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Target price policy and rural household income: Evidence from China

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Abstract: Agricultural subsidy policy can improve the planting enthusiasm of rural households by increasing their income. It is of great significance to assess and summarise the effect of the soybean and cotton target price subsidy policy and to determine future policy direction. Using the national rural fixed-observation point socioeconomic survey data from 2009 to 2017, the study employed the difference-in-differences (DID) method to evaluate the impact of the target price policy (TPP) on rural household income in China. TPP had no significant impact on the total income of rural households. Specifically, TPP increased the farm income of rural households but simultaneously reduced the wage income and had no significant impact on the other income. Moreover, the impact of TPP on rural household income varied with the planting scale and income level; the effect of TPP was strong among the non-poor or scale operation rural households. TPP implementation affected rural household farm and wage income by affecting farmers' allocation of working time and cost input. Therefore, implementing TPP should consider farmers' participation in non-farm employment, further adjust the subsidy intensity and scope, and combine direct subsidies with the poverty reduction effect in poor areas. The contribution of this article is to explore the implementation effect of target price subsidy policies from the perspective of farmers' income, to deconstruct farmers' income, and explore the mechanism of policy action. This paper provides a theoretical basis and policy inspiration for China to improve and adjust the agricultural subsidy policy, mobilise farmers' enthusiasm to cultivate, and ensure national food security.

Keywords: agricultural subsidy policy; difference-in-differences; farmers' income; influence mechanism; labour income allocation

Food security is an international concern and the cornerstone of each country's economic and social stability (Mukhopadhyay et al. 2018; Merem et al. 2019; FAO et al. 2021). Improving rural households' incomes and enhancing their planting enthusiasm is the key to ensuring food security (Zhang et al. 2022). Agricultural subsidies are relatively important among the many factors affecting rural household income (Alene and Coulibaly 2009). Many countries regard agricultural subsidies as the core of agricultural policy and direct means of supporting agricultural development (Ciaian et al. 2021). Various programs have been implemented influencing agricultural prices; such as early income protection, crop revenue coverage, counter-cyclical payments, and subsequently price loss coverage and agriculture risk coverage in the

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United States of America (USA); single farm payment in the European Union; new food law in Japan; and target price policy (TPP) in China (Coble and Barnett 2013; Tyllianakis and Martin-Ortega 2021; Quiroga et al. 2017). Generally, the subsidy policy based on agricultural product prices can improve income and expenditure from cultivation by increasing income (Kim and Chavas 2002; Liang and Meng 2024) and enhance farmers' planting enthusiasm.

China is a major global agricultural economy (Zhou et al. 2024). According to the United Nations Food and Agriculture Organization (FAO), China was the largest food producer and the third largest food exporter worldwide in 2021 (Huang and Yang 2017). More importantly, China needs to feed more than 22% of the global population, with only 7% of the global cropland (Piao et al. 2010; Zuo et al. 2018). Therefore, food security is a critical issue for China, and many measures have been taken to promote agricultural development (Lv et al. 2022). Agricultural subsidy is one of the most important industrial policies. Since the beginning of the 21st century, China's agricultural subsidy policy has continuously been reformed to regulate crop prices (Lopez et al. 2017). In 2008, TPP was implemented to stabilise agricultural product prices and increase crop production (Liu et al. 2020a). However, continuous increases in grain production have seriously distorted the market mechanism of agricultural products, thus intensifying the imbalance between the supply and demand of agricultural products in the domestic market (Li et al. 2020). When the prices of agricultural products fall, farmers' enthusiasm for planting decreases severely due to the decline in their income. To reform the structure of agricultural supply, the Chinese government implemented the TPP in 2014 (Central Committee of the Communist Party of China and State Council of the People's Republic of China 2014), which replaced the temporary purchase and storage policy (TPSP). The implementation of TPP affected soybean planting in Northeast China (including Heilongjiang Province, Liaoning Province, and Jilin Province) and cotton planting in the Xinjiang Uygur Autonomous Region. Soybeans, China's most globally integrated crop, exhibit significant price volatility and high sensitivity to international market fluctuations. Further, their cultivation is also relatively concentrated. Thus, soybeans are well-suited for targeted price pilot initiatives (Xu et al. 2016). China's cotton distribution channels are singular, and the comparative profitability and international competitiveness are declining. The target price subsidy policy has been implemented for cotton to enhance the global competitiveness of the cotton sector and the control ability of cotton product circulation (Hu et al. 2019; Wang 2021).

To date, researchers have focused on the following four impacts of TPP on agricultural production: *i*) supply of agricultural products, *ii*) market of agricultural products, *iii*) production behaviour of farmers, and *iv*) farmers' income. Studies of the first aspect showed that TPP did not significantly expand soybean planting area and had limited effect on the increase of domestic soybean output in China (He and Yu 2020). However, the analysis of cotton planting showed that TPP not only expanded the planting area in China (Wang et al. 2021) but also improved the technical efficiency of planting and yield per unit area (Gao and Du 2018). In contrast, Wang et al. (2021) reported a 'bubble' in cotton cultivation, where the policy expanded cotton production area by reducing the area of competing crops but reduced cotton yield per unit area. Studies of the second impact showed that TPP consolidated the domestic and international cotton markets and reduced cotton imports (Shang et al. 2020). In addition, regarding the futures premium or discount, the policy significantly affected the soybean market's futures and spot basis level, and realised the price guidance function of the futures market (Xu et al. 2020). Furthermore, studies consistently showed that TPP inhibited farmers' planting enthusiasm (Hu et al. 2019).

On the one hand, the policy reduces the enthusiasm of farmers planting soybeans due to the inability of market regulation and policy guidance (Liu et al. 2018). On the other hand, the target price of soybeans does not consider the comparative benefit of soybeans versus corn. The vitality of the domestic soybean market is weak, and market players are not very motivated to enter the market for purchasing, leading to a backlog of soybean inventory. Meanwhile, given the relatively high income from planting corn, farmers choose to plant corn. Therefore, the soybean target price subsidy policy has not achieved the goal of rationally adjusting the planting structure. Finally, Zhang (2022) used provincial panel data and reported that the soybean target price subsidy policy significantly promoted the operating income of rural households in China but reduced the wage and transfer income. According to the empirical analysis of the field survey of cotton farmers in Xinjiang, two independent studies consistently showed that the cotton target price subsidy policy played a significant role in promoting farmers' income from cotton (Lu et al. 2017; Qu and Wang 2021).

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Overall, TPP expanded the target crops' planting scale, enhanced the yield, and played a market adjustment function. Nonetheless, it remains unclear why the TPP inhibits farmers' enthusiasm for planting target crops (Hu et al. 2019), even though it can increase their household income (Zhang 2022). This high income-low enthusiasm paradox has not been studied. Therefore, this study aims to examine the effect of TPP from the perspective of rural household income and attempts to explain why some farmers have low enthusiasm for planting under TPP. Meanwhile, attempts are being made to account for the impact variability of TPP in different types of farmers' incomes in our study. Otherwise, analysing the influence mechanism of TPP on rural household income is also an important issue that this study endeavours to address.

