenon of financial exclusion by traditional financial institutions, promote residents' intertemporal consumption by facilitating customer experience, and enhance the availability of capital to promote technological innovation and regional entrepreneurship, thus having a significant positive impact on economic growth [56–61]. Based on the perspective of cointegration theory, some scholars have also confirmed that there is a long-term stable equilibrium relationship between financial inclusion and economic growth and that there is a two-way causal relationship between them [62, 63]. However, when some scholars use econometric methods to analyze the economic growth effect of financial inclusion,

they believe that the effect is negative or has no significance [64–66]. This is because in addition to the different definitions of financial inclusion, past studies have mostly focused on the linear effect or overall effect between financial inclusion and economic growth, ignoring the potential nonlinear effect or regional heterogeneity between them. As pointed out by Ali et al. [67], when exploring the economic impact of financial inclusion, it is necessary to include nonlinear effects or cross-group factors in the study, which can indicate the optimal strategy in different situations. When Li et al. [13] analyzed the economic growth effect of financial inclusion, they found that there was a significant positive impact in eastern China, but no significant impact in the central and western regions. Therefore, to explore the interactive relationship between financial inclusion and economic growth, we can try to conduct further in-depth analyses from the perspective of nonlinear effects or regional heterogeneity.

2.4. The Role of Income Inequality in Economic Growth and Poverty Alleviation. In addition to discussing the relationship between financial inclusion, economic growth, and poverty alleviation, many studies have also studied the impact of income inequality on economic growth and poverty alleviation performance. It is well known that income inequality and economic growth are usually regarded as exogenous shocks to an economy due to poverty. Inequality seems to be closely related to poverty, and scholars generally believe that it will have a negative impact on economic growth [68]. As pointed out in the literature by Bui et al. [69], the existence of inequality can undermine the effective implementation of policies, thereby hindering economic growth. In addition, widespread extreme income inequality is considered a huge threat to economic development, and poverty alleviation efforts in developing regions are slowing due to income inequality [70]. Its impact mechanism is that if the economic growth is accompanied by the widening of the income distribution gap, the poor groups will benefit from the growth less than the nonpoor groups, and the poverty alleviation effect of economic growth will be partially or completely offset by income inequality [71, 72]. Therefore, the World Bank has set a goal of ending extreme poverty by 2030 and improving the quality of life of the bottom 40 percent of people in every country by reducing income inequality. The question of how to solve the negative impact of income inequality on economic growth is a reality that governments must face. Some scholars have found that financial inclusion can help improve the relationship between income inequality and economic growth; that is, reducing income inequality through financial inclusion can turn the negative correlation between income inequality and economic growth into a positive correlation [73]. Several new findings have also been reported in the recent literature. In the process of poverty governance, financial inclusion and economic growth are important drivers of poverty alleviation, but the existence of income inequality will greatly reduce its poverty alleviation performance. For example, Wang et al. [74] found that economic growth played a

positive role in poverty alleviation in the BRICS countries, but rising inequality offsets the poverty alleviation effect of economic growth and weakened the effect of subsequent economic growth on poverty alleviation. Gutierrez-romero and Ahamed [30] found that in the poverty alleviation process of 121 countries around the world, the harmful impact of inequality on poverty alleviation is much greater than the positive effect of economic growth, and financial inclusion can achieve poverty alleviation by restraining the destructive impact of inequality rather than by improving economic growth. Therefore, when studying the impact of financial inclusion on poverty alleviation, scholars will also explore the impact of financial inclusion on income inequality. Some scholars believe that although inclusive finance can alleviate poverty, it cannot alleviate income inequality [14, 75]. Some studies have reached the opposite conclusion and found that financial inclusion significantly alleviates poverty rates and income inequality in developing countries [70, 76, 77]. In view of this, this article also tries to incorporate income inequality into the systematic analysis framework when examining the role of financial inclusion and economic growth in poverty alleviation in China.

In summary, the existing literature has laid the foundation for the research topic in this study, but there are still several issues that deserve further consideration. Firstly, when discussing the impact of financial inclusion on poverty alleviation, the existing literature does not strip the poverty alleviation effect of economic growth in advance, which is not conducive to identifying the real financial inclusion effect of financial inclusion. Secondly, the existing literature mainly focuses on the short-term linear relationship between financial inclusion, economic growth, and poverty alleviation, ignoring the possible endogenous problems and the long-term nonlinear relationship between variables, and these research methods need to be further explored and improved. Thirdly, there are significant differences in financial inclusion and economic development among the different regions in China. Whether there is regional heterogeneity in the impact of financial inclusion and economic growth on poverty alleviation remains to be verified. Finally, although the results of the poverty alleviation effect of financial inclusion continue to emerge, the existing literature has not given a clear answer as to whether income inequality has a negative impact on the poverty alleviation effect of financial inclusion. As a result, this study uses the panel data of 30 provinces in China from 2004 to 2019 to synthesize the financial inclusion index from the perspective of financial penetration, availability, and effectiveness. It also uses the PVAR model and time-varying nonparametric estimates technology under the theoretical framework of poverty index decomposition, so as to verify the nonlinear impact of financial inclusion, economic growth, and income inequality on poverty alleviation. This study aims at providing an indicative reference for the path selection and policy orientation of relative poverty governance.

3. Materials and Methods

3.1. Theoretical Framework. This study aims at estimating the actual impact of financial inclusion development and economic growth on poverty alleviation in China and focusing on whether there is regional heterogeneity in these impacts. Most of the studies on poverty decomposed the changes in the poverty index at different time points into the effects of economic growth and income distribution, and then discussed the effects of economic growth and income distribution on poverty alleviation [71, 78].

Based on this, we follow the poverty index decomposition theory proposed by Datt and Ravallion [71] and examine the extent to which poverty alleviation can be attributed to changes in financial inclusion and economic growth based on China's national and different regional levels. Poverty index decomposition theory is unique in that it reveals a framework for understanding poverty change, which can be decomposed into several specific components, and these components interact in complex ways. Next, referring to the research of Datt and Ravallion [71] and Luo [79], this study explains the principle of poverty index decomposition through a concise theoretical model. Given that P_t is the poverty index of a country or region in period t, according to the theoretical properties of the Lorenz curve, Datt and Ravallion [71] proved that P_t can be determined by three factors, namely, the poverty line Z_t, average income level U_t, and parameter vector $L_t(p)$ of the Lorenz curve. Then, P_t can be defined as

$$P_t = P(Z_t, U_t, L_t(p)), \tag{1}$$

$$P_t = P(U_t, L_t(p)). \tag{2}$$

Here, formula (2) is a simplified form of formula (1), indicating that there is no intertemporal change in the poverty line. Therefore, if there is no intertemporal change in the poverty line of a country or region, it can be determined that the change in the poverty index will be affected by both the average income level U_t and the change in income distribution $L_t(p)$. On this basis, assuming that period t is used as the reference period, the poverty index in period $t + n$ can be extended to the form of $P_{t+n} = P(U_{t+n}, L_{t+n}(p))$. According to Datt and Ravallion [71], the change of P_t can be subdivided into two cases. If the change in the Lorenz curve (income distribution) $L_t(p)$ is kept constant, only the average income level U_t changes; consequently, the change of poverty index P_t at this time is referred to as the growth effect. Conversely, if the change in average income level U_t is kept constant, only the Lorenz curve (income distribution) $L_t(p)$ changes; then, the change in poverty index P_t is called the distribution effect. The change in the poverty index P_t from period t to $t + n$ can be decomposed as follows:

$$\Delta P_t = \underbrace{P(U_{t+n}, L_t(p)) - P(U_t, L_t(p))}_{\text{growth component}}$$
$$+ \underbrace{P(U_t, L_{t+n}(p)) - P(U_t, L_t(p))}_{\text{redistribution component}} + \underbrace{\Delta R_t}_{\text{residual}}. \tag{3}$$

As shown in (3), the abovementioned poverty decomposition theory links poverty change, growth, and income distribution, providing a feasible theoretical framework for empirical analysis. Gutiérrez-Romero and Ahamed [30] believe that the theory can be implemented by regressing each component and poverty changes, and the expanded linear equation also adds financial inclusion variables. In the few available empirical studies, scholars generally use income inequality and economic growth indicators to reflect distribution and growth components, and a regression analysis using panel data usually only controls the year fixed effect. It is worth noting that the poverty decomposition theory can examine the extent to which changes in poverty at the macrolevel are attributable to the contributions of economic growth and income distribution, but it cannot capture the causal relationship between variables. In addition, in the empirical process, most of these studies use a static single equation to estimate the marginal effect coefficient of variables, which is usually plagued by endogeneity caused by reverse causality between variables. However, endogeneity has not attracted enough attention from previous scholars.

3.2. Econometric Model. According to the theoretical framework in Section 3.1, this article refers to the practices of scholars such as Abrigo and Love [80] and establishes a panel vector autoregressive (PVAR) model for empirical analysis. The PVAR model has proven to be a particularly useful tool for analyzing the dynamic interactions of endogenous variables [81], and the use of impulse response function (IRF) analysis facilitates the understanding of dynamic nonlinear connections between variables [82]. For example, when a variable is shocked by other variables, the IRF can reflect whether the response value brought by the shock is statistically significant and how it changes over time. As a simultaneous equation model, a PVAR model has the following advantages compared with a static single-equation method. Firstly, a PVAR model treats all variables in the system as endogenous variables, to effectively avoid the influence of endogenous problems on parameter estimation results. Secondly, a PVAR model can control for unobservable regional fixed effects and time fixed effects, and can also identify causal relationships between variables. Finally, through the orthogonalized impulse response function method, a PVAR model can also predict the nonlinear effects of external shocks, providing a forward-looking basis for policymaking [80]. Therefore, the PVAR model is an effective analytical tool for exploring the endogenous association of variables in the economic system. The variables are defined as poverty alleviation (RPOV), economic growth (GDP), income inequality (GINI), and financial inclusion development (IFI), these variables are called $y_{i,t}$ or $x_{i,t}$ in formula (4); I and t are used to represent different regions and years, respectively. θ_t, μ_i, and $\varepsilon_{i,t}$ are used to represent individual fixed effect, time fixed effect, and random disturbance terms, respectively. The lag order of the model was assumed to be j. The form of the PVAR model set in this article is as follows:

$$y_{i,t} = \mu_i + \theta_t + \sum_{j=1}^{n} \alpha_{i,i}^j y_{i,t-j} + \sum_{j=1}^{n} \beta_{i,i}^j x_{i,t-j} + \varepsilon_{i,t}. \tag{4}$$

