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Analysis of China's policy effect on poverty alleviation: evidence from Chongqing in the Three Gorges Reservoir Region

Min Zhu[1] · Chuanmin Shuai[1] · Xiaoyan Wang[2] · Zhihui Leng[1] · Fan Zhang[1]

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Abstract
With the continuous socio-economic development, the Chinese government has readjusted its poverty alleviation and development strategies, and established the targeted poverty alleviation policies in an attempt to holistically build a well-off society. Based on the panel data of nine national poverty-stricken counties (districts) in Chongqing in the Three Gorges Reservoir Region from 1998 to 2015, this paper quantitatively analyzed the effect of the national poverty alleviation policies in the context of targeted poverty alleviation by adopting the methodologies of a break-point regression and a panel regression. The results show that: (1) The national policy for targeted poverty alleviation has a significant effect on poverty reduction, and this effect has manifested since the beginning of its implementation, i.e. the net income of farmers in 2012 increased by 12.41%, as against that during 2010–2011. The per capita net income of farmers has increased by 33.64% from 2011 to 2015 during the implementation period of the targeted poverty alleviation policy, as against that during 1998–2010. The policy effect during 2011–2015 is also evident, for the net income of farmers increased by 21.23% compared with that from the beginning of the policy implementation in 2012; (2) Economic activity of the market and gross value of agricultural product in the poverty-stricken areas have significantly increased farmers' net income, specifically, for every 1% increase in the degree of market economic activity, farmers' net income will increase by 48.74%; Furthermore, for every 1% increase in gross value of agricultural product, the farmers' net income will increase by 3.7%. Finally, this paper proposed corresponding policy recommendations based on these findings.

Keywords Targeted poverty alleviation · Policy effect · Breakpoint regression · China · Three Gorges Reservoir Region in Chongqing

✉ Chuanmin Shuai
shuaicm@cug.edu.cn

Extended author information available on the last page of the article

1 Introduction

Poverty is a worldwide problem relating to social stability and sustainable development. How to eliminate extreme poverty has always been a common concern of all countries in the world. Fighting against extreme poverty is an important measure to realize mutual-share development and a holistic well-off society in China. The Chinese government has been exerting great efforts to help the poor rise out of poverty through economic development. On December 6th, 2011, the State Council Leading Group Office of Poverty Alleviation and Development officially released the Outline for Poverty Alleviation and Development in Rural China (2011–2020). The Outline pointed out that the issue of subsistence food and clothing for rural residents has been solved; Therefore, the focus of poverty alleviation has shifted from the stage of solving the problem of food and clothing to a new stage, at which it is aimed to consolidate the achievement of food and clothing, speed up poverty alleviation, improve the ecological environment, enhance and develop the capability of the poor population, and narrow the gap between the rich and the poor. On the basis of the issues to be addressed in the new stage, the Chinese government has formulated new poverty alleviation policies known as the targeted poverty alleviation policies. As a result of the execution of the country-wise new policies, China has achieved a great progress in poverty reduction during this period. By the end of March 2017, the remaining population in poverty stricken areas is about 40 million.

"Targeted poverty alleviation" was first proposed in November 2013 when China's general secretary Xi Jinping visited Hunan Province. In June 2015, Xi emphasized the necessity to scientifically plan for poverty alleviation and development in the "National 13th Five-Year Plan" period so as to ensure that the poor can be lifted out of poverty as scheduled by 2020. Since then, "Targeted Poverty Alleviation" has become a hot topic in China. The core essence of the targeted poverty alleviation policy lies in changing the extensive scope in the past and fine-tuning measures at the household level to help the poor. Targeted Poverty Alleviation aims at different poverty-stricken households and impoverished areas. The strategy uses differentiated and effective ways to precisely identify targets and implement accurate help, management, and assessment. Therefore, the goal is to guide the optimal allocation of various types of resources for alleviating poverty in poor villages and gradually build a long-term mechanism for poverty alleviation and poverty eradication. In 2011, the Chinese government substantially raised the poverty line (i.e., annual per capital net income of 2300 Yuan). "The number of poor people under the new poverty line was 122 million in 2011, which has reduced to 55.75 million by 2015, meaning that 66.36 million poor people had been lifted out of poverty in the past five years" (Wang and Liu 2016a, b).

Located in the Qinba Mountains, the Three Gorges Reservoir Region lies in the deep hinterland of inland China, where poverty alleviation and contiguous development are conducted. Given its poor natural conditions, the Three Gorges Reservoir Region belongs to a remote mountainous and poverty-stricken area, with the features of self-sufficiency and low agricultural productivity. Located in the heart of the Three Gorges Reservoir Region, Chongqing covers almost all the state-level poverty-stricken counties in this reservoir region, and it has always been the main battlefield for poverty alleviation in China.

What is the effect of targeted poverty alleviation policy? Is there any significant effect on poverty-stricken counties in Chongqing in the Three Gorges Reservoir Region? How effective is the policy at the beginning? What is the long-term effect of policy implementation? What are the main factors influencing the effect of the policy? To address these questions,

we selected the county-level data and used the break-point regression and panel regression. Specifically, in the rest of this paper, after literature review in Sect. 2, we introduced a break-point regression and a panel regression, and then presented the data resource and variable selection in Sect. 3. We tested the stability of the data in Sect. 4, and then, studied the policy effect at the beginning of the implementation of the targeted poverty alleviation though breakpoint regression in Sect. 5. On this basis, we employed a panel regression to study the policy long-term effect during the implementation in Sect. 6. Finally, we analyzed the various factors influencing the policy effect and concluded the paper in Sect. 7.