Based on the above aims and using the household-level micro panel data from the national fixed rural observation points socioeconomic survey provided by the Research Center of Rural Economy (RCRE), this study uses the difference-in-differences (DID) method to explore the impact of TPP on rural household income in China and empirically tests the internal impact mechanism. The possible contributions of this research are as follows. Firstly, this paper discusses the effect of TPP implementation from the perspective of rural household income and attempts to explain the 'high income-low enthusiasm' paradox described above by deconstructing the income. Secondly, the existing studies focus only on one crop when evaluating the effect of the policy. This study considers both soybean (economically important crop) and cotton (alimentary crop) as target plants for empirical analysis to avoid the difference in the impact of the policy on rural household income due to the selection of different target crops and to make more comprehensive and robust research conclusions. Thirdly, this study uses the DID method and household-level micro panel data based on the analysis of a large number of samples, which are highly representative over a long period. This approach is expected to accurately identify the net effect of TPP on rural household income. The results provide a theoretical basis and policy inspiration for China to improve the agricultural subsidy policy, mobilise the enthusiasm of farmers to cultivate, and ensure national food security.

Policy evolution and mechanism

Evolution of purchase and storage policies. The agricultural product market exhibits a cobweb-shaped divergence characteristic, and the agricultural product price is prone to large fluctuations (Xie and Wang 2017). A continuous bumper harvest during grain cultivation is often followed by a continuous reduction in production. This is caused by, apart from some uncontrollable factors, the relative surplus of grain, which makes it challenging to sell the produce and guarantee farmer income, reducing farmer enthusiasm and planting size. To ensure a steady increase in grain supply and farmer income, the Chinese government successively adopted different agricultural price-supporting policies over the past few decades.

i) Minimum purchase price policy. In 2004, China fully opened the grain market (Heerink et al. 2006). Under normal circumstances, grain prices are affected by market supply and demand. Therefore, to guarantee the grain supply, China's agricultural officials implemented the lowest purchase prices for key grain varieties in the main production areas, which was named the Minimum Purchase Price Policy (MPPP); this policy was launched for rice in 2004 and for wheat in 2006 (Huang and Yang 2017). According to this policy, once the market price of grain drops to a level lower than the minimum purchase price determined by the government, grain enterprises commissioned by the government will purchase grain from farmers at the minimum purchase price to prevent 'the Paradox of the Bumper Harvest' and protect the interests of farmers. In this process, the MPPP plays the 'price regulation' function. In the early stages of MPPP implementation, the policy stabilised the market prices of agricultural products, such as rice and wheat, and significantly increased farmer incentives to produce these grains (Liu et al. 2020b).

ii) Temporary purchase and storage policy. To improve the effect of agricultural subsidy policies, the Chinese government has continuously carried out agricultural policy reforms and further expanded the types of crops covered by agricultural subsidies. In 2007, the TPSP was introduced for corn, rapeseed, soybean, pork, sugarcane, and cotton (Garnaut et al. 2018). Under the TPSP, the government purchases specific varieties of crops according to the temporary purchase and storage prices. It stores them to reduce the market circulation of crops and stabilise their market price. The policy has effectively increased crop income (Hejazi and Marchant 2017).

However, TPSP had negative effects over time. By 2013, related agricultural products' minimum and temporary purchase and storage prices increased significantly. For example, the temporary storage price of corn and soybean increased by 60% and 24%, re-

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spectively. This seriously distorted the market mechanism of these agricultural products and increased the economic burden on the government (Huang and Yang 2017). The problems of high inventory, high imports, and high output gradually emerged, intensifying the disconnect between supply and demand in the domestic agricultural product market. Therefore, it was necessary to reform China's agricultural subsidy policy.

iii) Target price subsidy policy. To solve the problems caused by the TPSP, China implemented the TPP for soybean, which was effective in Heilongjiang Province, Jilin Province, Liaoning Province, and Inner Mongolia Autonomous Region from 2014 to 2017, and for cotton, which has been effective in Xinjiang Uygur Autonomous Region since 2014 (Figure 1).

TPP, a subsidy based on essentially the difference between the target price and market price, originated in the USA (Sharma 2014). The policy tries to increase farmer income and improve food security without distorting domestic market prices and accumulating large inventories. The policy support system is that the government sets a target price, and the market forms the actual crop price. If the market price is lower than the target price, the government subsidises producers according to the price difference. Conversely, the government subsidises consumers if the market price is higher than the target price. The policy plays a role in the market allocation and price mechanism of agricultural products to ensure farmer income.

At the early implementation stage, the effect of TPP was significant (Clever and Wu 2016). However, some scholars believe that the soybean TPP did not achieve the desired results after a specific time (Wang and Si 2021) because it did not take the price of the competing crops into account, such as corn. Compared with corn planting, the benefit of soybean planting was still not high, which could have dampened the enthusiasm for it. Therefore, the soybean target price subsidy policy in the above-mentioned areas was terminated in 2018. However, the cotton target price subsidy policy has remained functional. Hence, this policy fact was con-

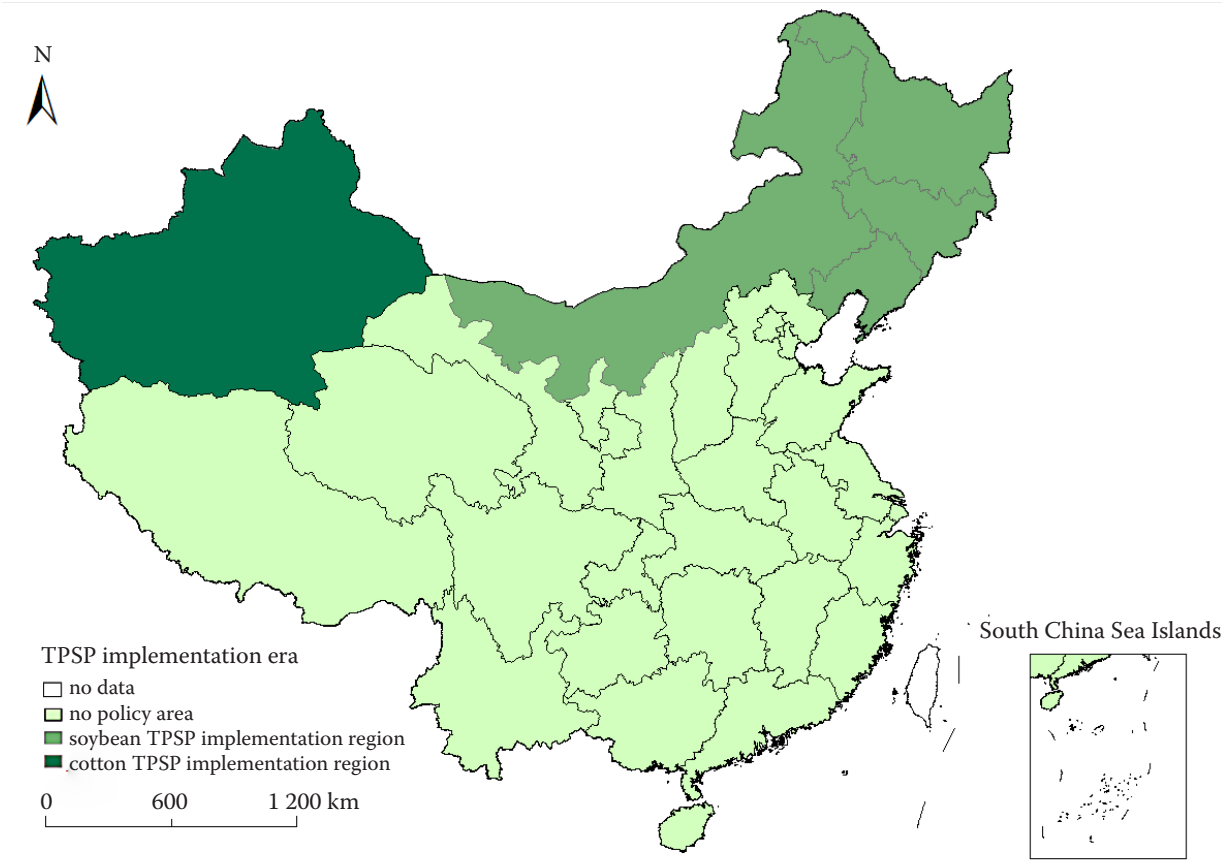

Figure 1. Sample distribution

TPSP – temporary purchase and storage policy
Source: Authors' own processing

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sidered when choosing the time span of our samples in the paper.