The PVAR method can provide the average effect of endogenous explanatory variables on RPOV, but it cannot reveal how this average effect evolves over time before and after a certain year. For example, the financial inclusion develops vigorously after China's State Council's "Government Work Report" in 2015. Is there a significant difference before and after this critical time point? This has been a problem for a long time. One idea is to build PVAR models before and after the event and compare whether there is a significant difference in their IRFs. However, Wan et al. [83] argued that the dynamic impacts of endogenous explanatory variables given by IRF are not directly comparable, especially for the direct comparison of IRFs of two different PVAR models. In addition, we also consider that there are only 4 years of sample data after 2015, which will aggravate the sample loss in the case of subregional testing, and it seems inappropriate to use short panel data to establish the PVAR model. Therefore, we borrowed the research ideas of Hailemariam et al. [84] and continued to use nonparametric time-varying coefficient panel data models (NP-TVP) after the PVAR model to capture the time-varying effects of the main explanatory variables on RPOV. NP-TVP technology uses a pooled local linear dummy variable estimator (LLDVE), which has the advantage that it does not need to specify a certain function followed by the regime conversion in advance and allows data to directly reveal the nonlinear relationship between variables by using its own information. LLDVE was first proposed by Li et al. [85] and has been applied by Hailemariam et al. [84], Awaworyi Churchill et al. [86], and Ren et al. [87] in empirical studies. The form of the NP-TVP is as follows:

$$Y_{i,t} = f_{i,t} + \sum_{j=1}^{d} \beta_{t,j} X_{it,j} + \alpha_i + \varepsilon_{i,t}, \tag{5}$$

where $Y_{i,t}$ denotes the measure of RPOV. i and t are used to represent different regions and years, respectively. $f_{i,t}$ are unknown trend functions, and $\beta_{t,j}$ denote the time-varying coefficient estimates. α_i reflects unobserved provincial fixed effect, and $\varepsilon_{i,t}$ denotes the disturbance term. Finally, $X_{it,j}$ represents the explanatory variables of IFI, GDP, and GINI, and we are more concerned with the coefficient of IFI in empirical analysis. The confidence interval of the estimation of time-varying coefficients was also obtained by simulation with the wild bootstrap method.

3.3. Variable Definition. Economic growth variable (GDP). In empirical analyses, some studies suggest using real GDP per capita as a proxy variable for economic growth [61]. This approach is because relative to gross GDP, real GDP per capita excludes the impact of population size in different regions and can more effectively reflect the quality of economic growth [88]. However, economic growth should include the two-dimensional meaning of growth quality and growth rate. Real GDP per capita reflects the quality

dimension of economic growth, while the real GDP growth rate can reflect the speed dimension. Under the framework of poverty index decomposition theory, this study prefers to interpret economic growth from the perspective of speed. Therefore, following the practice of scholars such as Erlando et al. [10] and Gutiérrez-Romero and Ahamed [30], the real GDP growth rate is used here to measure the economic growth level of each province in China.

Income inequality variable (GINI). The existing literature has basically reached a consensus on the measurement of income inequality, and the Gini coefficient is used as a general indicator to measure income inequality. The Gini coefficient has the advantages of comparability in both time and space, and its value range is between 0 and 1. The larger the value, the higher the inequality of income distribution. However, in the past, scholars have mostly used national-level household income sample survey data to measure the Gini coefficient. The results obtained in this case can only reflect income inequality at a national level and rarely provide detailed results of the Gini coefficient of each province in China. Therefore, this article uses the research ideas of Tian [89] to measure the Gini coefficient of each province by using household income group data at the macrolevel. The specific calculation formula is as follows:

$$\text{GINI}' = 1 - \frac{1}{PW} \sum_{j=1}^{n} \left(W_{i-1} - W_i \right) \times P_i, \tag{6}$$

$$\text{GINI} = P_c^2 \frac{u_c}{u} G_c + P_r^2 \frac{u_r}{u} G_r + P_c P_r \frac{u_c - u_r}{u}. \tag{7}$$

Formula (6) is an improved Gini coefficient expression based on the Lorenz curve principle. Among them, P is the total population, W is the total income, W_i is the income accumulated by the i-th group, and P_i is the proportion of the i-th group's population compared to the total population. On this basis, the Gini coefficients of urban residents and rural residents in each province can be calculated by using income grouping data; then, the overall Gini coefficient can be calculated by using the "group weighting method" shown in formula (7). In formula (7), G_c and G_r represent the Gini coefficient of urban and rural residents, respectively; P_c and P_r represent the proportion of urban and rural populations, respectively; u_c and u_r represent the per capita income of urban and rural residents, respectively; and u represents the per capita income of the province in which residents live.

Poverty alleviation variable (RPOV). Indicators of poverty alleviation are diverse, and the proxy variables used by scholars are also quite different. Most studies use poverty incidence as a proxy variable for poverty alleviation [10, 30]. However, there are two difficulties in using poverty incidence indicators. First, it involves setting the poverty line standard. The common practice is to refer to the poverty line standard provided by the World Bank, but this standard has the problem of being too absolute. Second, domestic statistical data are relatively scarce, and it is difficult to collect long-term dynamic poverty incidence data for each province. Therefore, referring to Li and Han [20], this article uses the proportion of the minimum living security population in

the total regional population to reflect the incidence of poverty at the provincial level. The minimum living security population refers to the sum of the minimum living security population of urban residents and rural residents.

Financial inclusion development variable (IFI). Given that financial inclusion is a multidimensional concept, previous studies have generally adopted the method of constructing a comprehensive index to measure the development of financial inclusion [13]. Among them, the index system designed by Sarma [90], Allen et al. [91], and Park and Mercado [14] are highly influential. They measure the comprehensive index of financial inclusion primarily from three dimensions of permeability, availability, and effectiveness. However, Pesqué-Cela et al. [92] systematically reviewed this and concluded that there is no universal financial inclusion indicator system, and indicators should be flexibly adjusted according to the actual conditions of different countries. Based on this, this study inherits the research ideas of the abovementioned literature and constructs an indicator system for the development of financial inclusion in China from four dimensions: geographic penetration, population penetration, service availability, and effective use. Specifically, the ratio of regional banking financial institutions to geographic area and the ratio of employees of banking financial institutions to geographic area are used to reflect the geographic penetration dimension. The dimension of population penetration is characterized by the ratio of regional banking financial institutions to the regional population and the ratio of employees in banking financial institutions to the regional population. The dimension of service availability is reflected by the ratio of the loan balance of regional financial institutions to the regional GDP and the balance of deposits of regional financial institutions to the regional GDP. The dimension of effective use is measured by indicators of the per capita loan balance of regional financial institutions and the per capita deposit balance of financial institutions. Finally, the specific formula for calculating the financial inclusion index in this study is as follows:

$$\text{IFI} = 1 - \frac{\sqrt{\left(w_{1,t} - s_{1,t} \right)^2 + \left(w_{2,t} - s_{2,t} \right)^2 + \ldots + \left(w_{m,t} - s_{m,t} \right)^2}}{\sqrt{\left(w_{1,t} \right)^2 + \left(w_{2,t} \right)^2 + \ldots + \left(w_{m,t} \right)^2}}. \tag{8}$$

Formula (8) is the expression of the synthetic comprehensive index. Among them, IFI represents the comprehensive index of financial inclusion development, $w_{m,t}$ is the weight of the m-th indicator calculated according to the coefficient of variation method in period t, and the coefficient of variation can be calculated by the ratio of the standard deviation to the mean of the m-th indicator in each province in period t. $s_{m,t}$ represents the weighted value of the m-th indicator in each province in period t, and each indicator needs to be dimensionless and processed by the range standardization method in advance.

3.4. Data Sources. Based on the principles of data availability, continuity, and comparability, this study utilizes the balanced panel data of 30 provinces in China from 2004 to

2019 for empirical analysis (excluding Tibet, Taiwan, Hong Kong, and Macau for reasons of data availability). Furthermore, according to the division method of China's "Seventh Five-Year Plan (1986–1990)," the country is divided into three types of economic regions: eastern, central, and western. The eastern region includes 11 provinces (or cities) including Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. The central region includes 9 provinces (or autonomous regions) including Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan. The western region includes 10 provinces (or autonomous regions) including Sichuan, Chongqing, Guangxi, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. It should be emphasized that the Chinese government has set up Liaoning, Jilin, and Heilongjiang as the Northeast Economic Zone separately in the "Eleventh Five-Year Plan (2006–2010)," and this division method of east, middle, west, and northeast is still in use today. However, considering the small sample size of the Northeast Economic Zone, many scholars still tend to use the traditional three major economic zones for empirical analysis. For recent related literature, please refer to Shi and Xu [93], Fan et al. [94], Ke et al. [95], Liu et al. [96], Ren et al. [97], and Luo et al. [98]. The economic growth rate, loan balance of financial institutions, deposit balance of financial institutions, and GDP data of each region are sourced from the official website of the National Bureau of Statistics of China. The income group data of urban and rural residents and the regional population data are from the "China Statistical Yearbook" and the "Statistical Yearbook" of various regions spanning several years. The minimum subsistence allowance population data are sourced from the "China Civil Affairs Statistical Yearbook" spanning several years and supplemented by the "China Statistical Yearbook." In addition, the number of banking financial institutions and the number of employees of banking financial institutions are sourced from the provincial "Regional Financial Operation Report" issued by the People's Bank of China. Finally, individual missing values were supplemented by querying the Statistical Yearbook of each region. The empirical aspect of this study was processed by Stata 17.0 software. Table 1 lists the descriptive statistics of all the variables.

4. Results and Discussion

4.1. Unit Root Test. Classical econometric theory holds that, before performing panel data regression analysis, a unit root test must be performed on variables to avoid the pseudoregression problem that may be caused by nonstationary variables. In addition, as pointed out by Blundell and Bond, when the variables have unit roots in a regression analysis, the generalized method of moments (GMM) will face the problem of weak instrumental variables [99]. Therefore, the stationarity of endogenous variables is a prerequisite for establishing a PVAR model. The null hypothesis of the panel unit root test is that the variable has a unit root; that is, the variable is a nonstationary panel sequence. If the result of the unit root test rejects the null hypothesis, it can be considered

TABLE 1: Descriptive statistics of variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	480	0.101	0.029	0.005	0.196
RPOV	480	0.049	0.034	0.002	0.169
GINI	480	0.476	0.058	0.316	0.656
IFI	480	0.439	0.281	0.013	0.997

that the variable meets the requirements of stationarity. In order to obtain a robust panel unit root test conclusion, this study adopts both the homogeneity LLC test and the heterogeneity IPS test. The specific test results are shown in Table 2. It can be seen from Table 2 that although the RPOV variable in the western region is not significant in the IPS test, the LLC test results are highly significant at the 1% level, and the rest of the variables have passed the significance test at the 10% level. Therefore, it can be considered that each variable is a stationary panel series. In fact, many literature studies often provide the results of panel cointegration tests after unit root tests, and panel cointegration tests are not a critical step when we use stationary variables to build PVAR models. However, in the case that the original data have a unit root, the panel cointegration test can help us further confirm whether there is a long-term stable equilibrium relationship between these variables, which is an important basis for continuing to build a PVAR model [100, 101].