2 Literature review

2.1 Researches on China's poverty alleviation policies' effectiveness on poverty reduction

Since China's reform and opening-up, the implementation of poverty alleviation policies has promoted poverty reduction in rural China (Zhang and Wang 2013). The implementation of poverty alleviation policies can significantly improve the effectiveness of poverty reduction (Škare and Družeta 2016). Barrett et al. (2017) determined that pro-poor policies resulted in an average increase of 35% in the GDP of sub-Saharan Africa GDP in 2000–2014. Carswell and Neve (2014) determined that the Poverty Alleviation Policy—National Rural Employment Guarantee Scheme can significantly reduce poverty in rural India. The "Endless Poverty Program" in Brazil eliminated hunger and extreme poverty, thereby resulting in a 15% decrease in the Gini index (Paessousa and Vaitsman 2014). Fossati (2016) assumed that pro-poor policies implemented in Indonesia respond promptly to the needs of the most vulnerable and have the most evident impact on the reduction of poverty among low-income families. Akhtar et al. (2015) proposed that the reduction of poverty in Pakistan is due to the government's pro-poor policies. The demand- oriented pro-poor interventions have been considerably effective in reducing poverty. Liu and Zhang (2017) studied the poverty alleviation effect of contiguous development in Hebei Province. The results show that the implementation of the Pilot Project of Contiguous Poverty Alleviation in the Poverty-Stricken Areas is generally effective. That is, the per capita net income of rural residents has increased by approximately 700 Yuan, an increase of 21%. (Wang and Liu 2016a, b) selected sample data from 1978 to 2012 in each of the four provinces of Guizhou, Gansu, Inner Mongolia and Hebei to analyze the policy effects of the "Eight-Seven Poverty alleviation Plan" for all poor counties. The research shows that the overall performances of each area are outstanding.

2.2 Researches on fiscal and monetary subsidies for poverty reduction

Conditional cash transfer programs (CCTs) are an important means of poverty reduction for policies (Saad-Filho 2015). Fiscal policy has the most substantial impact on poverty eradication, and federal social spending can be used to alleviate poverty at key stages of the cycle (Martini et al. 2014). Long-term financial and monetary pro-poor policies have long been beneficial to the poor to get out of poverty (Ali et al. 2017; Balasubramanian 2015; Gangopadhyay et al. 2015). Policy subsidies can significantly alleviate poverty in arid areas (Schulze et al. 2016). Further research by (Llorca-Rodríguez et al. 2017) proposed that the fiscal and monetary pro-poor policies in education, health and housing are more

effective in alleviating poverty and the dispersion of social security spending has exacerbated poverty. Saleem and Donaldson (2016) analyzed cases of poverty alleviation in 15 countries and found that pro-poor policies can improve the effects of poverty alleviation in four aspects, namely, industrialization, rural development, social welfare and employment resulting from oil production. Different poverty alleviation policies should be formulated based on the type of poverty to achieve an improved poverty alleviation effect (Mahadevan et al. 2016). Accordingly, adjustments should be made for future poverty alleviation policies in China in light of the dynamic structural characteristics of rural poverty (Zhang 2013a, b).

2.3 Researches on public poverty alleviation policies for poverty reduction

Apart from fiscal and monetary subsidies for poverty alleviation policies, there are also other poverty alleviation policies. Jia et al. (2017) believed that micro-finance and capital subsidies in pro-poor policies on poverty alleviation had a positive impact on the increase of farmers' incomes in poor villages, whereas the impact of capital subsidies is extremely weak. The implementation of pro-poor public policies has led to a decline in multi-dimensional poverty (Angulo et al. 2016). Public poverty alleviation policies have facilitated the reduction of poverty in ethnic minority areas, but reliance on economic growth alone cannot support poverty alleviation in ethnic minority areas (Li and Jiang 2017). An inherent mechanism of action is present among public policies, agricultural development and poverty reduction effects (Jiang and Liu 2016). Poverty reduction in assets can compensate for the deficiencies of existing income poverty alleviation (Zou and Qu 2017). Mutual aid funds are better for reducing the incidence, depth and the intensity of poverty in the short term than the subsidized loans for poverty alleviation. However, in the long run, the dynamic poverty reduction effect needs further observation (Chen et al. 2017). Good loans have been introduced to alleviate poverty through loans, grants and public works (Rogers 2014). The effect of poverty alleviation through poverty eradication through economic growth is significant (Wang and Gao 2017).

However, poverty alleviation policies are not always effective. Piperata et al. (2016) determined that the anti-poverty policies implemented in Brazil did not alleviate poverty significantly in the Amazon basin. Zhou and Tao (2016) argued that various problems remain in the "Eight-Seven Poverty Alleviation Plan" policy, thereby resulting in less than expected results. In the future, China will promote poverty reduction, further increase the participation of social institutions, promote the free flow of population and strengthen the transfer payment to certain groups. Chen and Shen (2014) analyzed the rural poverty in Tianjin and found that the poverty reduction effect of the government two subsidy policies was not evident among migrant workers and non-agricultural farmers, however, the effect of reducing poverty was apparent among farmers engaged in farming. Wang et al. (2015) argued that the inefficient use of fiscal funds for poverty alleviation has resulted in the inefficiency of pro-poor policies. Li (2014) believed that China's poverty alleviation policies are effective, but inefficient.

2.4 Researches on China's targeted poverty alleviation

Several scholars have studied China's targeted poverty alleviation. Zhang et al. (2013a, b) thought that target deviation in the targeted poverty alleviation policies led to the situation that "poverty-stricken areas" are larger than "poverty-stricken households" through

qualitative analysis. Wang et al. (2016) qualitatively analyzed the targeted poverty-alleviation policies and put forward an innovative path to targeted poverty eradication. Shen and Peng (2016) studied the targeted poverty alleviation policy and chain financing models, and proposed that industrial chain financing has a good overall effect on reducing poverty among farmer households. The proportion of poor households participating in industrial poverty alleviation is higher than that of non-poor households. The benefits of poverty from chain financing also show diminishing marginal revenue.