Mechanism analysis. The structure of the rural household income is relatively complex. The total income includes three categories: farm income, wage income, and other income (Xu et al. 2012). Farm income is obtained from engaging in agricultural operations and related veneration activities. Wage income includes the salary of rural cadres and teachers, local employment, and out-of-town employment. Other income includes property and transfer income, specifically including rental income, dividends, bonus income, land acquisition compensation, retirement funds, pensions, and other nonborrowing income.

TPP can affect the total income of rural households both directly (by increasing other income in the form of transfer income) and indirectly [by influencing the production-related decisions of farmers, such as agricultural investment and working time allocation (Burfisher and Hopkins 2012), which are important production factors]. Farmers allocate labour and capital as economically rational individuals depending on the input-output status and the trade-off between expected benefits and risks (Reardon et al. 2000). Therefore, this study expounds on the impact of TPP on working time allocation and planting capital input, which are used to explore the policy mechanism on rural household income. Figure 2 shows the influence mechanism of the TPP on rural household income.

Labour, a common factor affecting production, can flow between the farm and non-farm sectors (Becker 1965). Due to rural households' limited labour resources, the benefits obtained from farm actions and the wage income obtained from non-farm employment are opportunity costs for each other (Chang et al. 2012). Under the constraints of labour resources, rural households aim to maximise income by optimising labour allocation between the farm and non-farm sectors. Extant research shows that, when receiving agricultural subsidies, farmers tend to put more labour into agricultural production compared with non-farm production activities (Keeney 2000; Ahearn et al. 2006; Briggeman et al. 2007). TPP weakens the market risk because it can guarantee that farmers obtain agricultural benefits, especially when the agricultural product price is low, and then mobilises the planting enthusiasm of farmers to a certain extent. When more labour is invested in agricultural production, agricultural output and agricultural income increase. Correspondingly, less non-farm labour input leads to low wage income. Therefore, TPP can promote farm income and reduce wage income by affecting the working time allocation of rural households.

TPP mobilises the enthusiasm of subsidised households to engage in farming, which is reflected not only in the working time but also in the planting capital input, and the latter impacts the farm income and other income. Therefore, the policy reduces the planting risk of subsidised households. Consequently, subsidised households are more likely to expand investment in planting because of the stable expectations of farm production compared with subsidised rural households. A positive correlation is usually observed between farm production input and rural household farm income (Zhao and Tan 2019). However, expanding the planting capital input can crowd out the investment expenditure of farmers for generating interest income, which may have a negative impact on other in-

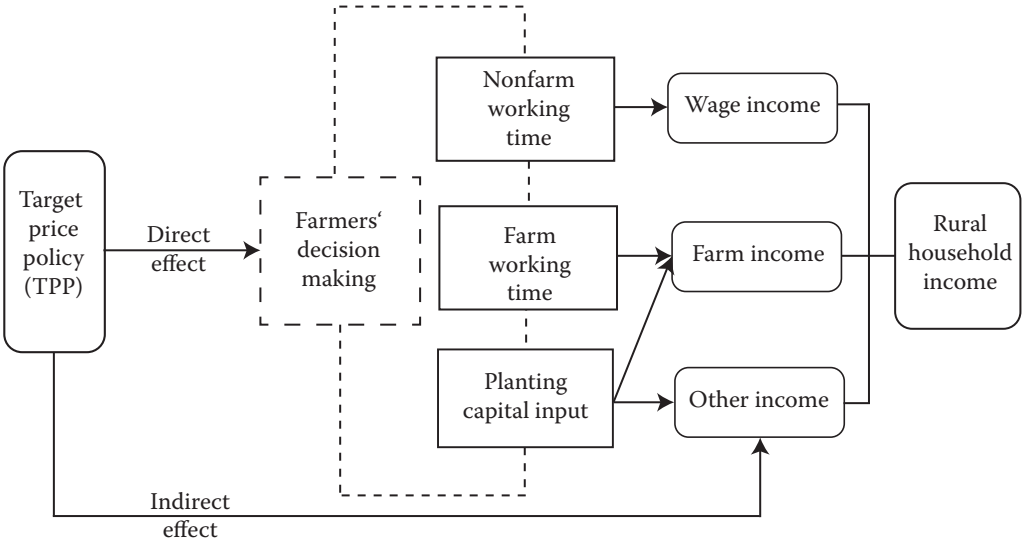

Figure 2. The influence mechanism of TPP on rural household income

TPP – target price policy
Source: Authors' own processing

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come. Therefore, TPP leads farmers to increase the input of planting expenses, thereby promoting rural household farm income and reducing other income.

To summarise, the TPP may affect all parts of rural household income. Besides increasing other income in the form of transfer income, the policy increases farm income by making farmers invest more working time and capital into planting, reduces wage income by decreasing the time allocation toward non-farm work, and can potentially shrink other income (e.g. interest income generated by investment expenditure) by expanding the planting capital input. Farm and wage income also account for the absolute proportion of total income (Haggblade et al. 2010; Asfaw et al. 2013). Hence, the effect of TPP on the total income of the rural household requires urgent empirical testing.

MATERIAL AND METHODS

Data

The data used in this study were derived from the national fixed rural observation points socioeconomic survey conducted by the Office of Rural Fixed-Observation Points (ORFP), affiliated with the RCRE at the Ministry of Agriculture and Rural Affairs in China. The survey covered 350 administrative villages in 31 provinces and municipalities across the country, tracking approximately 23 000 rural household samples; thus, this survey has continuous tracking, wide-ranging and sufficient sample size, and rich content. Since 2009, two items, 'local wage income' and 'out-of-town wage income', have been added to the questionnaire, thus allowing a more meticulous analysis of household income. Considering the termination of the soybean TPP in October 2017, the implementation year of the policy, and the availability of data, we used the survey data collected between 2009 and 2017 for empirical analysis to determine the policy effect fully.

Owing to the urbanisation, the merging of villages, and the flow of people, some rural households included in this survey database have changed since the interview. To obtain real 'fixed tracking' panel data, the original survey data has been screened by household code and the ages of household head and their spouse. First, for households with a code since 2009, it was checked whether the age of the head and that of their spouse matched the data obtained in the following year. If the data did not match, the sample was deleted. Consequently, 85 333 samples were retained. Then, samples missing or showing abnormal key variables, such as income and household resident population, or not meeting the balance sheet relationship of the questionnaire were excluded. Furthermore, as TPP only covered soybean and corn, only households growing at least one of these two crops were retained as samples. Based on the processing described above, the final data analysed in this study represent 4 406 households, with a total sample size of 14 579.