4.2. Model Estimation and Stability Test. The following details must be considered when using a PVAR model. It is necessary to select an appropriate model lag order, the over-identification test of instrumental variables cannot be ignored, and the PVAR model must be stable. Abrigo and Love [80] pointed out that the parameters and moment conditions of the PVAR model depend on the selection of the optimal lag order, and the choice of different lag orders may affect the estimation results of the model. A common practice is to use MAIC, MBIC, and MQIC statistics as the judgment criteria, and the minimum value among the three can be selected as the optimal lag order. However, this approach also requires the maximum lag period of the PVAR model to be specified in advance, so researchers must seek a compromise between the optimal lag period and model stability. Therefore, this study first sets the maximum lag as 4 based on the number of sample periods. Then, MAIC, MBIC, and MQIC statistics were comprehensively compared; the optimal lag order of the national sample PVAR model was set as order 2 and the optimal lag order of the eastern, central, and western PVAR model was set as order 1. In addition, when estimating the PVAR model it is also necessary to pay attention to the control of time and regional fixed effects. If the model is affected by potential factors that do not change with time or region, the PVAR estimation results will be biased and inconsistent. In this article, the generalized method of moments (GMM) method was used to obtain a consistent estimator, the time fixed effect was removed by the within-group mean difference method in advance, and the Helmert transformation method was then used to remove the regional fixed effect. These

Table 2: Unit root test of variables.

Variable	National		Eastern		Central		Western	
	LLC test	IPS test	LLC test	IPS test	LLC test	IPS test	LLC test	IPS test
GDP	−5.867***	−5.464***	−2.910***	−5.516***	−3.588***	−3.454***	−3.865***	−6.657***
	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RPOV	−5.562***	−6.656***	−4.445***	−3.119***	−1.442*	−2.626***	−3.933***	−0.386 (0.350)
	(0.000)	(0.000)	(0.000)	(0.001)	(0.075)	(0.004)	(0.000)	
GINI	−7.578***	−4.808***	−2.658***	−4.129***	−4.129***	−1.717**	−6.379***	−3.509***
	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.043)	(0.000)	(0.000)
IFI	−2.259**	−2.774***	−2.626***	−5.176***	−1.969**	−1.955**	−2.633***	−2.830***
	(0.012)	(0.003)	(0.004)	(0.000)	(0.025)	(0.025)	(0.004)	(0.002)

The values in the table correspond to the adjusted t-statistic of the LLC test and the Wt-bar statistic of the IPS test. The corresponding significance probability p values are in parentheses; ***, **, and *represent significance at the 10%, 5%, and 1% levels, respectively.

Table 3: GMM estimation results of the PVAR model.

RPOV	National	Eastern	Central	Western
L.GDP	0.028	−0.050***	−0.049*	−0.060
	(0.623)	(0.000)	(0.069)	(0.527)
L2.GDP	−0.062			
	(0.219)			
L.RPOV	0.886***	0.422***	0.714***	1.020***
	(0.000)	(0.000)	(0.000)	(0.000)
L2.RPOV	0.106			
	(0.396)			
L.GINI	0.128**	−0.046***	−0.092***	0.162*
	(0.040)	(0.006)	(0.000)	(0.054)
L2.GINI	−0.043			
	(0.282)			
L.IFI	−0.031**	−0.010***	−0.010***	−0.058***
	(0.012)	(0.000)	(0.001)	(0.000)
L2.IFI	−0.002			
	(0.830)			
Time fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Hansen's J	18.707 (0.284)	39.853 (0.160)	82.806 (0.393)	30.723 (0.531)
Observations	390	154	126	140

L represents the variable first-order lag. The significance probability p value is in parentheses; ***, **, and *represent significance at the 10%, 5%, and 1% levels, respectively. Due to space limitations, only the regression results of the RPOV variable are reported in the table.

practices minimize sample size loss, and lagged variables can still be used as valid instrumental variables for GMM estimation.

Table 3 reports the parameter estimation results of RPOV for each variable in the PVAR model. Hansen's J test shows that all instrumental variables are valid, and the reasonableness of the model estimation results is satisfied. From the estimated results, there is obvious regional heterogeneity in the impact of GDP on RPOV. The lagged value of GDP in the eastern region and central region has a significant negative impact on RPOV, although it is not significant in the western regions. The development of IFI has a significant role in promoting RPOV, which initially means that the development of IFI can be an important path for RPOV in China. In the regression of GINI on RPOV, its coefficients have different degrees of influence in different regions, which preliminarily suggests that the impact mechanism of income inequality on poverty alleviation is different. Finally, the lag term of RPOV has a consistent impact on itself and its coefficients are

significantly positive at the 1% level, which means that RPOV has a strong sticky effect. If the trend of RPOV cannot be effectively controlled, the regional poverty level will only worsen on the current basis. In the following sections, we will combine the impulse response function and the variance decomposition results to analyze the nonlinear effect between variables.

Figure 1 shows the stability test results of the PVAR model. The PVAR model can judge the stability of the estimation results by fitting the reciprocal of the eigenvalue modulus in the model. If the reciprocal of the eigenvalue modulus of the adjoint matrix in the PVAR model is within the unit circle, it means that the constructed model satisfies the stability condition [80, 102]. As shown in Figure 1, within the four groups of PVAR models in the national, eastern, central, and western regions, the reciprocal of each eigenvalue modulus is located inside the unit circle, and the reciprocal of each eigenvalue modulus is strictly less than 1. Therefore, the PVAR model established in this study satisfies the stability condition.
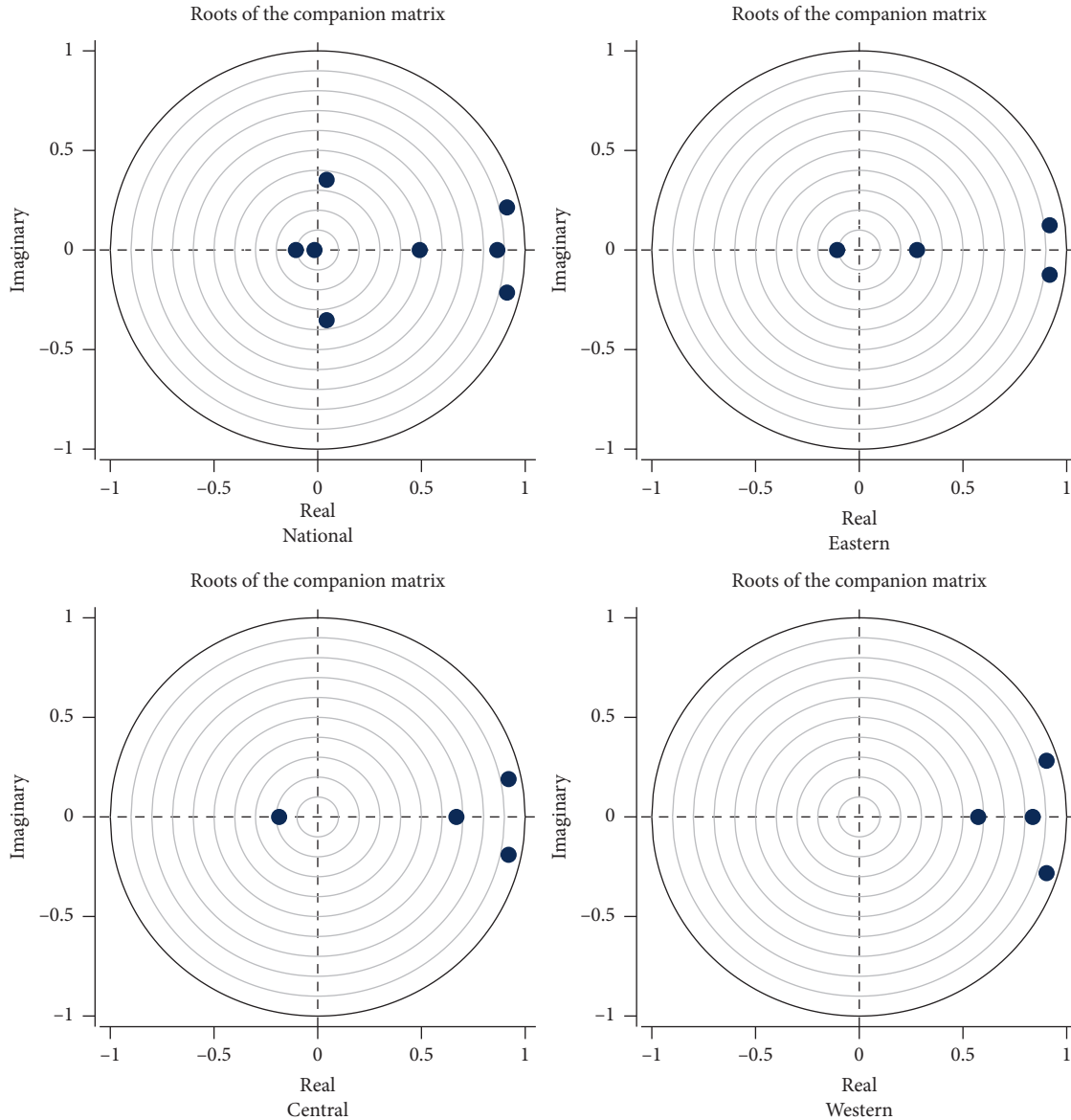
Figure 1: Stability test of the PVAR model.

4.3. Granger Causality Test. Like the time series VAR model, the PVAR model can also verify whether there is a causal relationship between economic variables. Table 4 reports the results of the panel Granger causality test to confirm the direction of the causal effect of each explanatory variable on RPOV. The Granger causality test is essential to test whether the lagged value of one variable can be introduced into the equation of other variables, and to judge whether the addition of lagged variables can improve the overall explanatory power of the equation, the panel Granger causality Wald test must be carried out under the framework of the existing PVAR model [103]. We make the null hypothesis that there is no causal relationship from the independent variable to the dependent variable, and the alternative hypothesis is that the independent variable is the Granger cause of the dependent variable, which can be judged by the p value of the corresponding statistic. As shown in Table 4,

there is a two-way Granger causality between GDP and RPOV in the eastern and central regions, and the null hypothesis is rejected at the 1% significance level. However, for the national and western regions, GDP is the only Granger cause of RPOV, and the null hypothesis is significant at the 1% and 5% levels, respectively. Similarly, there is a two-way Granger causality between GINI and RPOV in the eastern and central regions at the 5% levels. However, there is only a one-way Granger causality from RPOV to GINI across the national and western regions at the 5% levels. In addition, there is only a two-way Granger causality between GDP and GINI in the national and central regions at the 1% level, and only one-way Granger causality from GINI to GDP in the eastern and western regions. In particular, the empirical results demonstrated that there is strong support at the 1% level that IFI is the Granger cause of GDP, but the assumption that GDP is the Granger cause of IFI does not hold

TABLE 4: Panel granger causality test.