2.5 Researches on poverty-stricken counties in the Three Gorges Reservoir Region

Other scholars studied the issue of poverty alleviation in poverty-stricken counties in the Three Gorges Reservoir Region from various perspectives. Shuai et al. (2017) constructed a theoretical model of systematic dynamics of ecological poverty reduction in the Three Gorges Reservoir Region, revealing the complicated relations and dynamic feedback mechanism among geological disasters, ecological environment and immigrant poverty. Liu et al. (2017) put forward the countermeasures of poverty in the Three Gorges Reservoir Region from an ecological point of view. Hu and Wen (2015) analyzed the spatial correlation and differences of economic development in the impoverished mountainous areas of the Three Gorges Reservoir Region, and the dynamic mechanism of economic development from an economic and geographical point of view.

2.6 Researches on the break-point regression methodology in the poverty issue

Still other scholars used the break-point regression method to study the poverty issue. Lee (2016) used this method to analyze the effect of the Korean Welfare Work Program on poverty reduction and proposed that the national basic livelihood security system as a welfare work program had a positive effect on reducing labor market participation. Lü (2015) used a break-point regression to investigate the impact of intergovernmental transfers on local education spending in China during the "Eight-Seven Poverty Alleviation Plan" period. The research showed that intergovernmental transfers had not effected the reduction of illiteracy in poor counties. Litschig and Morrison (2013) used break-point regression to estimate the impact of intergovernmental transfer in Brazil on education outcomes and poverty reduction. Brazil's additional transfer payments had increased local government spending per capita by 20% over the past four years, per capita school attendance by approximately 7% and dropped poverty relieve rate by approximately 4%.

The review of the existing literature indicates current scholars studied the poverty issue from the perspectives of ecology and geography in the Three Gorges Reservoir Region. The research on the effect of targeted poverty alleviation policy is conducted mainly from a qualitative point of view. In the study of poverty alleviation policies, scholars analyzed the effects of these policies and different ways of alleviating poverty on poverty reduction. However, a dynamic assessment of the performance of poverty alleviation policies is lacking, especially the dynamic assessment of targeted poverty alleviation policies. Therefore, we selected the panel data from 1998 to 2015 in nine state-level poverty-stricken counties in the Three Gorges Reservoir Region in Chongqing, and conducted an empirical study on the effect of poverty alleviation policies under the national targeted poverty alleviation policies.

3 Research methods and data

3.1 Research methods

This paper has quantitatively analyzed the effect of national poverty alleviation policies in the context of targeted poverty alleviation, by adopting a break-point regression and a panel regression method.

3.1.1 Breakpoint regression

3.1.1.1 The regression discontinuity design Regression discontinuity design is a type of empirical method that can randomly analyze the causality between variables by effectively using the actual constraints. Lee (2008) argued that in the case where randomized experiments were unavailable, break-point regression can avoid the endogeneity of parameter estimation, thereby reflecting the causal relationship between variables. Regression discontinuity design defines the characteristic that the probability of being treated is a discontinuous function of one or a few variables. Hahn et al. (2001) proposed the first hypothesis of break-point regression. If we use the variable d to represent the disposal effect and x to represent the key variables for disposal, then,

$$d^{+} \equiv \lim_{x \to x_0^{+}} E[d_i | x_i = x] \text{ and } d^{-} \equiv \lim_{x \to x_0^{-}} E[d_i | x_i = x]$$

Moreover, $d^{+} \neq d^{-}$must exist. A variable must be present in using break point regression. That is, if the viable is above a critical value, then the individual accepts the disposal; and if the variable is below a critical value, the individual does not accept the disposition. In the break point regression, individuals below the threshold are treated as control groups instead of individuals not being disposed of. The sample differences near the critical value can better reflect the causal relationship between the disposal and other economic variables. Under certain assumptions, Hahn et al. (2001) used certain assumptions to prove that the break point regression can be used to study the causal relationship between the disposition and other economic variables by using the systematic changes of samples near the critical value.

In short, the internal validity of the break point regression is a quasi-test due to the random groupings around the break point. Due to the random grouping, the local average treatment effect (LATE) around $x = 2011$ can be consistently estimated.

$$\text{LATE} \equiv E\left(y_{1i} - y_{0i} | x = 2011\right) = E\left(y_{1i} | x = 2011\right) - E\left(y_{0i} | x = 2011\right)$$

The break point is 2011. Thus:

$$D_i = \begin{cases} 1 \text{ if } x_i \geq 2011 \\ 0 \text{ if } x_i < 2011 \end{cases}$$

Given that the individual has no systematic difference in all aspects around $x_i = 2011$, the only reason for the conditional expectation function $E(y_i | x)$ to jump over is the processing effect of D_i. Thus, this jump can be considered as the causal effect of D_i on y_i at $x = 2011$.

3.1.1.2 Regression discontinuity estimate As the breakpoint regression is a local randomized trial, the observations near the breakpoint in principle are selected for local regression. The range of observations near the breakpoint is a problem to be solved by regression discontinuity estimate.

Breakpoint regression estimate:

$$y_{i,t} = x_{i,t}\beta + \gamma_i t + \delta D_i + \mu_i + \varepsilon_{i,t} \qquad (c-h < t < c+h) \tag{1}$$

where c is the year 2011 of implementation of targeted poverty alleviation policy, and D is a measure of the policy effect at the breakpoint. h represents the bandwidth limited ranges of observations nearby the breakpoint for local linear regression[1]. The range of observation is between $c-h$ and $c+h$.