Variables

i) Explained variables. Rural household income is represented by the *per capita* income indicator and includes the *per capita* total income (*Total_inc*), *per capita* agricultural income (*Farm_inc*), *per capita* wage income (*Wage_inc*), and *per capita* other income (*Other_inc*), and used as the explained variable in this study as the family size of farmers varied; therefore, the income level of farmers could be better assessed by the *per capita* income indicator. Moreover, considering that the difference between *per capita* and total may affect the results, we used the total income indicators of rural households, such as gross income (*Ttotal_inc*), total agricultural income (*Tfarm_inc*), total wage income (*Twage_inc*), and total other income (*Tother_inc*), as the explained variables for robustness tests.

ii) Explanatory variables. To represent the implementation of TPP, $time_t \times treat_i$ was used as the explanatory variable in this study. This explanatory variable represents the interaction between the time dummy variable $time_t$ and the experimental group dummy variable $treat_i$. When household *i* begins to be subsidised by TPP, $treat_i = 1$. In other words, when household *i* is located in one of the four provinces of Heilongjiang Province, Jilin Province, Liaoning Province, and Inner Mongolia Autonomous Region, and cultivates soybeans or grows corn in the Xinjiang Uygur Autonomous Region. Otherwise, $treat_i = 0$. As the release of the 2014 policy document coincided with the end of soybean and corn planting, farmers needed time to reflect on the policy. Therefore, they could not immediately adjust their decision-making according to the policy in 2014. Considering this limitation, 2015 is the first phase of policy implementation. As the data in this paper cover all the years of the implementation of the TPP for soybeans, and soybean subsidies are part of the TPP policy (although the target price subsidy policy for soybeans was discontinued in 2018), this paper still included soybean subsidies in the scope of research, to fully assess the impact of the TPP policy on farmers' income, and providing effective inspiration for China's agricultural policy reform. In this study, the

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focus is on the estimated coefficient of fit, which reflects the treatment effect of the TPP.

iii) Control variables. Based on Wang and Shen (2014), we selected characteristics of the household head, family, and region as control variables. Characteristics of the household head included their age (*Age_ind*), number of schooling years (*Edu_ind*), and health status (*Health_ind*), which was scored on a scale of 1–5 as follows: 1 = incapacitated; 2 = poor; 3 = medium; 4 = good; and 5 = excellent. Characteristics of the household family included the number of household labour (*Labor_house*), living consumption expenditure (*Consu_house*), and the value of productive fixed assets (*FA_house*), while those of the region included the *per capita* net income of the village (*Income_vi*), the proportion of pure farming households in the village (*Farm_vi*), and *per capita* arable land area of the village (*Land_vi*).

iv) Mediating variable. Rural households' working hours and agricultural capital input were chosen as the mediating variables in this study. The number of working hours included on-farm working time (*Farm_time*) and non-farm working time (*Nonfarm_time*), which represented the farm labour input and non-farm employment behaviour of farmers. Agricultural capital input was represented by the annual planting costs (*Plant_costs*), which included the cost of seeds, farm manure (converted price), chemical fertilisers, agricultural film, pesticides, water, electricity, irrigation, animal power, mechanical operations, the depreciation of fixed assets, and other expenses.

The value of the variables mentioned above (such as income, assets, consumption, and cost) was deflated by province-level rural consumer price index (CPI) in 2003 to eliminate the impact of price fluctuations. The definitions, calculation methods and descriptive statistics of the variables are reported in Table 1 and Table 2.

Model

i) DID model. TPP for soybean and cotton in China provided us with materials for quasi-natural experimentation. Therefore, the DID method was employed to control the unobserved individual heterogeneity of each sample in the time dimension and eliminate the influence of unobserved and time-varying factors in the cross-section dimension. This approach effectively addresses endogeneity issues (Bertrand et al. 2004). The DID method was used to explore the impact of TPP on rural household income in China. By adding the double fixed effects of time and household to the DID method, the following regression model was determined:

$$Y_{it} = \beta_0 + \beta_1 treat_i \times time_t + \Sigma\alpha_{it} X_{it} + \gamma_i + \mu_t + \varepsilon_{it} \quad (1)$$

where: i – household; t – year; Y_{it} – explained variable; $treat_i \times time_t$ – core explanatory variable; X_{it} – control variable; γ_i – fixed household effect, which controls for unobserved household-level missing variables that do not change over time and may have an impact on household income; μ_t – fixed time effect, which controls for the unobserved omitted variables that do not change with households, such as macroeconomic development and climate; ε_{it} – random disturbance term, which was clustered at the household level in this study to alleviate the problems of heteroskedasticity and autocorrelation; β_0 – regression constant; β_1 – estimated coefficient of the core explanatory variable; α_{it} – estimated coefficient of the control variable.

Among these variables, β_1 represents the focus of this study, and its significance and symbol reflect the impact degree and direction of target price subsidy policy on rural household income, respectively.

ii) Parallel trend test model. The premise of the DID model is to satisfy the parallel trend assumption; that is, the trend of the experimental and control groups is the same before the policy takes effect. The event study method was used to test the parallel trend by referring to the research of Acharya et al. (2014), and using the following regression model:

$$Y_{it} = \theta + \sum_{k\geq -6}^{2} \beta_k treat_i \times time_t^k + \Sigma\alpha_{it} X_{it} + \gamma_i + \mu_t + \varepsilon_{it} \quad (2)$$

where: $treat_i \times time^k{}_t$ – controls for the leads and lags of the initial core explanatory dummy variable; $k = t - t^{treat \times time}$; $t^{treat \times time}$ – year when household i began to be subsidised by TPP.

When $k < 0$, $treat_i \times time_t^k = 1$ implies that it was k years before the household i was subsidised by TPP. When $k = 0$, $treat_i \times time_t^k = 1$ implies that it was k years after the household i was subsidised by TPP. When $k = 0$, $treat_i \times time_t^k = 1$ implies that it was the year the household i began to be subsidised by TPP. When $k = 0$, $treat_i \times time_t^k = 1$ implies the year in which the household i began to be subsidised by TPP. To fully test for parallel trends, let $k \in [-6, 2]$. β_k captures the dynamic trend of the household, both before and after the implementation of the

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Table 1. Definitions and calculation methods of the variables

Type	Variables	Definitions	Calculation methods
Explained variables	*Total_inc*	gross income	the sum of *per capita* total agricultural income, *per capita* total wage income and *per capita* total other income
	Farm_inc	*per capita* total agricultural income	the sum of food crop income, cash crop income, and other agricultural operation income is divided by the number of people in the household
	Wage_inc	*per capita* total wage income	the sum of the wage derived from migrant labour, wage earnings from local employment, and wages earned by state employees
	Other_inc	*per capita* total other income	the sum of non-agricultural operation income, property income and transfer income
Explanatory variable	*treat* × *time*	dummy variable of type (0,1)	manually assigned value of 0 or 1 to the farmer, depending on whether the farmer is affected by the policy.
Control variables	*Age_ind*	household head's age	the value of this variable is given directly in the questionnaire
	Edu_ind	number of schooling years for the head of household	the value of this variable is given directly in the questionnaire
	Health_ind	health status for the head of household	the value of this variable is given directly in the questionnaire
	Labour_house	number of household labour	the value of this variable is given directly in the questionnaire
	Consu_house	household's living consumption expenditure	the value of this variable is given directly in the questionnaire
	FA_house	household's productive fixed assets value	the value of this variable is given directly in the questionnaire
	Income_vi	net income of the village	the sum of the net income of each household in the village, and net household income is the total household income minus the total household expenditure
	Farm_vi	proportion of pure farming households of the village	the number of farm households divided by the number of non-farm households
	Land_vi	*per capita* arable land area of the village	the arable land area of the village divided by the total number of people in the village
Mediating variables	*Farm_time*	household's on-farm working time	the sum of time spent in farming by family members and employees.
	Nonfarm_time	household's non-farm working time	the sum of time spent in migrant work, local employment, and state work.
	Plant_cost	household's annual planting costs	the sum cost of seeds, farm manure (converted price), chemical fertilizers, agricultural film, pesticides, water, electricity, irrigation, animal power, mechanical operations, the depreciation of fixed assets, and other expenses.

