



A study assessing the impact of income relative deprivation and cooperative membership on rural residents' health: A pathway towards improving the health status of rural residents

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ABSTRACT

Rural residents' health status is related to their happiness, socioeconomic status, personal development, and the ideals of living, but individual income relative deprivation has a negative impact on their health. Hence, this study aimed to examine that how to alleviate the negative impact of income relative deprivation on rural residents' health. Based on a literature review, it is the first study to propose that cooperative membership could help alleviate the adverse effects of income relative deprivation on rural residents' health. It survey data from 466 farm households in Shandong Province in China and employs an endogenous switching probit model to solve the endogenous problems. The results show that relative deprivation positively affects farmers' membership in a cooperative but negatively impacts their health. More importantly, the results indicate that membership in a cooperative improves farmers' health and alleviates the adverse effects of relative deprivation. These findings not only expand the empirical research on the positive impact of relative deprivation but also provide a new pathway towards improving the negative impact of income relative deprivation on rural residents' health. That is, the government should guide smallholder farmers to join professional cooperatives and encourage the development of 'multi-functional' cooperatives to play a greater role in improving rural residents' health.

1. Introduction

Individuals always tend to benchmark themselves to others who are better off rather than those worse off, creating a psychological gap linked to relative deprivation [1,2]. A substantial number of studies provide evidence of negative impacts on individuals' health attributed to relative deprivation [1,3–13]. These negative effects are manifested in the increase in psychological pressure [1,14], the frequency of smoking and drinking [4], the increased probability of chronic diseases [15,16], and a decrease in the probability of individuals' access to public goods and active participation in social activities, which lead people to not obtain enough social and emotional support, thus increasing the risk of disease and death [17].

In rural areas of China, farmers live and work in villages; therefore, they are familiar with one another and less connected to people from

other areas. Hence, they are more likely to compare their income to others who live in the same village [18–20]. Farmers are relatively deprived if they feel more disadvantaged in income than their peers in the same village, and in turn, higher income differences lead to a more significant increase in relative deprivation [9]. Previous studies have also confirmed that the negative impact of income relative deprivation on health is greater among rural residents than urban residents [21–24]. In addition, with the rapid development of industrialisation and urbanisation, as well as rural transformation in China, many young residents migrate to cities and towns to work while the elderly remain in the countryside. As a result, the elderly in rural areas are economically disadvantaged and are more likely to perceive relative deprivation [20,22,25,26]. Health as human capital is related to rural residents' happiness and welfare [27], socioeconomic status [28–31], personal development, and the ideals of living [32–34]. Therefore, it is necessary

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to explore how to alleviate the negative impact of income relative deprivation on rural residents' health.

The existing theoretical literature suggests that the adverse impact of negative income deprivation on rural residents' health can be effectively alleviated by improving the level of farmers' absolute income [8,31,35] and increasing social capital [5,36]. The reasons are that the increase in absolute income could narrow income differences and then reduce rural residents' relative deprivation, thus alleviating their psychosocial stress [5,8]; the increase in social capital may improve people's sense of belonging and relieve anxiety [37], enhance their self-esteem and confidence [38], and increase their access to additional health-related knowledge, as well as provide a means to fully express negative emotions, which can improve their mental health [5]. Increasing absolute income and social capital is a direct way to alleviate the negative impact of relative deprivation on health. What about indirect methods? For example, several studies have considered that cooperative membership plays a pivotal role in increasing rural residents' income [39–42], improves their livelihoods [43], and increases their welfare [42,44,45]. Furthermore, the existing literature has focused on the positive roles played by the social function of agricultural cooperatives, such as increasing rural residents' social capital [46–49] and improving rural residents' human capital through experience exchange and training sessions [49]. Hence, whether cooperative membership increases rural residents' income and their social capital, thus helping alleviate the negative effects of relative income deprivation on rural residents' health, this need further empirical study.

The study aimed to examine whether cooperative membership alleviates the adverse effects of relative deprivation on rural residents' health using endogenous switching probit (ESP) models. The reason for adopting the ESP model was that the identification variable in the selection equation of the ESP model not only effectively controls for the endogeneity of variables [50], but also considers the unobservable variables that could simultaneously affect a farmer's decision to be a cooperative member and their health. Moreover, data collected from 466 farmers from Shandong Province in China was used to conduct the empirical analysis. Shandong Province is not only one of the largest agricultural provinces in China, but also ranks at the top in terms of the total number of farmers' professional cooperatives registered by 2020.