Given the uncertainty about the rang of h and function form, nonparametric local regression estimate the policy effect of δ. In the nonparametric local regression, the criterion for ascertaining optimal bandwidth entails minimizing the mean square error of the two regressions function at the breakpoint, which was proven by Imbens and Kalyanaraman (2012). That is:

$$m_1(x) \equiv E\left(y_1|x\right), \quad m_0 \equiv E\left(y_0|x\right), \text{ then,}$$

$$\delta = m_1(c) - m_0(c), \quad \hat{\delta} = \hat{m}_1(c) - \hat{m}_0(c),$$

By calculating the formula to get the optimal bandwidth,

$$\min_h \; E\left\{\left[\hat{m}_1(c) - m_1(c)\right]^2 + \left[\hat{m}_0(c) - m_0(c)\right]^2\right\}$$

3.2 Data and variable selection

In this paper, the research object comprises nine state-level poverty-stricken counties in the Three Gorges Reservoir Region in Chongqing, namely: Wanzhou, Fengdu, Wulong, Kaixian, Yunyang, Fengjie, Wushan, Wuxi and Shizhu. The data are selected from the "Chongqing Statistical Yearbook", "Chongqing Rural Statistical Yearbook" and the statistical information from nine counties. The data from 1998 to 2015 are collected for analysis. This paper has analyzed the short-term and long-term effects of the implementation of the targeted poverty alleviation policy, which started to implement in China in 2011.

The statistical characteristics of the main variables (see Table 1) and the mean value of each indicator after the implementation of the targeted poverty alleviation policy show significant differences from the corresponding characteristics and values prior to the implementation of the policy (see Table 2).

Table 2 shows that the mean value of all indicators after the implementation of the targeted poverty alleviation policy is considerably higher than those before the implementation. Moreover, such difference is statistically significant at the 1% level. That is, all indicators have significant differences before and after the implementation of the poverty alleviation policy.

[1] Lee and Lemieuxa (2010) argues that the larger the rang of bandwidth become, the more observations for estimation will present thus, the more accurate estimate results will be get, the greater the bias in the average treatment effect will become. Whereas, if the rang of bandwidth is small, the accuracy of estimate results decreases but the deviation decreases.

Table 1 Statistical characteristics of the major variables

Variable name	Sample size	Mean value	SD	Minimum value	Maximum value
Per capita annual net income of farmers (Yuan per year)	162	3796.073	2575.359	1183	10,729
Forestry, animal husbandry and fishery output value (Million Yuan)	162	243404.4	173691.2	58,494	889,327
Total retail sales of consumer goods (Million Yuan)	162	327474.7	435269.3	23,143	2,879,819

Source calculation results using EViews 8.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

Table 2 Differences in major variables before and after implementation of targeted poverty alleviation policy

Before policy implementation				After policy implementation			Two sample t-statistic
Variable name	Sample size	Mean value	SD	Sample size	Mean value	SD	
Per capita annual net income of farmers (Yuan)	117	2428.146	1238.096	45	7352.682	1521.471	−19.38***
Forestry, animal husbandry and fishery output value (Million Yuan)	117	173020.6	95378.03	45	426402.5	197445.2	−8.25***
Total retail sales of consumer goods (Million Yuan)	117	187993.2	198745.8	45	690126.7	634,724	−5.21***

The *t* test checks the null hypothesis that the variable is equal to the mean value after the implementation of the poverty alleviation policy. Where: *** indicates that the rsults are statistically significant at the 1% level

Source: calculation results using EViews 8.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

The dependent variable in this paper is the per capita annual net income of farmers, which is used to evaluate the effect of the targeted poverty alleviation policy. Many scholars opt for the per capita net income of farmers to assess the effect of pro-poor policies (Wang and Wang 2017; Zhang et al. 2013a, b). In order to facilitate the calculation and reduce the impact of heteroscedasticity, the original data have been logarithmically transformed.

The independent variable, namely, gross agricultural product in impoverished areas and market economic activity in poor areas, represent the macroeconomic indicators that affect the effectiveness of poverty alleviation policies. Liu et al. (2017) used the market economic activity in poor areas as a macro measure of the effectiveness of pro-poor policies. That is, the logarithm of the total retail sales of consumer goods is taken as an index to measure the market economic activity in impoverished areas to reflect the market economic development effects. Moreover, market economic activity reflects a series of market-economy-related development effects, for example, the improvement of production and living standards in poor areas is driven by economic activities including industrial poverty alleviation, finance and entrepreneurship poverty alleviation in poor areas (Liu et al. 2017). Numerous studies verified that the "Gross Agricultural Product in Poverty-Stricken Areas" has positive effects on poverty alleviation (Zhang et al. 2013a, b); Wang and Wang 2017).

4 Data stability test

Econometric theory shows that the nonstationarity problem in panel data structures will change the result of the asymptotic distribution of ordinary least squares (OLS) estimates, thereby leading to false regressions. Therefore, the processing of long-term panel data should entail testing the stability of each variable (unit root test) (Wang et al. 2008). Prior to the panel data regression analysis, a unit root test should be conducted to avoid false regression and ensure data stability (Liu 2011).

4.1 Timing chart of panel sequence

The sequence diagram of the panel is drawn for cursory observation as to whether the broken line of the representative variable from each observation value drawn contains the trend line and/or the intercept term, so as to prepare for further panel unit root tests.

We have conducted the panel time series diagrams (see Figs. 1, 2, 3) for the logarithms of the per capita net income of farmers, gross value of agricultural product and market economic activity respectively.

Figures 1, 2 and 3 show that the intercepts of these variables are not 0, thereby indicating the presence of an intercept term. The graphs show a trend of rapid growth, thereby indicating the existence of a time trend term.

4.2 Panel unit root test

Panel unit root test comprises three test modes, namely both time-term and intercept items, only the intercept, none of the above, by using Eviews 8.0 software. Based on the results from Figs. 1, 2 and 3, we used the test of the time trend and intercept.