Source: Authors' own processing

policy. Therefore, the changes in coefficients β_{-6}–β_2 can test the hypothesis of the parallel trend.

iii) Mediating effect model. A model was built based on the three-step method described by Baron and Kenny (1986) to test whether the above mechanism (*Farm_time*, *Nonfarm_time*, *Plant_costs*) exists.

The first step verified the impact of TPP on rural household income. This has already been completed

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Table 2. Descriptive statistics of the variables

Variables	Observations	Units	Mean	SD	Min	Max
Total_inc	14 579	10^3 USD	1.48	1.58	0.00	32.02
Farm_inc	14 579	10^3 USD	0.85	1.37	0.00	28.58
Wage_inc	14 579	10^3 USD	0.27	0.69	0.00	37.04
Other_inc	14 579	10^3 USD	0.09	0.19	0.00	6.06
Treat × time	14 579	–	0.00	0.02	0.00	0.15
Age_ind	14 494	year	7.53	2.86	0.00	14.04
Edu_ind	13 624	year	1.00	0.5	0.00	2.93
Health_ind	14 048	–	0.27	0.16	0.15	0.77
Labour_house	14 067	people	0.38	0.17	0.00	1.7
Consu_house	14 551	10^4 USD	0.25	0.38	0.00	5.52
FA_house	14 382	10^4 USD	0.43	0.55	0.00	1.69
Income_vi	14 551	10^4 USD	0.25	0.38	0.00	5.52
Farm_vi	14 208	–	0.07	0.05	0.00	0.15
Land_vi	14 051	10^3 m^2	0.22	0.22	0.00	1.06
Farm_time	14 519	month	0.53	0.91	0.00	17.28
Nonfarm_time	14 519	month	1.24	1.52	0.00	27.16
Plant_cost	14 579	10^4 USD	0.33	0.68	0.00	23.87

Total_inc – gross income; *Farm_inc* – *per capita* total agricultural income; *Wage_inc* – *per capita* total wage income; *Other_inc* – *per capita* total other income; *Treat × time* – dummy variable of type; *Age_ind* – household head's age; *Edu_ind* – number of schooling years for the head of household ; *Health_ind* – health status for the head of household; *Labour_house* – number of household labour; *Consu_house* – household's living consumption expenditure; *FA_house* – household's productive fixed assets value; *Income_vi* – net income of the village; *Farm_vi* – proportion of pure farming households of the village; *Land_vi* – *per capita* arable land area of the village; *Farm_time* – household's on-farm working time; *Nonfarm_time* – household's non-farm working time; *Plant_cost* – household's annual planting costs

Source: Authors' own processing

in benchmark result analysis section, and it will not be repeated here.

The second step verified the impact of TPP on the mechanism variables:

$$Mech_{it} = \delta_0 + \delta_1 treat_i \times time_t + \Sigma\alpha_{it} X_{it} + \gamma_i + \mu_t + \varepsilon_{it} \quad (3)$$

where: $Mech_{it}$ – mediating variables, including working time and agricultural capital input of rural households.

The third step included the dummy variable of policy implementation and mediating variables:

$$Y_{it} = \phi_0 + \phi_1 treat_i \times time_t + \delta_2 Mech_{it} + \Sigma\alpha_{it} X_{it} + \gamma_i + \mu_t + \varepsilon_{it} \quad (4)$$

The focus was on the regression coefficients of δ_1 and δ_2. Among these, δ_1 represents the economic effect of TPP on mediating variables, and δ_2 represents the existence and status of the role of working hours and agricultural capital input in mediating the effect of TPP on rural household income.

RESULTS AND DISCUSSION

Benchmark results

Table 3 reports the impact of TPP on rural household income. The coefficients of the core explanatory variable were positive but not statistically significant when *Total_inc* and *Other_inc* were the explained variables. When *Farm_inc* and *Wage_inc* were the explained variables, the coefficients were positive and negative, respectively, and both were significant at the 1% level. This means that TPP significantly increased agricultural income, reduced the wage income of rural households, and had no statistically significant impact on the total income or other income of rural households in China. When *Farm_inc* and *Wage_inc* were the explained variables, the coefficients of the core explanatory variable

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Table 3. Results of TPP on the rural household income

Variables	*Total_inc* (1)	*Farm_inc* (2)	*Wage_inc* (3)	*Other_inc* (4)
Treat × *time*	1.0826 (1.2410)	3.6826*** (4.0733)	–1.0752*** (–5.0500)	0.2202 (1.5146)
Age_ind	0.0057 (1.0179)	0.0069 (1.5820)	–0.0010 (–0.3362)	0.0001 (0.1256)
Edu_ind	0.0125 (0.4018)	–0.0054 (–0.2341)	0.0180 (0.9495)	–0.0031 (–0.6181)
Health_ind	–0.3410*** (–3.5845)	–0.1605** (–2.3958)	–0.1558*** (–2.8547)	0.0197 (1.1281)
Labour_house	–0.4251***(–4.0094)	–0.3915*** (–4.1926)	–0.1950*** (–3.3842)	–0.0575*** (–4.1998)
Consu_house	–0.0402 (–0.7154)	–0.1074** (–2.1252)	0.0731*** (2.7385)	–0.0039 (–0.4784)
FA_house	0.0570 (1.1139)	0.0591 (1.2704)	–0.0103 (–0.5629)	0.0058 (0.9674)
Income_vi	0.2863*** (3.7878)	0.1039 (1.5926)	0.0461** (2.0418)	0.0409*** (4.5148)
Farm_vi	–0.4636 (–1.2112)	–0.2515 (–0.7622)	–0.0820 (–0.3579)	–0.0240 (–0.5011)
Land_vi	0.0245 (0.3059)	0.0715 (1.0683)	–0.0486 (–1.1649)	0.0197 (1.4350)
Constant	8.8981*** (16.8785)	6.0340*** (13.9951)	1.5896*** (5.2615)	0.4739*** (6.0396)
Household-fixed effect	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes
Observations	12 111	12 111	12 111	12 111
R^2	0.0593	0.0203	0.0448	0.0888

*,**,*** $P < 0.10$; $P < 0.05$, and $P < 0.01$, respectively; standard errors are shown in parentheses; TPP – target price policy; *Total_inc* – gross income; *Farm_inc* – *per capita* total agricultural income; *Wage_inc* – *per capita* total wage income; *Other_inc* – *per capita* total other income; *Treat* × *time* – dummy variable of type; *Age_ind* – household head's age; *Edu_ind* – number of schooling years for the head of household; *Health_ind* – health status for the head of household; *Labour_house* – number of household labour; *Consu_house* – household's living consumption expenditure; *FA_house* – household's productive fixed assets value; *Income_vi* – net income of the village; *Farm_vi* – proportion of pure farming households of the village; *Land_vi* – *per capita* arable land area of the village

Source: Authors' own processing

were 3.6826 and –1.0752, respectively. This indicates the implementation of TPP increased the annual *per capita* farm income of subsidised households by approximately USD 559.85 (RMB 3 682.6), but reduced the annual *per capita* wage income of these households by approximately USD 157.16 (RMB 1 075.2) on average.