Null hypothesis	Chi^2 statistic			
	National	Eastern	Central	Western
GDP is not a granger reason for RPOV	19.543*** (0.000)	139.530*** (0.000)	11.480*** (0.001)	5.078** (0.024)
GDP is not a granger reason for GINI	16.575*** (0.000)	1.311 (0.252)	24.541*** (0.000)	0.000 (0.982)
GDP is not the granger reason for IFI	3.859 (0.145)	29.326*** (0.000)	17.135*** (0.000)	3.581* (0.058)
RPOV is not a granger reason for GDP	2.072 (0.355)	22.396*** (0.000)	3.295*** (0.069)	0.400 (0.527)
RPOV is not a granger reason for GINI	4.788* (0.091)	7.412*** (0.006)	36.849*** (0.000)	3.72* (0.054)
RPOV is not a granger reason for IFI	8.757** (0.013)	13.038*** (0.000)	11.849*** (0.001)	12.884*** (0.000)
GINI is not a granger reason for GDP	23.418*** (0.000)	101.424*** (0.000)	208.324*** (0.000)	3.427* (0.064)
GINI is not a granger reason for RPOV	0.706 (0.702)	89.795*** (0.000)	7.827*** (0.005)	0.033 (0.855)
GINI is not a granger reason for IFI	6.300** (0.043)	0.892 (0.345)	1.241 (0.265)	8.298*** (0.004)
IFI is not a granger reason for GDP	27.021*** (0.000)	149.635*** (0.000)	75.887*** (0.000)	8.870*** (0.003)
IFI is not a granger reason for RPOV	41.158*** (0.000)	143.092*** (0.000)	106.827*** (0.000)	47.599*** (0.000)
IFI is not a granger reason for GINI	1.628 (0.443)	2.640 (0.104)	1.013 (0.314)	3.718* (0.054)

The significance probability p value is in parentheses; ***, **, and *represent significance at the 10%, 5%, and 1% levels, respectively.

at the national level. Finally, there is a two-way Granger causality between IFI and RPOV in the national, eastern, central, and western results, and the null hypothesis is rejected at least at the 1% significance level. The above results show that there is mutual influence among the four endogenous explanatory variables, and the conclusion further supports the necessity of using the PVAR model in this article. From the perspective of policy implications, the path of GDP, IFI, and GINI can effectively affect RPOV. However, given the complex causal relationship among various variables, government departments must take regional heterogeneity into account when formulating poverty alleviation strategies.

4.4. Analysis of Impulse Response Function. In order to further investigate the interactive relationship between GDP, GINI, IFI, and RPOV, we utilize the impulse response function (IRF) to analyze the shock effects among variables. More precisely, IRF reflects the dynamic impact of the shock variable on the response variable in different time horizons; that is, when the error term in each model is subjected to an external shock of one standard deviation, how the response variable changes over time in the present and future [83]. Since the construction of the IRF matrix in the PVAR model depends on regression parameters, a Monte Carlo simulation and bootstrap sampling methods can be used to estimate the confidence interval of the IRF [80]. Therefore, if the 0 horizontal line lies outside the confidence interval, we consider the IRF to be statistically significant [102]. We calculated the standard error of the IRF using the Monte Carlo simulation (1000 times) method and then obtained the confidence interval with a confidence level of 95%. The confidence interval gives the 2.5% and 97.5% quantile values of the IRF, and some studies have expanded the confidence interval to the 90% confidence level for analysis as needed [104]. Figures 2–5 show the orthogonalized IRFs in different regions. The solid and dotted lines in the figures represent the IRF and its confidence interval curve, respectively. The horizontal and vertical axes represent the prediction time and IRF value, respectively. An important feature of IRF is

that it tends to be stable in the long run, which means that the IRF can indicate the time it takes for the sequence to converge to a steady state after a shock [105]. In this article, the prediction time is set to 20 to observe whether there is a convergence trend of IRF. In fact, many of the IRFs in Figures 2–5 were no longer significant after 15 periods. In the end, we found that extending the prediction time (30 or 40) gave the exact same conclusion, and all IRFs converged to 0 in the long run, which means that the convergence rate of IRFs is relatively slow. The reason may be that, as pointed out by Enders [106] in the book, the stability of the system determines the convergence, and if the reciprocal of each eigenvalue modulus is gathered at the centre of the circle (see Figure 1), the convergence rate of the IRF may be accelerated.

Figure 2 shows the results of the IRF analysis of the national sample. As can be seen, the impulse response of GINI to a standard deviation shock from IFI is positive and statistically significant, but this positive effect is only significant in the four periods after the shock, and over time, this positive effect is no longer significant and gradually converges to 0. The impact of IFI has a significant negative effect on RPOV. The value of IRF increases rapidly with time and reaches a maximum value (−0.005) in the 5th period, after which this effect gradually decays and is no longer significant, and the IRF shows an obvious positive U-shape from the 1st to the 10th period. However, the response of GDP to IFI shocks is always not significant. In addition, the shock response of each variable to GINI is relatively weak, except that the short-term shock of GINI to itself has a positive response in the first two periods, and the rest of the variables showed a significant shock response in the current period, but the absolute values of these IRFs are almost all close to 0. Furthermore, the response value of IFI increased rapidly under a one-unit RPOV shock and reached a maximum value (0.117) in the 7th period, and then, this positive effect gradually decayed and became insignificant after the 10th period. Similarly, the positive effect of RPOV shock on GINI also showed a characteristic of increasing first and then decreasing with time. In other words, we found that the effects of RPOV on both IFI and GINI exhibited a
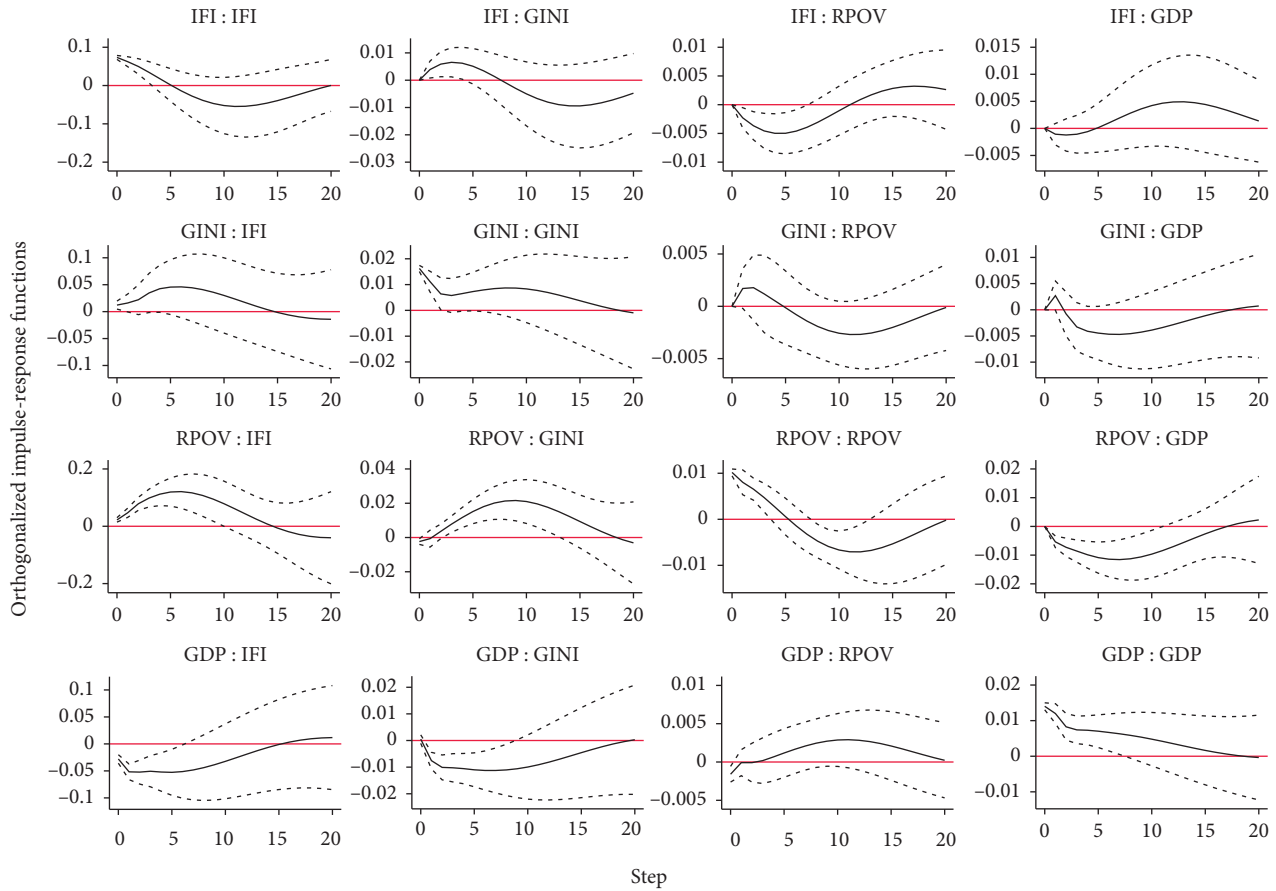
Figure 2: Impulse response function at the national level.

very distinct inverted U-shaped feature. The negative response of GDP to the RPOV shock showed a positive U-shaped characteristic, and the value of the IRF gradually increased with time and reached a maximum value (−0.012) in the 7th period, and then, this effect gradually decayed and was no longer significant by the 12th IRF. Finally, IFI and GINI have a significant negative response to GDP shock, and the IRF values of the 5th period (−0.053) and the 7th period (−0.011) reached the maximum value, but the IRF of economic growth on poverty alleviation was only significant in the 1st period, which means that the impact of economic growth on RPOV is short term. In general, at the national level, the interaction of all variables is nonlinear, and the IRFs all show obvious positive U-shaped or inverted U-shaped characteristics.

The above results show that although the development of financial inclusion at the macrolevel increases income inequality in the short term, it can effectively promote poverty alleviation in the long term. This is consistent with the results of Gutiérrez-Romero and Ahamed [30], who argue that this effect is a combined result of the indirect effect of inequality on poverty alleviation and the direct effect of financial inclusion development on poverty alleviation. Compared with the conclusion of Erlando et al. [10], we found no evidence that economic growth will lead to poverty in the initial stage of the shock, and the results show that economic growth has a significant inhibitory effect on poverty in the early stage.