The study contributes to the growing literature in three ways. It is the first study to investigate the effects of relative deprivation on the membership of farmers' cooperatives, which contributes to expanding the application field of relative deprivation theory and strengthening empirical research on the positive effects of relative deprivation. Second, a discussion was conducted in existing research fields on the impact of cooperative membership on farmers, providing novel evidence for further promotion of specialised farmer cooperatives in China. Third, from the perspective of cooperative participation, this study explored the path to alleviating the adverse effects of income relative deprivation on farmers' health, providing a new pathway for existing research towards improving the health status of rural residents.

The remainder of this paper is organised as follows: The next section comprises the literature review and research hypotheses. Section 3 presents the sample data and estimation model used in the analysis. Section 4 discusses the empirical results in detail, followed by the conclusion of this study in the final section.

2. Literature review and research hypotheses

To date, existing studies have explored the effects of relative deprivation on individual health, well-being, quality of life, migration decision, and willingness to withdraw from homesteads (Table 1). To summarise, there are two main research topics on the impacts of relative deprivation. One is the impact of relative deprivation on rural residents' health, well-being, and quality of life related to health; for example, relative deprivation has an adverse effect on residents' health [7,8,21,25,51], a negative impact on their quality of life [22,51], and

Table 1

Summary of research topics on the impacts of relative deprivation.

Research subject	Author, year
The relationship between relative deprivation and health	Wildman [12]; Yngwe, Fritzell [3]; Eibner and Evans [4]; Kondo, Kawachi [6]; Gravelle and Sutton [9]; Subramanyam, Kawachi [11]; Salti [10]; Ren, Q [8]; Huang and Yang [59]; Huang, Ren [5]; Gero, Miyawaki [1]; Lyu and Sun [7]; Sung, Qiu [60]; Cai, Laporte [21]
The relationship between relative deprivation and well-being	Chan, Wong [61]; D'Ambrosio and Frick [62]; He, Fu [63]; Ni, Jia [52]; Chen [53]
The relationship between relative deprivation and quality of life	Qin, Xu [22]; Xia and Ma [51]
The relationship between relative deprivation and migration decision	Stark, Micevska [56]; Hyll and Schneider [64]; Ren, Q [65]; Kafle, Benfica [57]; Sani Ibrahim, Ozdeser [55]
The relationship between relative deprivation and willingness to withdraw from homesteads	Si, Jiang [58]

reduces their well-being [52–54]. The other topic is the impact of relative deprivation on residents' behaviour; for example, relative deprivation is an important driving factor in a household's decision to migrate temporarily or permanently [8,55,56]. The impact of relative deprivation on migration is more pronounced in male-headed households engaged in agriculture in rural areas [57]. Further research revealed that relative deprivation significantly and negatively affects rural residents' willingness to withdraw from homesteads [58]. However, to date, there has been little discussion of the effect of relative deprivation on rural residents' willingness to be cooperative members.

2.1. Relative deprivation and cooperative membership

Previous research has assumed that each farmer is a rational economic player who expects utility maximisation [66,67]. According to the theory of the optimising peasant by [68], farmers join cooperatives to maximise utility. Therefore, by establishing a utility maximisation function, this paper analyses whether farmers join cooperatives. Here, we establish the farmers' utility maximisation function according to Stark [69] study, which found that individual utility depends on absolute income and relative deprivation from a vertical comparison of individual income. Relative deprivation is when one is worse off compared to someone, thereby accompanied by feelings of anger and resentment [70,71]. In rural China, farmers live and work in villages; therefore, they are familiar with one another and less connected to people from other areas. Therefore, they are more likely to compare their income to others who live in the same village [18]. As a result, farmers are relatively deprived if they feel more disadvantaged in income than their peers in the same village, and in turn, higher income differences lead to a more significant increase in relative deprivation [9].

We suppose that U_i denotes the utility of farmer i , y_i represents the annual household income of farmer i , and R_i means the relative deprivation perceived by farmers i . Therefore, according to Stark's (1984) study, the utility function of farmer i could be postulated as

$$U_i = U(y_i, R_i) \quad (1)$$

with

$$\frac{\partial U}{\partial y} > 0, \frac{\partial^2 U}{\partial y^2} < 0 \quad (2)$$

$$\frac{\partial U}{\partial R_i} < 0, \frac{\partial^2 U}{\partial R_i^2} > 0 \quad (3)$$

Thus, farmers' utility increases with absolute household income, however, there is a diminishing utility of relative deprivation. This definition is in line with the finding of Fehr and Schmidt [72] who

considered that the rational economic player is not only self-interested but also green with jealousy; that is, an individual will encounter the negative effect of jealousy when his income is lower than that of others. This feeling of jealousy and depression is defined as relative deprivation by psychologists; therefore, it is also considered to be a negative effect of relative deprivation.