The possible reason why TPP did not significantly affect the *per capita* total income of subsidised households is that the increase in agricultural income and the decrease in wage income offset each other. In other words, implementing TPP improves farmers' planting enthusiasm, which is consistent with the conclusions of a previous study (Liu et al. 2018). However, the policy only increases farm income and does not increase the total income of rural households. The key to increasing the total income of rural households is to increase their wage income, which relies on more government funding to improve farmers' education level and vocational skills. Here, the paradox of high income–low enthusiasm is effectively answered.

Robustness tests

i) Parallel trend test. The results of the parallel trend test are shown in Table 4. The regression coefficients of $Before^k$ were not significant and did not show regular changes, indicating that the difference in the income trend among households before the implementation of TPP was not significant, regardless of whether the household began to be subsidised by TPP. The DID model set above passed the parallel trend test. In the two periods after the implementation of TPP, the significance and sign of $After^k$ were the same as those of the benchmark regression, which verifies the robustness of the model. The absolute values of $After^2$ for coefficients *Farm_inc* and *Wage_inc* were significantly lower than those of $After^1$, indicating that the income effect of TPP weakened over time.

ii) PSM-DID test. The implementation selection of TPP is not random and is related to the sown area and the yield of regional crops. Although the DID model can effectively avoid endogeneity, it cannot avoid the bias of sample selection. Propensity score matching (PSM) is based on the theoretical framework of the counterfactual reasoning model, which matches the control group with the treatment group and can effectively solve the sample selection bias of non-random data. PSM with a radius of 0.05 was selected and combined with the DID method. It is necessary to conduct

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Table 4. Results of the parallel trend test

Variables	*Total_inc* (1)	*Farm_inc* (2)	*Wage_inc* (3)	*Other_inc* (4)
Before[6]	–0.5658 (–0.3789)	–2.5058 (–1.7195)	0.8506 (1.7558)	–0.1110 (–0.3216)
Before[5]	0.2355 (0.1587)	–1.5264 (–1.0518)	0.7305 (1.5035)	–0.0812 (–0.2372)
Before[4]	1.3060 (0.8755)	–0.4211 (–0.2873)	0.7073 (1.4791)	–0.0986 (–0.2861)
Before[3]	0.0572 (0.0377)	–0.7663 (–0.5198)	–0.3487 (–0.7054)	0.1233 (0.3767)
Before[2]	0.4466 (0.2856)	–1.1311 (–0.7636)	0.7470 (1.3566)	–0.0694 (–0.2003)
Before[1]	1.4287 (0.9291)	0.6200 (0.4150)	0.2625 (0.5391)	–0.1705 (–0.5124)
Current	1.5520 (0.9136)	1.5934 (0.9553)	–0.2958 (–0.5645)	–0.0891 (–0.2587)
After[1]	3.5663 (1.1310)	6.6756** (2.0549)	–1.1616** (–2.0082)	0.3504 (0.6870)
After[2]	0.3184 (0.1757)	3.4239* (1.7377)	–1.0356* (–1.9011)	0.6008 (1.1571)
Control variables	yes	yes	yes	yes
Constant	8.9996*** (15.3137)	6.4560*** (12.8376)	1.4698*** (4.7058)	0.4858*** (4.8263)
Household--fixed effect	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes
Observations	12 111	12 111	12 111	12 111
R^2	0.0618	0.0280	0.0477	0.0915

*,**,*** $P < 0.10$; $P < 0.05$, and $P < 0.01$, respectively; standard errors are shown in parentheses; 1–6 – period before target price policy implementation; *Total_inc* – gross income; *Farm_inc* – *per capita* total agricultural income; *Wage_inc* – *per capita* total wage income; *Other_inc* – *per capita* total other income

Source: Authors' own processing

the balance test and common support hypothesis test on the matching effect of PSM to ensure that the results of the PSM-DID test have an unbiased net effect. After matching, the standard deviation values of all variables decreased significantly and approached 0 (Figure 3), indicating that the PSM matching passed the balance test. Additionally, most of the observations were on support, and only a small number of samples were off support [Figure S1 in the Electronic Supplementary Material (ESM)]. The kernel density curves were also plotted before and after matching (Figures S2 and S3 in the ESM), which revealed a large difference between the control and treatment groups before matching, although the two types of samples seemed to be consistent after matching. In short, PSM matching passed the premise test and screened out unbiased ideal samples to estimate the DID model.

Table 5 summarises the estimation results of the DID model using samples that satisfy the common support hypothesis after PSM matching. The sign and significance of the coefficients were consistent with those in Table 3, which indicates that the benchmark regression results were robust when considering selection bias.

iii) Placebo test. The treatment group for the placebo test were randomly selected to exclude the interference of missing variables, similar to the practice of Ferrara et al. (2012). Samples were randomly selected as the treatment group, and the number of treatment groups was the same as that of subsidised households. Additionally, employing the baseline model, we conducted a rigorous regression analysis 1 000 times, incorporating a synthetic binary variable, to meticulously assess the stability of our findings under randomized treatment conditions. It can be seen that the regression coefficients estimated based on random samples flanked 0 and conformed to a normal distribution (Figures S4–S6

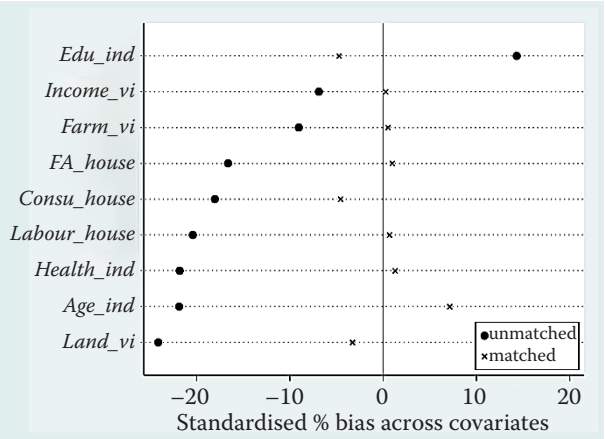

Figure 3. Covariate standardisation bias test

Edu_ind – number of schooling years for the head of household; *Income_vi* – net income of the village; *Farm_vi* – proportion of pure farming households of the village; *FA_house* – household's productive fixed assets value; *Consu_house* – household's living consumption expenditure; *Labour_house* – number of household labour; *Health_ind* – health status for the head of household; *Age_ind* – household head's age; *Land_vi* – *per capita* arable land area of the village

Source: Authors' own processing

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Table 5. Results of the PSM-DID test

Variables	*Total_inc* (1)	*Farm_inc* (2)	*Wage_inc* (3)	*Other_inc* (4)
Treat × *time*	0.6645 (0.6972)	3.2194*** (3.3129)	–1.1352*** (–4.6643)	0.1747 (1.1079)
Control variables	yes	yes	yes	yes
Constant	9.3650*** (13.5657)	6.6600*** (10.7112)	1.4740*** (5.6868)	0.3908*** (3.4205)
Household--fixed effect	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes
Observations	7 362	7 362	7 362	7 362
R^2	0.0759	0.0289	0.0582	0.1025

*,**,*** $P < 0.10$; $P < 0.05$, and $P < 0.01$, respectively; standard errors are shown in parentheses; PSM-DID – combination of propensity score matching model and differences-in-differences model; *Total_inc* – gross income; *Farm_inc* – *per capita* total agricultural income; *Wage_inc* – *per capita* total wage income; *Other_inc* – *per capita* total other income; *Treat* × *time* – dummy variable of type

Source: Authors' own processing

in the ESM). Further calculations revealed that the mean values of regression coefficients were 0.0044, 0.00097, 0.0015, and 0.0043 in the four simulations, which greatly differed from the benchmark regression coefficients. The probability of getting benchmark results based on random results is extremely low. Therefore, the benchmark results can be examined with the placebo test, thus excluding the possibility of a large bias due to omitted variables.

iv) Replacing the interpreted variable. Next, the robustness test used total income indicators as the interpreted variables (Table 6). The significance and sign of the coefficients were consistent with the benchmark results. This confirmed the robustness of the DID model and verified that the conclusion based on the benchmark regression is robust.