Panel unit root tests are divided into (1) individuals containing common unit root tests (assuming that first-order autoregressive coefficients are consistent across all cross-sectional samples) and (2) individuals containing different unit roots (assuming that the

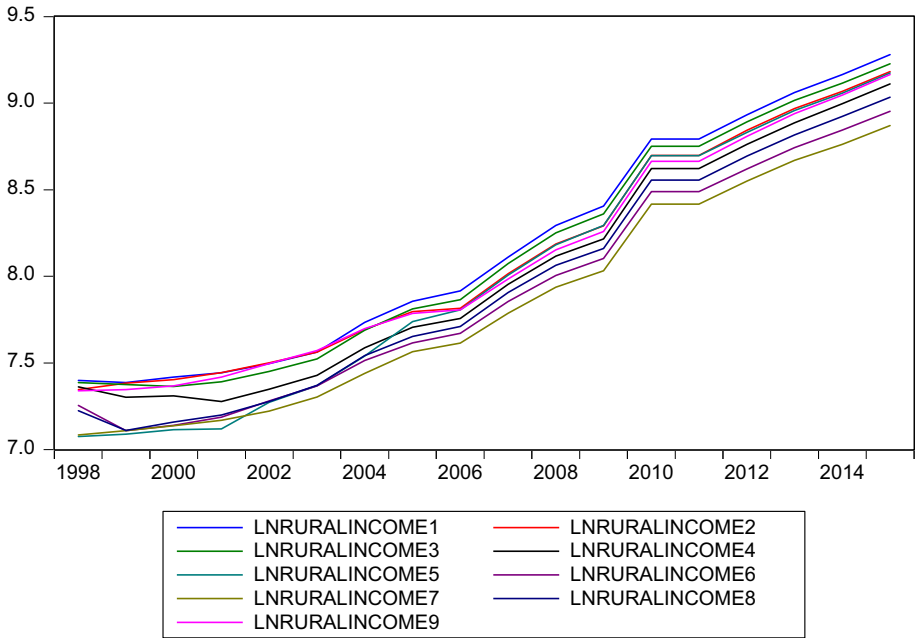

Fig. 1 Panel time series of per capita net income of farmers (logarithm) in impoverished counties. *Note*: A line represents time trend of per capita net income of farmers in an impoverished county of Chongqing. Total number observation is 9

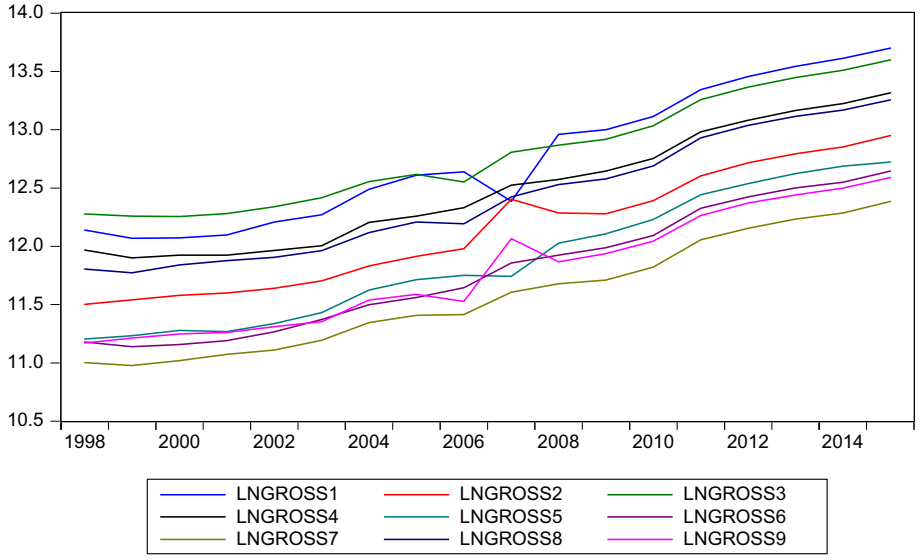

Fig. 2 Panel time series of gross agricultural product (logarithm) in impoverished counties. *Note*: A line represents time trend of gross agricultural product in an impoverished county of Chongqing. Total number observation is 9

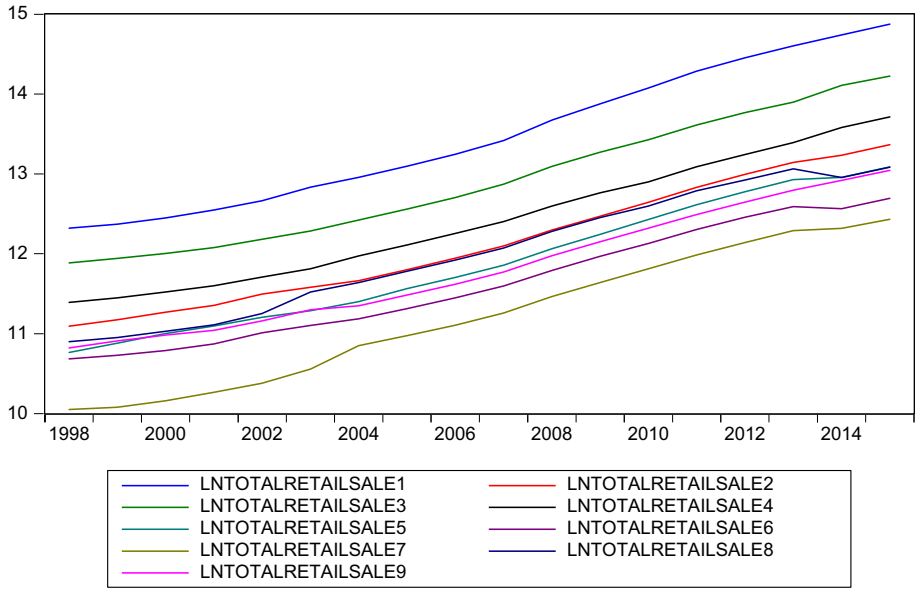

Fig. 3 Panel time series of market economic activity level (logarithm) in impoverished counties. *Note*: A line represents time trend of market economic activity level in an impoverished county of Chongqing. Total number observation is 9