We suppose that y_i^1 and R_i^1 represent the annual household income of farmer i and the relative deprivation perceived by farmer i before being a cooperative member, respectively. The utility function of farmer i before being a cooperative member could be postulated as

$$U_i^1 = U(y_i^1, R_i^1) \quad (4)$$

People are born with an aversion to inequality [73,74]. Inequality may make people in a disadvantaged position dissatisfied and stimulate individuals and promote optimistic expectations [75]. If an individual feels significant relative deprivation for a long time, he or she must take positive action [76]. For example, relative deprivation stimulates an individual's sense of competition and enterprising motivation [77,78]; relative deprivation plays a negative partial intermediary effect between regional brands of agricultural products and farmers' green production [79] and partially mediates the relationship between organisational fairness and service innovation behaviour [76]. With the promotion of agricultural cooperatives, farmers could choose to join cooperatives to reduce relative deprivation since being a cooperative member contributes to an increase in household income [39–42,80]. We suppose that the annual household income of farmer i increases to y_i^2 . Furthermore, the increase in household income could reduce relative income deprivation if the reference group for comparison does not change. We suppose that the relative deprivation perceived by farmer i reduces to R_i^2 from R_i^1 ; then, the utility function of farmer i being a cooperative member could be posited as

$$U_i^2 = U(y_i^2, R_i^2) \quad (5)$$

The utility of farmers will improve with the increase in income and with the corresponding decrease in relative deprivation shown in Eq. (2) and Eq. (3). This suggests that the increase in household income could not only enable farmers to obtain better utility satisfaction but also narrow the income gap and reduce the negative utility caused by jealousy [72]. Hence, $U_i^2 > U_i^1$, that is, the utility of farmer i is improved after being a cooperative member. Therefore, the stronger the relative deprivation perceived by farmers who pursue the maximisation of utility, the lower the utility and the more willing they are to join the cooperative. However, there are also cases where cooperative membership has a heterogeneous impact on farmers' income [81] or has no effect on farmers' situations [82]. Therefore, we propose the following hypothesis:

Hypothesis 1. The likelihood of cooperative membership is higher for farmers with higher relative deprivation.

2.2. Cooperative membership and farmers' health

Existing studies have shown that cooperative membership could influence farmers' health through three pathways. First, a considerable amount of literature has shown that smallholder farmers in many developing countries face socioeconomic difficulties such as limited access to credit and extension services, shortage of modern agricultural technologies and equipment, high transaction costs of accessing input and output markets [40,83], and counterfeit production materials (e.g. insecticide, fertilisers, seeds) from unscrupulous suppliers. These restrictions could harm smallholder farmers' rights and interests and affect their mental status, causing psychosocial stress [84]. Agricultural cooperatives are referred to as vital foundations that could allow small farmers in developing countries to overcome difficulties by enhancing their bargaining power [80,85], strengthening their economic position [86], influencing the adoption of technology-enhancing productivity

[87], and improving agricultural technical efficiency [88,89]. All of the above stabilise smallholder farmers' moods, improving their living standards and quality of life [84].

Second, farmers in rural areas are familiar with each other and less connected to people in other areas; therefore, they are more likely to compare their incomes to those of others with higher incomes who live in the same village [5]. People are relatively deprived if they feel more disadvantaged in income compared to peers in the same village, and, in turn, higher income differences would cause a more significant increase in relative deprivation [9]. Thus, deprivation may lead to psychosocial stress, bringing about illness [4] or weakening their ability to access local health-related resources [90]. A cooperative member could contribute to increasing farmers' income [39–42,80] which not only narrows income differences but also reduces farmers' relative deprivation, thus alleviating their psychosocial stress [5] helping farmers to obtain local health-related resources to meet their livelihood needs, thereby improving their health conditions. Moreover, a higher income could ensure that farmers have sufficient money to obtain better health care, thereby improving their health.