Heterogeneity analysis

i) Heterogeneity of scale operation. TPP targets crop growers in the implementation area, and the subsidy amount depends on the planting scale. The principle of TPP is offering subsidies to farmers based on the area they cultivate; that is, offering more subsidies to farmers who grow more, fewer subsidies to farmers who grow less, and no subsidies to farmers who do not grow. Hence, the area under soybean and cotton cultivation reflects the subsidy level. Based on the actual characteristics of soybean and cotton planting in China, households with a total sown area of soybean and cotton exceeding 20 000 m^2 were regarded as scale operations, and those with less than 20 000 m^2 of sown area were regarded as off-scale operations.

Table 7 reports the regression results of heterogeneity in planting size. TPP had a significant positive impact on the total income, farm income, and other income of households of scale operation. In contrast, the results of off-scale operation households were close to that of full samples, in which only the coefficient of farm income was significantly positive, while the coefficient of wage income was significantly negative. Furthermore, the values of all coefficients of *time* × *treat* for the scale operation group were higher than those for the off-scale operation group. These results suggest that the impact of TPP on farmer income is sensitive to the scale of rural households.

For the other income, the scale operation households of soybean and cotton receive more subsidies than off-scale operation households, which significantly increases their transfer income to levels exceeding their loss of interest income caused by planting capital investment. Scale operation households input more land than off-scale operation households, and

Table 6. Regression results obtained by replacing the interpreted variable

Variables	*Total_inc* (1)	*Farm_inc* (2)	*Wage_inc* (3)	*Other_inc* (4)
Treat × *time*	0.8464 (0.4128)	5.9313*** (2.9670)	–5.7547*** (–6.5041)	0.6698* (1.7206)
Control variables	yes	yes	yes	yes
Constant	20.7118*** (12.8118)	15.1698*** (10.3437)	4.5733*** (4.9853)	0.9688*** (4.3671)
Household--fixed effect	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes
Observations	12 111	12 111	12 111	12 111
R^2	0.0971	0.0192	0.1191	0.1229

*,**,*** $P < 0.10$; $P < 0.05$, and $P < 0.01$, respectively; standard errors are shown in parentheses; *Total_inc* – gross income; *Farm_inc* – *per capita* total agricultural income; *Wage_inc* – *per capita* total wage income; *Other_inc* – *per capita* total other income; *Treat* × *time* – dummy variable of type

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Table 7. Analysis of the heterogeneity of scale operation

Variables	Scale operation				Off-scale operation			
	Total_inc	*Farm_inc*	*Wage_inc*	*Other_inc*	*Total_inc*	*Farm_inc*	*Wage_inc*	*Other_inc*
Treat × *time*	12.5243*** (3.0972)	8.8086** (2.2373)	0.0807 (0.4646)	1.6449*** (2.8394)	0.3105 (0.3659)	3.2339*** (3.5695)	–1.1076*** (–4.8191)	0.2305 (1.4208)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes
Constant	11.6481 (1.4986)	11.6452 (1.6133)	0.3091 (0.6171)	1.3632* (1.7354)	8.5963*** (15.9572)	5.6357*** (12.9186)	1.6854*** (5.3743)	0.4292*** (5.2764)
Household-fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
Observations	483	483	483	483	11 628	11 628	11 628	11 628
R^2	0.2571	0.2113	0.0511	0.2724	0.0559	0.0163	0.0466	0.0857

*,**,*** $P < 0.10$; $P < 0.05$, and $P < 0.01$, respectively; standard errors are shown in parentheses; *Total_inc* – gross income; *Farm_inc* – *per capita* total agricultural income; *Wage_inc* – *per capita* total wage income; *Other_inc* – *per capita* total other income; *Treat* × *time* – dummy variable of type

Source: Authors' own processing

their opportunity cost for obtaining wage income is also higher for wage income. Before the implementation of the policy, the allocation of factors for scale operation households was already inclined toward the farm sector. As the policy does not have a major impact on the non-farm employment of scale operation households, the wage income of these households was not significantly affected. Scale operation households grow two crops with resource endowment advantages and production experience for farm income. TPP is more likely to mobilise the planting enthusiasm of scale operation households and improve their production output (Chen et al. 2011; Wang et al. 2018), so that scale operation households can obtain higher agricultural income.

ii) Heterogeneity of income. To determine whether TPP has a certain poverty reduction effect, we explore the difference in the impact of TPP on rural household income among households with different income levels. According to the relevant research, the poverty line is set at USD 3.2 per person per day (World Bank 2020). Households with an income of less than USD 3.2 per person per day comprise the poor group, while those above this threshold comprise the non-poor group. Here, the poverty standard was converted into the RMB equivalent using the purchasing power parity (PPP). In other words, the poverty line in this study was converted using the conversion factors of Chinese household consumption from 2009 to 2017.

Table 8 shows the results of income heterogeneity. The coefficients of *time* × *treat* for the non-poor group were positive and negative when *Farm_inc* and *Wage_inc* were the explained variables, respectively, and both were significant at the 1% level; however, they were positive but not statistically significant when *Total_inc* and *Other_inc* were the explained variables. This means TPP did not significantly increase the total income of non-poor rural households but significantly promoted their farm income and significantly inhibited their wage income. Additionally, the coefficient value of *time* × *treat* for the non-poor group was significant when *Farm_inc* and *Wage_inc* were the explained variables, which suggests that the implementation of TPP increased the annual *per capita* farm income of subsidised households by approximately USD 644.94 (RMB 4 179.2), but reduced the annual *per capita* wage income of these households by approximately USD 184.52 (RMB 1 195.7), on average. It was positive and significant only if *Other_inc* was the explained variable and all the other coefficients were not significant. This implies that TPP increased only the other income of poor households and had no significant impact on their total income, farm income, and wage income.

The proportion of transfer subsidy in the total income of the poor group was larger than that of the non-poor group, indicating that the policy significantly increases the other income of the poor group. However, poor households tend to have fewer factors at their disposal to invest in agriculture, and job opportunities are limited by their education level (Du et al. 2005). The scope of poor farmers to change their management decisions is very limited; therefore, policy implementation has no significant effect on their total income,

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Table 8. Analysis of the heterogeneity of income

Variables	Non-poor group				Poor group			
	Total_inc	*Farm_inc*	*Wage_inc*	*Other_inc*	*Total_inc*	*Farm_inc*	*Wage_inc*	*Other_inc*
Treat × *time*	1.5503 (1.5664)	4.1792*** (4.0727)	–1.1957*** (–4.8025)	0.2361 (1.4124)	–0.2489 (–0.7492)	0.7623 (0.5297)	–0.1493 (–1.3897)	0.3054* (1.7954)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes
Constant	10.1316*** (14.1874)	6.8365*** (11.1002)	1.9588*** (4.6872)	0.5406*** (5.2074)	2.9047*** (16.9025)	1.8120*** (11.9161)	0.1181 (0.7754)	0.3498*** (5.6047)
Household-fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
Observations	9 328	9 328	9 328	9 328	2 783	2 783	2 783	2 783
R^2	0.0623	0.0240	0.0543	0.0816	0.1699	0.0997	0.0223	0.1547

*,**,*** $P < 0.10$; $P < 0.05$, and $P < 0.01$, respectively; standard errors are shown in parentheses; *Total_inc* – gross income; *Farm_inc* – *per capita* total agricultural income; *Wage_inc* – *per capita* total wage income; *Other_inc* – *per capita* total other income; *Treat* × *time* – dummy variable of type

Source: Authors' own processing

farm income, and wage income. In short, the income effect of TPP is noticeable for non-poor households with more disposable factors; however, the policy has not yet achieved the effect of poverty reduction for poor households.