Table 3 Stability test result of the per capita net income of farmers

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−4.71253	.0000	9	153
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−2.82452	.0024	9	153
ADF-Fisher Chi-square	34.7726	.0101	9	153
PP-Fisher Chi-square	41.6988	.0012	9	153

**Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality

Source calculation results using EViews 8.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

coefficients of first-order auto-regressions of different cross-sectional samples can differ). Two types of test methods are employed, that is the same root test method (LLC test) and the different root test methods (IPS test, Fisher-ADF test and Fisher-PP test). Among these methods, LLC, IPS and Fisher-ADF test evaluate their original hypothesis which contains unit root (Ren 2008).

These figures reveal that the variables (logarithms of the per capita net income of farmers, gross value of agricultural product and market economic activity) show intercept and time trend items. Therefore, the panel unit root test adopts both the time trend and intercept by using the Eviews software. Three test methods were used in this paper to enhance the

Table 4 Stability test result of the gross value of agricultural product

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	− 6.18029	.0000	9	151
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	− 3.33493	.0004	9	151
ADF-Fisher Chi-square	38.8671	.0030	9	151
PP-Fisher Chi-square	102.032	.0000	9	153

**Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality

Source calculation results using EViews 8.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

Table 5 Stability test result of the market economic activity level

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	− 3.69711	.0001	9	145
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	− 1.65510	.0490	9	145
ADF-Fisher Chi-square	27.5001	.0701	9	145
PP-Fisher Chi-square	42.0367	.0011	9	153

**Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality

Source calculation results using EViews 8.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

reliability of the research results. Accordingly, these tests are conducted with the same root (LLC test) and the test with different roots (IPS, Fisher-ADF and Fisher-PP test). These test results are shown in Tables 3, 4 and 5.

Tables 3, 4 and 5 show that these variables (i.e. the per capita net income of farmers, gross value of agricultural product and market economic activity level) have passed the significance test (significance level of 5%) in the case of the original value test through the four test methods (LLC, IPS, Fisher-ADF and Fisher-PP test). These test results indicate that these variables do not contain unit roots and represent a smooth panel time series data. Hence, these variables can be used to perform panel data regression analysis.

5 Effect of the targeted poverty alleviation policy at early stage of implementation—a break point regression approach

This paper analyzed the effects of the targeted poverty alleviation policy. No systematic difference is determined in all aspects for poor counties in 2010 (the previous year before the implementation of targeted poverty alleviation policy) and in 2011 (the year of implementation). The only difference is whether or not to implement the targeted poverty alleviation

Table 6 Results of the local regression with covariates at different bandwidths

zlnru	Coef.	Std. Err.	z	P > |z|	[95% conf. interval]	
lwald	−.0335854	.0478535	−.70	.483	−.1273765	.0602056
lwald50	.1165566	.0337053	3.46	.001	.0504954	.1826179
lwald200	−.0238754	.0432748	−.55	.581	−.1086923	.0609416

Estimating for bandwidth 3.292158728541752; Estimating for bandwidth 1.646079364270876; Estimating for bandwidth 6.584317457083504

Lwald, lwald50 and lwald200 represent the local linear regression with the optimal bandwidth of 1, .5 and 2 times, respectively. The value of estimating for bandwidth means the local regression within the range at the breakpoint 2012. The bandwidth values of 3.29, 1.65 and 6.58 represent the local linear regression with the optimal bandwidth of 1, .5 and 2 times, respectively

Source calculation results using Stata 13.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

policy. Therefore, break-point regression can be used to identify the policy effects at the early stage of the policy implementation. Given the lag of economic operation, the effect of the policy implementation is often reflected in the second year. Hence, the breakpoint of this research is set to 2012.

The break point regression equation is as follows:

$$y_{i,t-1} = x'_{i,t}\beta + \gamma_i t + \delta D_i + \mu_i + \varepsilon_{i,t}$$

$$D_i = \begin{cases} 1 & \text{if } x_i \geq 2012 \\ 0 & \text{if } x_i < 2012 \end{cases} \tag{2}$$

where, i represents the national poverty-stricken counties (Wanzhou, Fengdu, Wulong, Kaixian, Yunyang, Fengjie, Wushan, Wuxi and Shizhu) in the Three Gorges Reservoir Region of Chongqing. The year of 2012 is set the breakpoint, which is the second year of the policy implementation. The dummy variable of policy implementation is D_i, and its' coefficient δ is a measure of the policy effect at the breakpoint. Covariates $x'_{i,t}$ refers to the activity level of market economy and gross value of agricultural products in poor areas. The independent variables $y_{i,t-1}$ represent the first-order lag of logarithm net income of famers. These lag values reflect the real rural per capital net income due to economic operation law, whereas the values of current net income of famers do not always reflect the actual one. $\varepsilon_{i,t}$ is a perturbation item that changes with the region and time. u_i is a disturbance item that represents the heterogeneity of the region. This paper reports two aspects: (1) the results of the local linear regression in the condition of different bandwidths which are the optimal bandwidth of .5, 1 and 2 times; (2) The results of the local regression whether or not to add the covariates (see Tables 6, 7).