Scholars believe that economic growth can greatly promote poverty alleviation, and the increase in income inequality may offset part of the poverty alleviation effect of economic growth [79]. However, our empirical results show that economic growth has played a positive role in alleviating poverty and reducing income inequality, and poverty alleviation in turn reduces income inequality and promotes economic growth. Income inequality only offsets part of the poverty alleviation effect of financial inclusion development. On the one hand, it is evident that the development of financial inclusion has indeed expanded opportunities for the disadvantaged in China to obtain financial services, enhanced the economic capacity of the disadvantaged, and improved the level of welfare; economic growth also plays a key role in the process of poverty alleviation. On the other hand, the policy goal of financial inclusion is to make financial services more accessible to the disadvantaged, but given the differences in the ability of the rich and the poor to access credit funds, if the rich benefit more from it, it will lead to increased income inequality [107], thereby weakening the poverty alleviation effect of financial inclusion. Therefore, policy departments should not only pay attention to the impediment of unbalanced income distribution to poverty alleviation, but also further improve the targeted benefit of poor groups during the implementation of financial inclusion policies, so that financial resources can more accurately reach target groups.
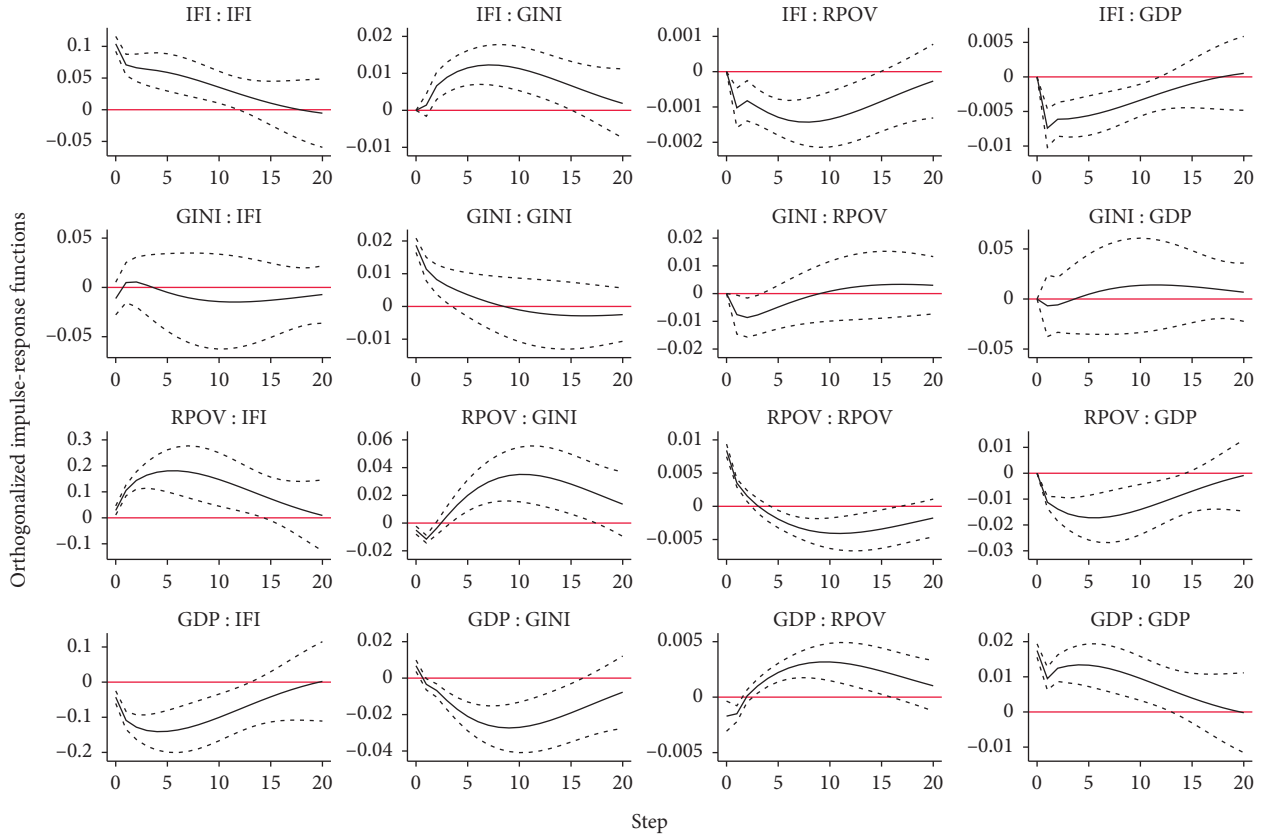
FIGURE 3: Impulse response function in the eastern region.

Figure 3 presents the results of the IRF analysis for the eastern region. When faced with the shock of one standard deviation of IFI, RPOV and GDP show a negative response, while GINI shows a positive response to the shock. Specifically, the shock response of GINI became significant in the second period, and the response intensity reaches the maximum value (0.012) in the 8th period, and the IRF converges to 0 after gradually decaying. The shock response of RPOV showed a fluctuating increase with time and decreased rapidly after reaching the maximum value (−0.002) in the 8th period, and the IRF basically tended to a steady state after the 15th period. Therefore, their IRFs resemble inverted U-shaped or positive U-shaped curves, respectively. The shock response of GDP is a positive V-shape, and the response remains significantly negative, with the maximum value of IRF (−0.006) occurring in the 2nd period. The response of each variable to GINI shock is relatively weak, and only RPOV has a significant short-term negative response to GINI shock. Similar to the empirical results from a national perspective, the RPOV shock has a significant positive impact on IFI, the IRF reaches a maximum value (0.181) in the 6th period, and then, the IRF tends to 0 after gradually weakening in the 5th to 15th period. The response of GINI to RPOV shocks remained negative in periods 1-2, but shifted to a positive effect that first enhanced and then weakened in periods 3–15, and its maximum value (0.035) occurred in period 10. This means that the responses of IFI and GINI to poverty shocks are both inverted U-shaped

relationships. On the contrary, GDP has a significant negative response to RPOV shock, with a maximum value (−0.017) occurring in the 6th period, and its IRF exhibits a positive U-shape and returns to steady state in the long run. In addition, GDP shock has a significant negative effect on IFI, with IRF showing a positive U-shape and reaching a maximum (−0.141) in the 4th period. The impact of GDP on GINI is positive at the beginning of the shock and turns negative at the beginning of the second period, its IRF reaches the maximum value (−0.027) in the 9th period, and the IRF also shows a positive U-shape. The impact of GDP on RPOV was negative in periods 1-2 and positive in periods 2–15, and the maximum value of IRF (0.003) occurred in period 10. Therefore, given that the IRF in the eastern region is mainly U-shaped or inverted U-shaped, we believe that there is a significant dynamic nonlinear relationship between the variables.

The above results show that the development of financial inclusion is effective in promoting poverty alleviation in the eastern region, but it also has a negative impact on income inequality, which further supports the views of Gutiérrez-Romero and Ahamed [30]. The existing literature generally suggests that financial inclusion can improve income inequality [108], but we believe that the development of financial inclusion exacerbated income inequality in eastern China. This result also verifies the previous research conclusions of Huang and Zhang [57] that the development of financial inclusion has amplified income inequality in China

in the short term. In addition, economic growth in the eastern region inhibits the development of financial inclusion and promotes long-term poverty, indicating that financial inclusion and economic growth are not coordinated to play a role in poverty alleviation, which is contrary to the conclusions of Qian et al. [60]. One of the reasons is that China's economic reform has spatially nonequilibrium characteristics, prioritizing the development of the eastern region's economic level and financial inclusion and lowering the threshold for the transfer of labor from traditional sectors to modern industrial sectors; income inequality will widen as the share of modern industrial sectors rise [109]. Secondly, China's financial inclusion system is still dominated by state-owned institutions, but it is difficult for the target group served by state-owned banks to move down to the poor. Information asymmetry may lead to the phenomenon of "financial exclusion" in a financial inclusion policy, leading to the group with capital needs being unable to benefit from financial services [20, 59]. Some scholars believe that financial exclusion will not only widen the income gap [11], but even have a depressing effect on economic growth [59]. Therefore, while maintaining rapid economic growth, the eastern region should establish a diversified supply channel of financial inclusion to reduce the negative impact of financial exclusion, which is crucial to promoting regional poverty alleviation and economic growth.

Figure 4 shows the results of the IRF analysis for the central region. As can be seen, GINI does not show a significant response when shocked by one standard deviation of IFI, but RPOV has a significant negative response to this shock. After being shocked by one unit of IFI, the RPOV will have a gradually increasing negative response, and the IRF will reach the maximum value (−0.002) in the 7th period, and then, the effect will gradually weaken and converge to 0 in the long run. Similarly, the response trend of GDP to IFI shock is basically consistent with that of RPOV, and their IRF shows a U-shaped curve. However, for the shock of one standard deviation of GINI, IFI only produced significant positive responses in the first two periods; then IRF converged rapidly. On the contrary, GDP rapidly produced a negative response and the response amplitude continued to expand, reached the maximum value (−0.005) in the first period, and then gradually weakened; IRF showed a V-shaped curve. Interestingly, although the response of GINI to its own shock was always positive during period 1–10, IRF showed a decreasing trend from strong to weak, which means that GINI has a long-term inertia effect. The RPOV shock in the central region still has a significant positive impact on IFI, the maximum response amplitude (0.056) appeared in the 5th period, the IRF gradually increased before the 5th period, and the IRF gradually weakened after the 5th period, until the effects begin to disappear after the 13th period. In addition, the RPOV shock had a significant positive impact on GINI and had a significant negative impact on GDP, and the IRF presented a positive U-shape and an inverted U-shape, respectively, indicating that the response amplitudes increased first and then decreased with time, and the maximum values

appeared in period 8 (0.006) and period 6 (-0.005), respectively. The response of RPOV to its own shock is U-shaped. Before the 5th period, it mainly has a positive effect, but after the 5th period, it mainly has a negative effect. The IRF gradually converges to 0 after the 17th period, indicating that poverty also has a strong inertial effect. Finally, when shocked by one standard deviation of GDP, the IFI and GINI have a significant short-term negative response to the shock, and their IRFs both exhibit the characteristics of a V-shaped curve with their respective maximum values (−0.051 and −0.014) both appearing in the first period. Although GDP shocks have a significant positive effect on RPOV, the IRF immediately generates a significant positive response and declines sharply in the first period. After the second period, the IRF begins to show an inverted U-shaped relationship, which gradually converges to 0 after reaching the maximum value in the sixth period. Overall, the empirical results in the central region are basically consistent with those in other regions.