Analysis of the influence mechanism

Table 9 illustrates the validation results of the mediation effect test. The robustness of the mediation was tested using the methods of Sobel and Bootstrap (Taylor et al. 2008). The results of the Sorbel test showed

Table 9. Results of the mediation effect test

Variables	(1) *Farm_time*	(2) *Farm_inc*	(3) *Nonfarm_time*	(4) *Wage_inc*	(5) *Plant_cost*	(6) *Farm_inc*
Time × *treat*	0.1320 (0.1656)	3.6688*** (4.1563)	–2.3060*** (–2.7255)	–0.9389*** (–4.3636)	1.1804** (2.2266)	3.4044*** (3.7975)
Farm_time	–	0.1043*** (4.8341)	–	–	–	–
Nonfarm_time	–	–	–	0.0657*** (5.1448)	–	–
Plant_cost	–	–	–	–	–	0.2357*** (3.4264)
Control variables	yes	yes	yes	yes	yes	yes
Constant	3.2119*** (12.5040)	5.6991*** (13.1541)	5.0226*** (8.3598)	1.3737*** (4.6909)	1.9730*** (12.0720)	5.5691*** (12.3176)
Household–fixed effect	yes	yes	yes	yes	yes	yes
Year–fixed effect	yes	yes	yes	yes	yes	yes
Observations	12 111	12 111	12 111	12 111	12 111	12 111
R^2	0.3904	0.0256	0.2819	0.0585	0.0128	0.0324
Sobel test	0.9399 ($z = 7.77$, $P = 0.00$)		0.04560 ($z = 16.13$, $P = 0.00$)		2.8907 ($z = 16.13$, $P = 0.00$)	
Bootstrap test (indirect effect)	[6.6646, 10.5423]		[0.1022, 0.3450]		[2.1527, 3.6287]	
Bootstrap test (direct effect)	[0.5188, 1.3029]		[–2.2707, –1.5248]		[4.5595, 8.5414]	

*,**,*** $P < 0.10$; $P < 0.05$, and $P < 0.01$, respectively; standard errors are shown in parentheses; *Farm_inc* – *per capita* total agricultural income; *Wage_inc* – *per capita* total wage income; *Treat* × *time* – dummy variable of type; *Farm_time* – household's on-farm working time; *Nonfarm_time* – household's non-farm working time; *Plant_cost* – household's annual planting costs

Source: Authors' own processing

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that the *z*-values of all coefficients were greater than 1.65, and their *P*-values were less than 0.10. After sampling 1 000 times using the Bootstrap method, the 95% confidence intervals of the direct and indirect effects did not include 0. Thus, the mediation effect passed the Sobel and Bootstrap tests.

The regression results of the working time distribution of households, as the mediation report, are shown in the first four columns of Table 8. The coefficients of the explanatory variables when *Farm_time* and *Farm_inc* were the explained variables, which represent the regression results of farm working time as the mediation variable, indicated that the TPP encourages farmers of subsidised households to increase their farm working time input. Farm working time was positively correlated with farm income. The coefficients of the explanatory variables when *Nonfarm_time* and *Wage_inc* were the explained variables, which estimate the non-farm working time as the mediation variable, indicated that the policy causes farmers to reduce their non-farm working time, which was positively correlated with the wage income of rural households. Lastly, the coefficients of the explanatory variables when *Plant_cost* and *Farm_inc* were the explained variables, which represent the regression results of the planting input as a mediator, demonstrate that the policy stimulates farmers to increase their investment in planting, which was positively correlated with farm income.

Overall, the impact path of TPP on the income of subsidised households is the allocation of working time and the input of planting costs. The policy promotes the increase in rural household farm income by promoting the input of their farm working time and planting costs, and reduces the wage income of rural households by lowering their non-farm working time. The regression results of the mediation test verify the above-described results of the mediation theory analysis.

CONCLUSION

Considering the implementation of TPP as a quasi-natural experiment, this study employs the DID method to examine its impact on rural household income based on the national fixed rural observation points socioeconomic survey data from 2009 to 2017. Based on the results, the following conclusions are made.

First, TTP generally did not increase the rural household income. Specifically, TPP had no significant impact on rural households' total income and other income (including property income and transfer income) but significantly increased their agricultural income and reduced their wage income.

Second, the effect of TPP on rural household income varied depending on the planting scale and income level of the household. Specifically, TTP can significantly increase the total income and agricultural income of scale operation households but only increase the agricultural income, not the total income, and even decrease the wage income of off-scale operation households. Meanwhile, there is a significant impact on the agricultural income of non-poor households and other income of poor households.

Third, TPP affects the agricultural income level of farmers by changing the allocation of labour time and investment in planting funds of rural households. This policy encouraged farmers to invest more farm working time and planting costs, thereby boosting the rural household farm income. The policy enabled households to reduce the time spent on non-farm employment, reducing their wage income.

Policy implications. Based on the above research and conclusions, this paper proposes the following policy implications.

First, TTP can favour large-scale growers, such as cooperatives, agricultural enterprises, large and specialised family businesses, family farms, and other new agricultural entities. The large-scale operation of target crops should be conducted through rural land transference. Large-scale growers allocate resources efficiently and promote cropping development. Due to this, their total income and agricultural income increase under TPP. Off-scale growers can get paid by transferring their land-use rights. They can gain more wage income and other income through non-agricultural jobs, such as manufacturing, service, and construction industries.

Second, as TPP is not a universal policy and fails to achieve the effect of poverty reduction, it should be combined with direct subsidies for poor households. Simultaneously, policymakers are eager for rural non-farm growth to provide a way to shake off a large part of rural poverty (Haggblade et al. 2010). Developing a non-farm economy in poor areas and guiding farmers to participate in non-farm employment by providing the necessary training and employment opportunities could overcome the shortcomings of TPP and facilitate poverty reduction.

Finally, the government should take appropriate measures to stimulate the participation of farmers in non-farm employment. On the one hand, the government can increase the efficiency of agricultural

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production by encouraging the innovation of agricultural production technology, which would release more labour force into non-farm employment. Farmers shift more of their time and energy from farming operations to non-farm employment, such as manufacturing industry, service, and construction business workers, increasing their wage income and other income. On the other hand, the government can strengthen the support for non-farm employment and entrepreneurship of rural households in terms of funds and education, which would eliminate the impediments preventing farmers from entering non-farm employment.

Scope for future research. This study has a few limitations. First, to evaluate the impact of the TPP on rural household income, control variables and fixed effects were added to the DID model and robustness tests. However, there may still be unconsidered variables that were not added to the model. Therefore, the results obtained may be an over- or under-estimation of the true results. Second, although the differences in the income and operation scale of farmers were considered, the differences in the other characteristics of farmers, such as household consumption and the number of working members per household, were not analysed. To overcome this limitation, more influencing factors will be incorporated into the model, and more heterogeneity tests will be conducted in future research.

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