The empirical result in Table 6 shows that by adding the covariate (the logarithm of the market economic activity, gross value of agricultural product in the poverty-stricken area), adopting local linear regression with .5 times of the optimal bandwidth whose value is 1.65[2], the policy of targeted poverty alleviation exerts an extremely significant positive effect on the per capita net income of farmers (in log), with an effect of .117 ($p < .001$).

[2] The bandwidth value of 1.65 means the local regression within the range of ± 1.65 at the breakpoint 2012, i.e., a local regression using the data from 2010 to 2014 in nine counties of Chongqing.

Table 7 Results of the local regression without covariates at different bandwidths

zlnru	Coef.	Std. Err.	z	P > |z|	[95% conf. interval]	
lwald	−.0238114	.0810315	−.29	.769	−.1826302	.1350074
lwald50	.1384815	.0589615	2.35	.019	.022919	.2540439
lwald200	−.0197575	.071858	−.27	.783	−.1605966	.1210816

Estimating for bandwidth 3.292158728541752; Estimating for bandwidth 1.646079364270876; Estimating for bandwidth 6.584317457083504

Lwald, lwald50 and lwald200 represent the local linear regression with the optimal bandwidth of 1, .5 and 2 times, respectively. The value of estimating for bandwidth means the local regression within the range at the breakpoint 2012. The bandwidth values of 3.29, 1.65 and 6.58 represent the local linear regression with the optimal bandwidth of 1, .5 and 2 times, respectively

Source calculation results using Stats 13.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

Table 8 Robustness test results for the breakpoint regression

zlnru	Coef.	Std. Err.	z	P > |z|	[95% coef. interval]	
lngross	−.1204041	.3677187	−.33	.743	−.8411196	.6003114
lntotalretai ~ e	−.0266775	.5608876	−.05	.962	−1012997	1.072642
lwald	−.3960365	.0986452	−4.01	.000	−.5893775	−.2026955
lngross50	.1047109	.2166195	.48	.629	−.3198554	.5292772
lntotalreta ~ 50	.1556428	.3307301	.47	.638	−.4925763	.8038619
lwald50	3.32e-18	.0581651	.00	1.000	−.1140016	.1140016
lngross200	−.0393306	.247545	−.16	.874	−.5245099	.4458487
lntotalret ~ 200	−.0104908	.3775258	−.03	.978	−.7504277	.7294461
lwald200	−.214555	.0695747	−3.08	.002	−.350919	−.078191

Source calculation results using Stata 13.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

That is, at the early stage of the policy implementation in 2012 compared with 2010–2011, the effect of the targeted poverty alleviation in 2012 was .117. In Table 7, for which no covariate is added, the targeted poverty alleviation policy has a positive effect on the net income of farmers (in log) when local linear regression is performed based on .5 times the optimal bandwidth.

5.1 Robustness test of the results of the breakpoint regression

Other covariates should be assessed for the present "jumps" in the cutoffs. If other covariates have significant jumps at the cutoffs, the jumps in the cutoffs for the independent variables will not be caused by disposal effects alone. The condition shows that the breakpoint regression cannot be effectively causal inference and it is invalid.

Table 8 indicates that the covariates (the market economic activity and gross value of agricultural product in impoverished areas) are not significant at .5, 1 and 2 times the optimal bandwidth. These results show that the targeted poverty alleviation policy alone

generates a change in the per capita net income of farmers. Accordingly, the robustness test of the breakpoint regression has passed.

6 Long-term effect of China's poverty alleviation policy: a panel regression approach

Breakpoint regression can only estimate the processing effect near the breakpoint and cannot identify the processing effect away from the breakpoint. In other words, the break-point regression can only estimate the effect of the targeted poverty alleviation policy on the year when the policy just starts to implement. Therefore, the breakpoint regression cannot estimate the policy effect after the implementation of the policy, that is, the year from 2011 to 2015. The research data in this paper cover the period of up to 18 years, which is substantially higher than the number of explanatory variables. Therefore, we also employed a long panel regression to estimate the policy effect during the period 2011-2015 after the national targeted poverty alleviation policy.

Long panel regression formula is as follows:

$$y_{i,t-1} = x'_{i,t}\beta + \gamma_i t + D\delta_{i,t} + \mu_i + \varepsilon_{i,t} \tag{3}$$

Among variables, $y_{i,t-1}$ for the explained variable, is the first-order lag of logarithm of rural net income. Following the law of economic operation, the data of rural net income in one year is often not the actual feedback of rural net income in that year, and the real effect will occur one year afterwards. The key explanatory variable $\delta_{i,t}$ is the dummy variable for the poverty alleviation policy. The poverty alleviation policy is set to 0 for 1998-2010 and 1 for 2011-2015. The coefficient D before $\delta_{i,t}$ is the effect of the duration (from 2011 to 2015) of the policy implementation. $x'_{i,t}$ is the control variable, namely, the logarithm of the degree of market economic activity and the number of gross agricultural product in poor area. u_i is the disturbance that represents the heterogeneity of the region. $\varepsilon_{i,t}$ is a disturbance item that changes with the region and time. The empirical results are shown in Table 9.

Table 9 shows that the policy's dummy variable is significantly positive at the 1% level. That means that it has a value of .29. Hence, the policy effect of national pro-poor policies from 2011 to 2015 is .29.

In terms of control variables, the coefficient of the degree of market economic activity in the impoverished areas is .397, and the coefficient of agricultural product in impoverished areas is .037. Both values are significantly positive at the 1% level. These findings suggest that the more prosperous the market economy is, the faster the rural per capita net income increases. Moreover, the higher the gross agriculture product in poor areas grows, the more rapidly the per capita net income of farmers boosts.