The above empirical results still support the theoretical mechanism that financial inclusion development helps poverty alleviation, which is consistent with the direction of influence in the national and eastern regions. Research shows that there are obvious differences in the level of financial inclusion and poverty among different regions in China [5], and there is a significant negative relationship between the level of financial inclusion and poverty in the eastern and central regions [110]. However, the dynamic relationship between financial inclusion development and poverty alleviation in the central region shows a long-term impact, which is no different from the mid- and long-term impacts in the national and eastern regions. A possible reason is because the Rise of Central China Plan started in 2004 and has transferred a large amount of funds to the central region to support economic development, which has improved the level of financial inclusion in the central region [13]. Income inequality and poverty levels in the central region are at moderate levels in all regions, and the relative balance between financial inclusion and economic development makes the short-term poverty alleviation effect of financial inclusion more obvious. The effect of financial inclusion on income inequality in the central region is not significant, which is consistent with the findings of Park and Mercado [14], who point out that it is questionable whether financial inclusion in developing Asian countries (especially China) has any inhibitory effect on income inequality. Furthermore, economic growth in the central region helps reduce income inequality, a finding which supports the main conclusions of Hailemariam et al. [84], who examined the determinants of income inequality and argued that economic growth leads to a significant reduction in income inequality. Overall, the improvement of income inequality in the central region primarily depends on the path of economic growth, while financial inclusion mainly plays a role in poverty alleviation. In the future, government departments should pay attention to the breadth and depth of financial inclusion development, and actively guide the flow of funds among different income groups, so that financial inclusion can also form a supporting role in reducing income gaps.
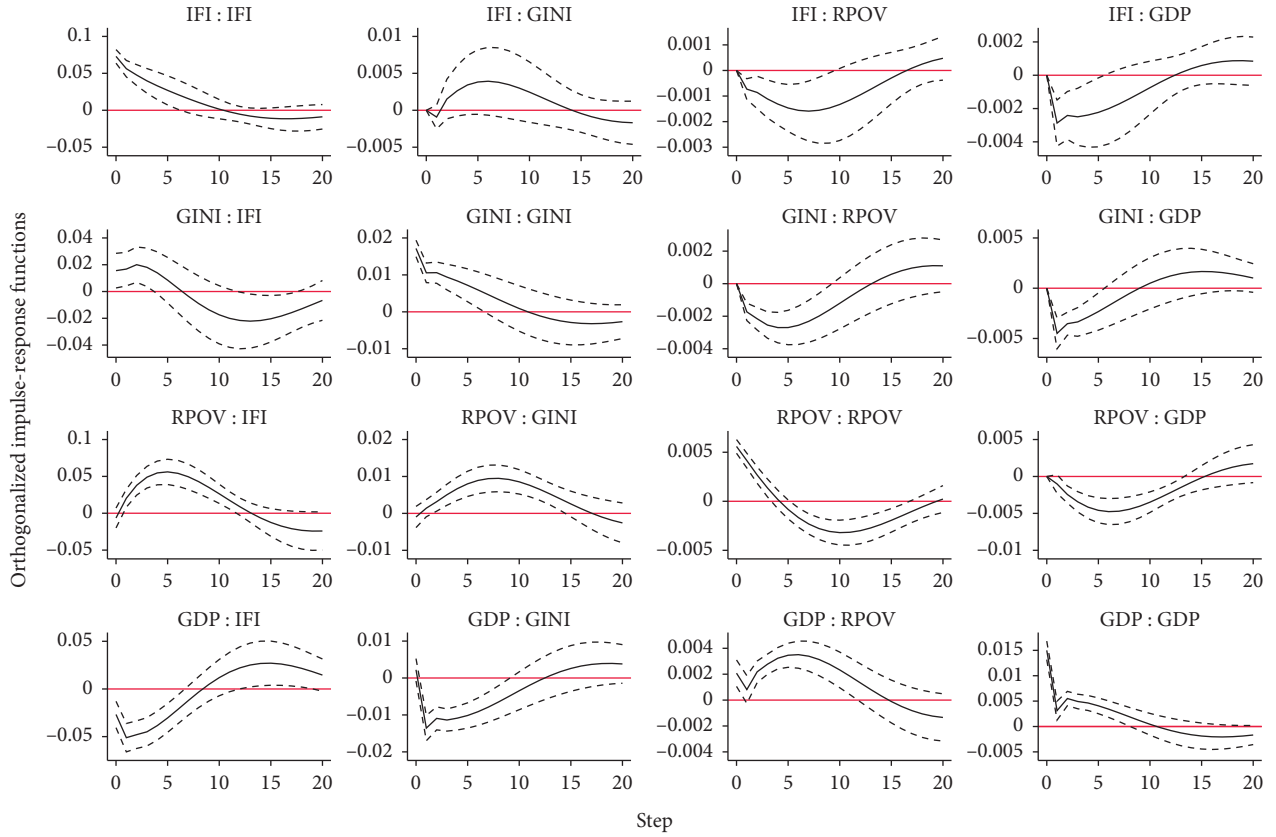
Figure 4: Impulse response function in the central region.
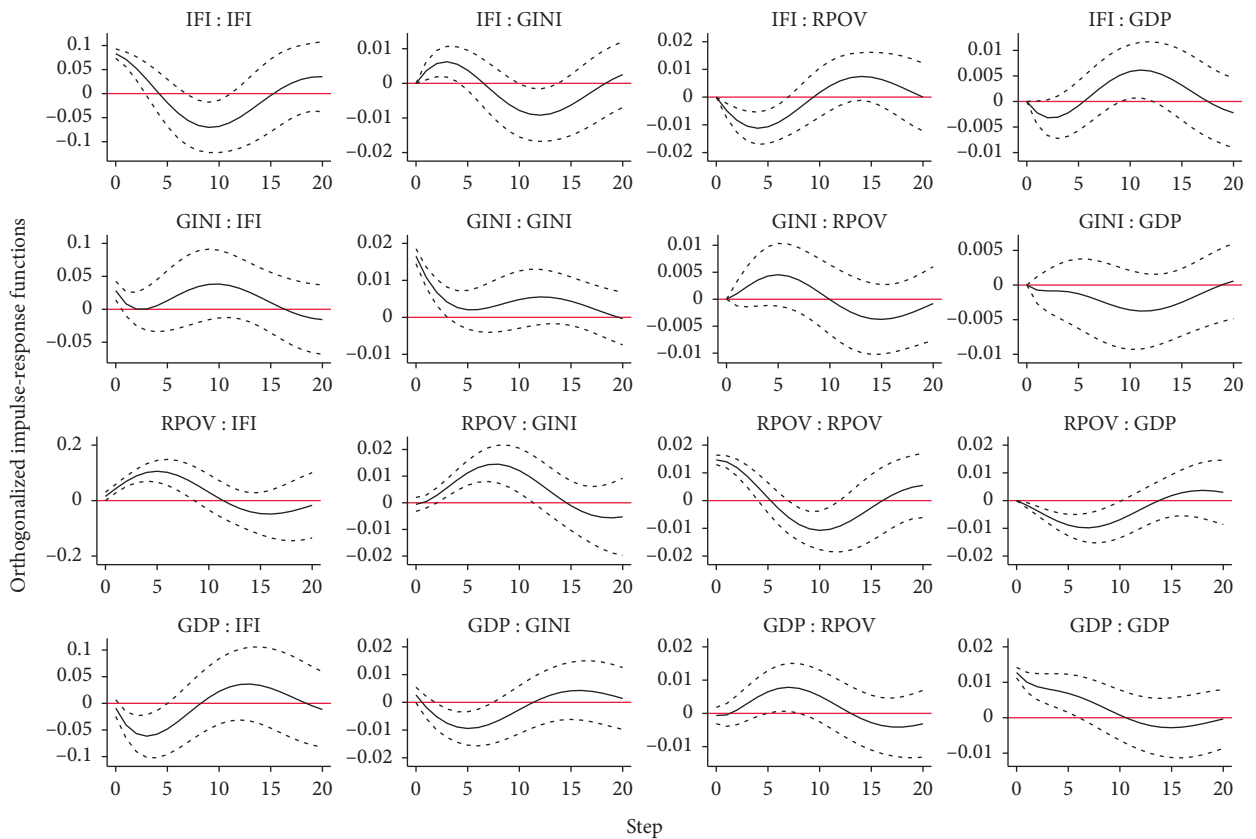

Figure 5: Impulse response function in the Western region.

Figure 5 shows the IRF of various variables in the western region to external shocks. RPOV still has a significant negative response to the IFI shock. Specifically, the impact of IFI on RPOV has a positive U-shape, reaching a maximum (−0.011) in the 4th period after the shock and then gradually weakening the response range. IFI has a significant positive effect on GINI, and the impulse response curve exhibits an inverted U-shaped short-term characteristic, which is highly consistent with results across the national, eastern, and central regions. Similar to the results in the national and eastern region, we found no evidence that the GINI shock led to changes in GDP and RPOV, which only had a transient-positive effect on themselves. After being shocked by one standard deviation of RPOV, in addition to a certain inertial impact on itself, IFI shows a significant positive response, the IRF reaches a maximum value (0.106) in the 5th period, and then, the response amplitude gradually decays, and the effect disappears after the 9th period. Therefore, the effect of RPOV on IFI and GINI is also inverted U-shaped, which is completely consistent with the empirical results in other regions. Another result is that the influence of RPOV on GDP shows a positive U-shaped curve, but it always remains negative in period 1–14, and the maximum value (−0.010) appears in period 8; this conclusion is also very robust. Finally, for IFI and GINI, when they were impacted by one standard deviation of GDP, they both immediately had a significant negative impact in the 1st period. The maximum value of the IFI response (−0.062) appeared in the 3th period, while the maximum value of the GINI response (−0.009) appeared in the 5th period; IRFs all show a positive U-shaped relationship. However, their IRFs were insignificant in periods 6 and 7, respectively, implying that the impact on GDP was short-term rather than permanent. Furthermore, RPOV only had a short-term positive response to the GDP shock in the 7th period. Although IRF was confirmed to be significant by the confidence interval, this effect was basically negligible. Therefore, we believe that the interaction of variables in the western region is mainly nonlinear.

In summary, financial inclusion development in the western region has effectively promoted poverty alleviation, but it has also widened income inequality to a certain extent. This conclusion remains robust under different regional samples, indicating that the mechanism of using financial inclusion to alleviate poverty is in line with China's economic development reality. Combined with the previous analysis, we also found that financial inclusion development in the western region has a stronger impetus to poverty alleviation, while economic growth has a significant inhibitory effect on income inequality. We did not find evidence in the previous literature that the miracle of poverty alleviation in China stemmed entirely from market-led economic growth [83], but that does not mean that we should deny the role that economic growth plays in tackling poverty. This is because poverty issues are often intertwined with issues such as income distribution and poverty alleviation policies, the poverty alleviation elasticity of economic growth changes dynamically in different periods, and the ultimate poverty alleviation effect will

gradually weaken over time [79]. When the internal income gap is relatively serious, the poverty alleviation effect of economic growth will be greatly limited; that is, economic growth will not spontaneously benefit poor groups [111]. In addition, financial inclusion development did not have an impact on the economic growth of the western region, which is different from the conclusions of some scholars that financial inclusion contributes to economic growth [59]. In fact, if the development of financial inclusion only focuses on solving the contact exclusion of the poor—but cannot alleviate the use exclusion of key financial services such as credit funds—then the development of financial inclusion will not necessarily promote regional economic growth [35]. Therefore, in China's strategy to prevent the return of poverty, government departments should shift resources and policy focus to income inequality, and should no longer rely on the trickle-down effect of economic growth. Financial inclusion can become an important means of poverty governance in the future. The premise is to provide financial products that meet the needs of poor groups, to truly give full play to the inclusiveness of financial funds.

4.5. Analysis of Variance Decomposition. In order to investigate the impact of IFI, GDP, and GINI on RPOV, based on the impulse response analysis, this study further uses the variance decomposition (FEVDs) method to obtain the variance contribution rates of the impulse responses of different equations to the fluctuation of endogenous variables. Referring to the practice of Hailemariam et al. [84], we set the forecast period of variance decomposition to 10 years, and the results are shown in Table 5. At the national level, the fluctuation of RPOV in the first period was mainly caused by itself and GDP. The contribution rate of GDP was 2.4%, and the contribution rate of RPOV was as high as 97.6%. Later, it gradually decomposed into other variables. The fluctuation of RPOV in the tenth period was caused by itself and IFI. The contribution rate of RPOV was still as high as 62.8%; the contribution rate of IFI increased to 28.2%, and the contribution of GDP and GINI was relatively weak. From a regional perspective, the contribution rates of RPOV in the first period of the eastern, central, and western regions were 96%, 87.9%, and 99.8%, respectively, and the contribution rates of GDP in the same period were 4%, 12.1%, and 0.2%. Over time, the contribution rates of RPOV in the tenth period dropped to 81.8%, 36.7%, and 65.1%, and the contribution rates of IFI rose to 6.8%, 7%, and 31.8%. RPOV in each region is the main factor leading to its own changes throughout the forecast period, but the contribution of IFI has gradually increased over time. As mentioned above, on the one hand, the poverty problem has strong inertia, and the solution to the poverty problem requires a long-term process. On the other hand, financial inclusion has a time lag effect when it plays a role in poverty alleviation; that is, financial capital investment needs to go through a certain period before it can be transformed into the welfare of the poor. Finally, by comparing the mean values of variance contribution rates, we find that there is cross-regional

TABLE 5: Variance decomposition results of RPOV.

Period	GDP	RPOV	GINI	IFI
National				
1	0.024	0.976	0.000	0.000
2	0.014	0.940	0.016	0.029
3	0.011	0.886	0.025	0.078
4	0.009	0.825	0.026	0.139
5	0.010	0.762	0.025	0.204
6	0.013	0.704	0.023	0.260
7	0.019	0.659	0.023	0.298
8	0.029	0.632	0.026	0.313
9	0.040	0.624	0.032	0.305
10	0.051	0.628	0.039	0.282
Mean	0.022	0.764	0.024	0.191
Eastern				
1	0.040	0.960	0.000	0.000
2	0.057	0.925	0.006	0.012
3	0.055	0.912	0.014	0.018
4	0.064	0.888	0.020	0.028
5	0.089	0.849	0.023	0.040
6	0.124	0.802	0.023	0.051
7	0.162	0.757	0.021	0.059
8	0.196	0.721	0.018	0.065
9	0.223	0.694	0.016	0.067
10	0.243	0.676	0.014	0.068
Mean	0.125	0.818	0.016	0.041
Central				
1	0.121	0.879	0.000	0.000
2	0.087	0.851	0.053	0.009
3	0.131	0.749	0.103	0.017
4	0.190	0.628	0.154	0.027
5	0.251	0.518	0.193	0.038
6	0.299	0.438	0.215	0.048
7	0.332	0.388	0.224	0.056
8	0.350	0.365	0.223	0.062
9	0.357	0.360	0.216	0.067
10	0.357	0.367	0.207	0.070
Mean	0.248	0.554	0.159	0.039
Western				
1	0.002	0.998	0.000	0.000
2	0.001	0.942	0.002	0.054
3	0.002	0.844	0.010	0.143
4	0.012	0.730	0.022	0.236
5	0.033	0.620	0.036	0.312
6	0.062	0.531	0.047	0.359
7	0.095	0.474	0.055	0.376
8	0.125	0.449	0.057	0.368
9	0.147	0.452	0.056	0.345
10	0.159	0.471	0.052	0.318
Mean	0.064	0.651	0.034	0.251

The values in the table are the results of 1000 simulations using the Monte Carlo method. Due to space limitations, only the variance decomposition results of the RPOV variables are reported in the table.

heterogeneity in the dynamic effects of endogenous variables on poverty alleviation. The intensity of the impact of IFI on RPOV is followed by the western region (25.1%), eastern region (4.1%), and central region (3.9%); the impact on GDP is followed by the central region (24.8%), eastern region (12.5%), and western region (6.4%); the impact on GINI is followed by the central region (15.9%), western region (3.4%), and eastern region (1.6%). Overall, China's financial

inclusion development system is still in its infancy, and there is still much room for expansion in the depth and breadth of financial inclusion development.

4.6. Robustness Check. In previous empirical results, the relationship between IFI and RPOV maintained a consistent conclusion, which can be regarded as robust to a certain

extent. However, although the PVAR model does not need to consider potential endogeneity issues, it treats all variables in the system as endogenous variables, resulting in empirical results that may be affected by the ordering of endogenous variables. Specifically, the orthogonalized IRF values may change due to the order of the endogenous variables in the Cholesky decomposition, and the variables ranked in the front will have a shock to the variables in the rear, but the variables in the rear may only affect the variables in the front, causing the final shock effect to lag by one cycle. Therefore, Abrigo and Love [80] suggested re-ordering endogenous variables in the PVAR model based on the results of the Granger causality test, and performing robustness tests on the results of the IRF and variance decomposition. Based on this, we found that there is a complex reverse causal relationship between endogenous variables, and it is still impossible to determine the lead-lag order of variables. Finally, this article re-establishes the PVAR model following the component order under poverty decomposition theory; that is, the variable order is set as GINI $\longrightarrow$ GDP $\longrightarrow$ IFI $\longrightarrow$ RPOV. The results of the robustness test are shown in Figure 6. Due to space limitations, Figure 6 only reports the IRF of IFI to RPOV in each region and the variance decomposition results of RPOV (we have not reported all the robustness test results, which are retained by the authors for request). From the impulse response graph, we can see that the response amplitudes of the national, eastern, central, and western regions are highly consistent with previous results, and the direction of the impact has not changed. From the variance decomposition diagram, RPOV is still the main factor causing its own fluctuations, and the contribution of IFI gradually increases over time and the impact of IFI on RPOV in the western region is still the highest. In summary, the empirical results of this article are robust.

5. Time-Varying Nonparametric Estimates

The point estimates from the PVAR model help identify the average impact of endogenous explanatory variables on RPOV, but the regression coefficient cannot capture the difference in the impact of financial inclusion policies before and after the Chinese government's official inclusion of the support program in 2015. Although some scholars have tried to compare the impact difference at different time points through IRF, such as applied data from the pre- and post-COVID-19 periods to discuss the impact of oil prices on the stock market [105]. But as we have discussed in Section 3.2, some scholars have questioned this research design. According to Chai et al. [112], standard PVAR models with fixed parameters only allow nonlinear effects between variables to be described by IRF, provided that the regression coefficients do not change over different periods of IRF. However, the results of the IRF may be inaccurate due to the time-varying state of the variables. Therefore, we re-estimated the time-varying effects of endogenous explanatory variables on RPOV using the LLDVE-based NP-TVP method and obtained the standard errors of the time-varying regression coefficients using the Monte Carlo simulation

(1000 times) method. Figure 7 shows the time-varying nonparametric estimation results of RPOV by IFI, the gray range represents the 95% confidence interval of the time-varying regression coefficient, and the dashed line in the figure represents the key node in 2015; because the financial inclusion develops vigorously after China's State Council's "Government Work Report" in 2015, we are more concerned with the time-varying effect of IRF on RPOV in this article. We found that the effect of IFI on RPOV remained negative at the national level and in the eastern, central, and western regions, and the confidence intervals of the regression coefficients did not contain 0 in most years, indicating that the effect of IFI on RPOV was statistically significant.

As shown in Figure 7, the estimation results of NP-TVP not only confirmed that the influence of IFI on RPOV was time-varying, but also meant that the influence of IFI on RPOV was nonlinear in each region. Specifically, from a national perspective, the impact of IFI on RPOV was −0.003 in 2004, and the absolute value of the regression coefficient reached its maximum value (−0.021) in 2015. The marginal effect of IFI has been increasing until 2015, and after 2015, the marginal effect value has resumed a gradual downward trend. In the eastern region, the minimum value of the impact of IFI on RPOV (−0.002) also occurred in 2004, and although there was a slight fluctuation in the value of the marginal effect of IFI in the first 3 years, the marginal effect then rose rapidly and reached a maximum value (−0.008) in 2013; after 2015, its marginal impact resumed the trend of gradual attenuation. For the central region, the marginal impact of IFI on RPOV also showed a trend of increasing first and then decreasing. The minimum value of the absolute value of the regression coefficient (−0.004) appeared in 2004 and reached the maximum value (−0.020) in 2013. In the western region, the trend of the marginal impact of IFI on RPOV is completely consistent with that of other regions. The absolute value of the regression coefficient was the smallest (−0.003) in 2004, and the maximum value (−0.037) of the marginal impact appeared in 2016. Therefore, the results of NP-TVP imply that the influence of IFI on RPOV presents a positive U-shaped feature, which is consistent with the conclusion obtained from IRF within the framework of PVAR. Interestingly, this article finds that around 2015 may be an inflection point for the marginal impact of IFI on RPOV. In other words, the marginal impact of IFI has been increasing until 2015, and the marginal impact of IFI has been decreasing after 2015.