Table 9 Long Panel Regression Results

zruln	Coef.	Std. Err.	z	P>|z|	[95% coef. interval]	
dum	.2903037	.0361149	8.04	.000	.2195198	.3610875
lntotalretailsale	.3970061	.0405892	9.78	.000	.3174528	.4765594
lngross	.0366262					
new_id						
2	.4924785	.0560261	8079	.000	.386693	.6022876
3	.1847045	.0274144	6.74	.000	.1309733	.2384356
4	.2864471	.0445101	6.44	.000	.1992089	.3736854
5	.490215	.0740863	6.62	.000	.3450086	.6354214
6	.5143804	.077804	6.61	.000	.3618875	.6668734
7	.6153834	.0920076	6.69	.000	.4350519	.7957149
8	.3703364	.0628216	5.90	.000	.2472084	.4934644
9	.6098757	.068957	8.84	.000	.4747225	.7450289
t	.0351656	.0067851	5.18	.000	.0218671	.0484641
_cons	1.829675	.5128457	3.57	.000	.8245156	2.834834

The long panel regression use feasible generalized least squares. The value of the dependent variable is the partial correlation coefficient

Source calculation results by the authors using Stata 13.0 software based on data from the *Chongqing Statistical Yearbook*, *Chongqing Rural Statistical Yearbook*, and the statistical yearbooks of the nine counties

7 Conclusions and recommendations

7.1 Conclusions

(1) The national policy for targeted poverty alleviation has significant poverty reduction effects.

The duration of the targeted poverty alleviation policy was from 2011 to 2015, and the policy effect manifested the moment the policy was implemented and continued to take effects. The immediate and long-term policy effects were derived from breakpoint and long-term regression analyses. The panel data from 1998 to 2015 of the nine national poor counties (districts) of Chongqing were used to verify the effect of the targeted poverty alleviation policy. Results indicate that the policy effects at the beginning (i.e., in 2012) and during the five-year (2011–2015) policy implementation were .117 and .29, respectively. At the early stage of policy implementation in 2012, the per capita net income of farmers in the area increased by 12.41% (i.e., $(e^{0.117} - 1) \times 100\%$) compared with 2010–2011. As shown by the variable of per capita net income of farmers (in logs), the coefficient of before-policy dummy $\delta_{i,t}$ can be interpreted as the impact on the percentage of per capita net income of farmers during the 2011–2015 period, which essentially means the effect of the national policy on poverty alleviation targets. Furthermore, in the course of policy implementation, the per capita net income of farmers in the poverty-stricken counties increased by 33.64% (i.e., $(e^{0.29} - 1) \times 100\%$). The comparative results suggest that the long-term effect was more demonstrated than that at the early stage of policy implementation, as evidenced by the 21.23% net increase in per capita net income of farmers.

(2) Market economic activity and agricultural product have a significant impact on the per capita net income of farmers in the impoverished areas.

The result of long panel regression indicates that the coefficient of the degree of market economic activity in poverty-stricken areas is .397. For every 1% increase in the degree of the market economic activity, the per capita net income of farmers in the impoverished areas will increase by 48.74% (i.e., $(e^{0.397} - 1) \times 100\%$). Therefore, the regression results show that some prominent measures, such as industrial, financial and entrepreneurial activities, should be considered to raise the per-capita net income of farmers in the poor areas, in addition to the targeted poverty alleviation policy.

From the long-term panel regression, the coefficient of agricultural product in the poor areas is .037. For every 1% increase in the total agricultural product in the poor areas, the per capita net income of farmers also increases by 3.7% (i.e., $(e^{0.037} - 1) \times 100\%$). The results show that the higher the total agriculture product in poor areas grows, the faster the per capita net income of farmer increases. Accordingly, the poverty-stricken counties in the Three Gorges Reservoir Region mainly focus on agricultural product, as evidenced by the increase in the per capita net income of farmers.

7.2 Policy recommendations

Based on the above conclusions, we propose the following recommendations:

(1) China should continue to increase its investment in poverty-stricken Chongqing counties in the Three Gorges Reservoir Region as part of its national poverty alleviation policy. In this research, we have proved that the implementation of national poverty alleviation policy has significantly enhanced the rural per capital net incomes in the poor areas. That means, during initial implementation, such targeted poverty alleviation policy has played the key role in increasing the per capita net income of farmers. The early stage of implementation the national poverty alleviation policy has remarkably improved the per capita net income of farmers in the poor areas. The effect of the net income of farmers per capita after the implementation of the targeted poverty alleviation policy becomes even more effective. Through the poverty alleviation policy, the per capita net income of famers increases steadily year by year. These positive results suggest that China should continuously strengthen its policy investment in the poverty-stricken regions, including the Three Gorges Reservoir Region. The investment should focus on accelerating poverty eradication to assist further the communities to move out of their impoverished state, which in turn can help reach the goal that no one is left behind in poverty eradication by 2020.

(2) As part of the government effort, rural markets in poor areas should be activated to accelerate regional economic development and ultimately lift the areas out of poverty. Our research results show that the market economic activities and gross agricultural product have significantly increased the per capita net income of the impoverished farmers. Therefore, the central and local governments of China should take actions to institutionalize rural markets in the impoverished communities, such as those poverty-stricken Chongqing counties in the Three Gorges Reservoir Region. Subsequently, the comprehensive strength of local farmers can be consolidated and expanded at the level of regional economic development, thereby contributing to the goal of building a well-off society.

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Affiliations

Min Zhu[1] · Chuanmin Shuai[1] · Xiaoyan Wang[2] · Zhihui Leng[1] · Fan Zhang[1]

Min Zhu
zhumin1234562003@aliyun.com

Xiaoyan Wang
meilv1320@126.com

Zhihui Leng
3396143801@qq.com

Fan Zhang
15674230@qq.com

[1] School of Economics and Management, China University of Geosciences, 388 Lumo Road, Hongshan District, Wuhan 430074, China

[2] Hubei Maternal and Child Health Hospital, Wuhan, China