Based on the opinions in the previous literature, we believe that there may be three reasons for the above changes. Firstly, an important factor is that the Chinese government has been accelerating progress of achieving the poverty control target. Since reform and opening-up in 1978, the Chinese government has been working hard to eradicate poverty. For example, the poverty rate dropped from 94% in 1981 to 4% in 2014 [113]. Especially in the last 20 years, the eradication of absolute poverty by 2020 has become a task that governments at all levels must complete and before 2015 is a critical period for poverty governance. Local officials will use various administrative measures or political resources to speed up the poverty governance process [114], and specific
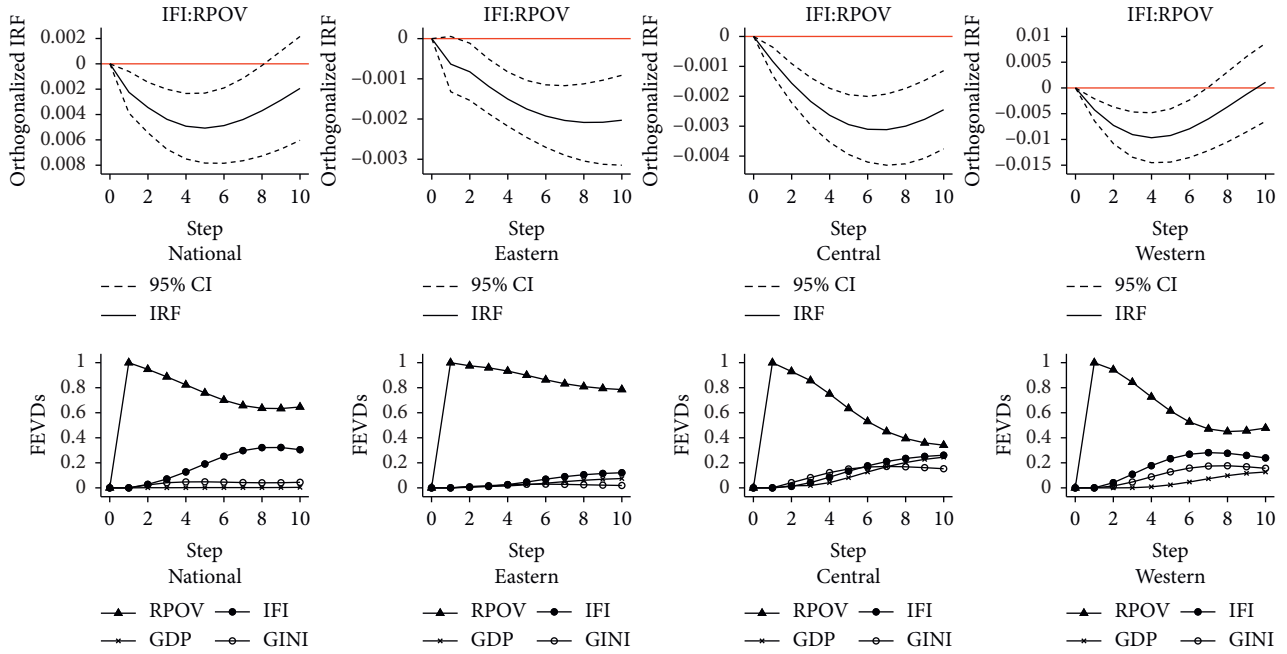
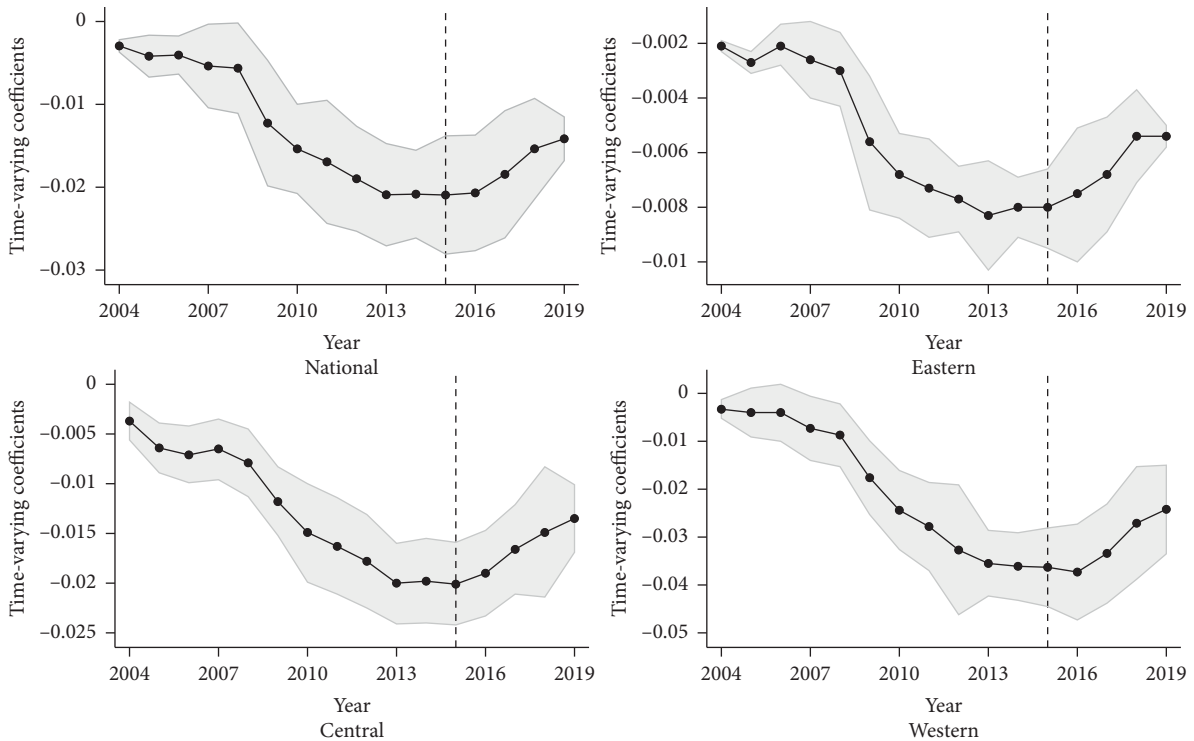FIGURE 6: Robustness test (adjusting variable order).

FIGURE 7: Nonparametric time-varying coefficient estimation results.

poverty alleviation measures include vocational education and training, helping cadres' residencies in impoverished villages, microfinance, and poverty alleviation resettlement [115]. Therefore, the speed of poverty alleviation continued to accelerate before 2015, which also means that any poverty reduction path may effectively release the poverty reduction effect. Secondly, the State Council proposed to vigorously develop inclusive finance late, so it is difficult to produce obvious policy effects in the short term. Although China's, the State Council's "Government Work Report" in 2015 programs to vigorously develop financial inclusion, but financial inclusion has been widespread in China in various

forms. In fact, as described in our review of the literature, the United Nations advocated for governments to implement financial inclusion systems as early as 2005. However, China only officially included financial inclusion in the official document in 2015, and the full release of the policy effects usually takes some time. In addition, due to the sharp decline in the number of poor people in China after 2015, even if inclusive finance welcomes new development opportunities, the marginal effect on poverty will be difficult to show. Therefore, the policy effects of financial inclusion may be more pronounced in other ways, such as its role in promoting household consumption and diversity of consumption, which have been documented in the literature [116–118]. Finally, some scholars have tried to use the marginal utility theory to explain the impact of IFI on RPOV. They believe that the marginal impact of IFI on RPOV essentially increases first and then decreases [119, 120], similar to the Kuznets curve in development economics. However, to the best of our knowledge, these views are based on theoretical analysis. This article uses PVAR and NP-TVP methods to carry out empirical analysis from a nonlinear perspective, which further verifies the rationality of these conclusions.

6. Conclusions

Based on the poverty decomposition theory, this study puts financial inclusion development, economic growth, income inequality, and poverty alleviation in a unified PVAR model analysis framework and uses the balanced panel data of 30 provinces in China from 2004 to 2019 to reveal the direction and intensity of the impact of various factors on poverty alleviation in the different regions of China. The research findings are as follows. Firstly, financial inclusion development in China has a significant role in promoting poverty alleviation. This conclusion has strong robustness in empirical analysis in different regions, indicating that the mechanism of using financial inclusion to promote poverty alleviation is in line with the reality of China's economic development. Secondly, in general, the poverty problem shows strong inertia over time. During the inspection period, the role of economic growth in poverty alleviation is relatively limited, and financial inclusion development is the factor that contributes the most to poverty alleviation. Thirdly, the nonlinear linkage effect among the factors is significant. Financial inclusion development has a positive U-shaped impact on poverty alleviation and an inverted U-shaped impact on income inequality, indicating that the poverty alleviation effect of financial inclusion has the law of diminishing marginal utility. Fourth, there is spatial heterogeneity in the impact of financial inclusion and economic growth on poverty alleviation. Financial inclusion development has the strongest effect on poverty alleviation in the western regions, while the improvement effect of economic growth on poverty alleviation is more significant in the central and eastern regions, reflecting

that each region has different economic paths in achieving poverty alleviation. Finally, although the development of financial inclusion can effectively promote poverty alleviation, income inequality offsets part of the poverty alleviation effect. In the future, financial inclusion policies must pay more attention to the benefits of poor groups.

Based on the above research conclusions, this article proposes the following policy implications. Firstly, actively promote the formation of stable policy goals for China's financial inclusion service system. Financial inclusion policies should strictly implement the targeting of small and microenterprises, farmers, urban low-income people, poor people, disabled people, the elderly, and other special groups and build a financial inclusion system that is beneficial to the poor through the guidance of the government and the market, so that the financial system is gradually adjusted and improved considering the policy effects. In practice, it is necessary to avoid the target deviation caused by the "financial exclusion" problem under complete market dominance and to also prevent the risk of financial asset loss that may be caused by excessive government intervention. Secondly, broaden the supply channels of financial inclusion products and services. China's financial inclusion system is still dominated by state-owned banks. Due to the limited repayment ability of poor groups, traditional credit channels have been unable to meet market demand. Policy departments should encourage banks and other formal financial institutions and private informal financial institutions to innovate financial service models, develop new products, such as microfinance and Internet finance, and promote digital service methods, such as "online intelligent approval," to improve financial inclusion. Thirdly, the policy orientation on poverty governance should focus on improving income distribution. It is worth noting that the contribution of economic growth to poverty alleviation in the western regions has weakened, and general economic growth has been unable to play a role in poverty alleviation. While stabilizing economic growth, government departments must not only promote the transformation of the growth mode to a type of economic growth that benefits the poor, but must also correct the discriminatory allocation of funds between the rich and the poor, and reduce the negative impact of income inequality on the effectiveness of financial inclusion in poverty alleviation. Finally, implementation of a differentiated financial inclusion development strategy. For the economically underdeveloped central and western regions, the focus should be on improving the breadth of financial services, focusing on improving the penetration and convenience of financial services by increasing the delivery of various financial service points. For the economically developed eastern region, more attention should be paid to improving the utility of financial services, strengthening the ratio of financial services to poor groups by formal institutions and ensuring that poor groups can obtain the financial services they need in a reasonable way. Essentially, promoting the financial inclusion system according to local conditions and paying attention to improving institutional

conditions will help China's economy develop in a balanced way, improve income inequality, and realize a poverty alleviation path that takes into account fairness and efficiency.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Authors' Contributions

Z. Chen and H. Zhu conceived the study. Z. Chen helped with the methodology and software. Z. Chen, H. Zhu, B. Cao, and W. Zhao validated the study. Z. Chen performed the formal analysis. B. Cao and Y. Cai investigated the study. H. Zhu helped with resources. Z. Chen, Y. Cai, and W. Zhao curated the data. Z. Chen prepared the original draft of the manuscript and reviewed and edited the manuscript. Z. Chen, W. Zhao, and B. Cao carried out visualization. H. Zhu supervised the study and helped with project administration and funding acquisition. All the authors have read and agreed to the published version of the manuscript.

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