Third, with the rapid development of industrialisation and urbanisation, as well as rural transformation in China, the countryside is emptying and decaying as many rural residents migrate to cities and towns [34], which brings about two effects. On the one hand, traditional rural collective economic organisations or communities are disappearing, weakening rural social interaction between farmers, leading to the dispersion of farmers, and reducing their sense of security, which affects farmers' health [37]. On the other hand, farmers are affected by the market economy system and urban multiculturalism, which causes serious emotional shocks and psychological gaps among farmers [18]. Numerous studies maintain that agricultural cooperatives contribute to the viability of rural communities and rural development [91–94]. By holding various technical training or entertainment activities, cooperatives allow smallholder farmers to gather [43,49], which may help them improve their sense of belonging and relieve anxiety, thus improving their health. In addition, these activities enrich the spiritual lives of farmers and address their emotional requirements [37], as well as strengthen social interaction between farmers and deepen their social trust [95,96]. Social trust could improve residents' self-esteem and confidence when handling affairs [38]. Meanwhile, social interaction among farmers could help increase their access to additional health-related knowledge, as well as provide a means to fully express negative emotions, which can improve their mental health [37].

However, several studies indicate that whether the effects of agricultural cooperatives on their members are positive or negative depends on which indicators are considered [97–99]. In addition, there is evidence of cooperatives facing various challenges, such as poor management, socioeconomic constraints, and financial irregularities [43,100,101]. With this consideration, the following hypothesis is postulated:

Hypothesis 2. Farmers who are members of a cooperative may have better health than small farmers.

2.3. Cooperative membership, relative deprivation and farmers' health

The literature claims that relative deprivation adversely impacts farmers' health because it encourages increased psychological pressure and decreased social capital [4,17,102]. However, as described in Sections 2.1 and 2.2, cooperative membership could help alleviate the adverse effects of relative deprivation on farmers' health caused by psychological pressure. On the other hand, cooperatives, as a community, reorganise smallholder farmers, which meets their social interaction requirements. Furthermore, various activities such as training sessions and technical exchange meetings held by cooperatives help farmers communicate and interact with others more frequently and broadly, deepen interpersonal trust and social trust, and, in turn, expand

social capital. Therefore, being members of cooperatives could help deprived farmers alleviate the adverse effects of relative deprivation on their health caused by social capital. Accordingly, we propose the following hypothesis:

Hypothesis 3. Cooperative membership could help alleviate the adverse effects of relative deprivation on farmers' health.

3. Methodology

3.1. Data source

The data used in this study were collected from Shandong Province. The reasons for selecting this sample area are as follow. First, according to the communication of the third agricultural census of Shandong Province (No. 4), there were 69,500 administrative villages and 19.629 million peasant households in Shandong Province, the highest in the country. Second, Shandong is one of the largest agricultural provinces in China. In terms of the total output value of agriculture forestry stockbreeding fishery in 2020, according to the statistical communiqué of Shandong Province on the national economic and social development of 2020, it was 1019.06 billion Chinese yuan in Shandong Province, which became the first province to exceed one trillion Chinese yuan in China. With regard to total grain production in 2020, it was about 54.47 billion kilograms in Shandong Province, which has exceeded 50 billion kilograms for seven consecutive years. Third, regarding the development of professional farmers' cooperatives, the above-mentioned communiqué showed that 236,000 professional farmers' cooperatives had been

registered in Shandong Province by 2020, which is in the top rank of China.

The random sampling method was used to select the study area. The specific sampling process was as follows: First, regarding location selection, we comprehensively considered the influence of multiple factors, such as the development situation of agriculture and agricultural cooperatives, the scale of population and farmland areas in administrative villages, and the need for regional coordination and balance. Ten cities (counties or districts) in Shandong Province were selected as the final sample area (as shown in Fig. 1). Then, two villages were randomly selected from each sampled city (county, district), and the random sampling method was used to select 25 households from each sample village. Finally, we conducted a face-to-face field survey in November 2020 and December 2020. A total of 500 questionnaires were administered, and 466 valid questionnaires were obtained, excluding those that missed key information or obvious errors. The response rate of questionnaires was 93.2%.

3.2. Estimation model

One of the study's empirical analyses examined agricultural cooperative membership on farmers' health. The cooperative membership variable is dichotomous, implying that a probit or logit regression model may be appropriate. However, a major limitation of using these binary models in the study is that being a cooperative membership is not necessarily random [103,104], which could result in possible selectivity bias [105]. That is, whether farmers participate in cooperatives is a rational decision made by farmers based on their conditions and

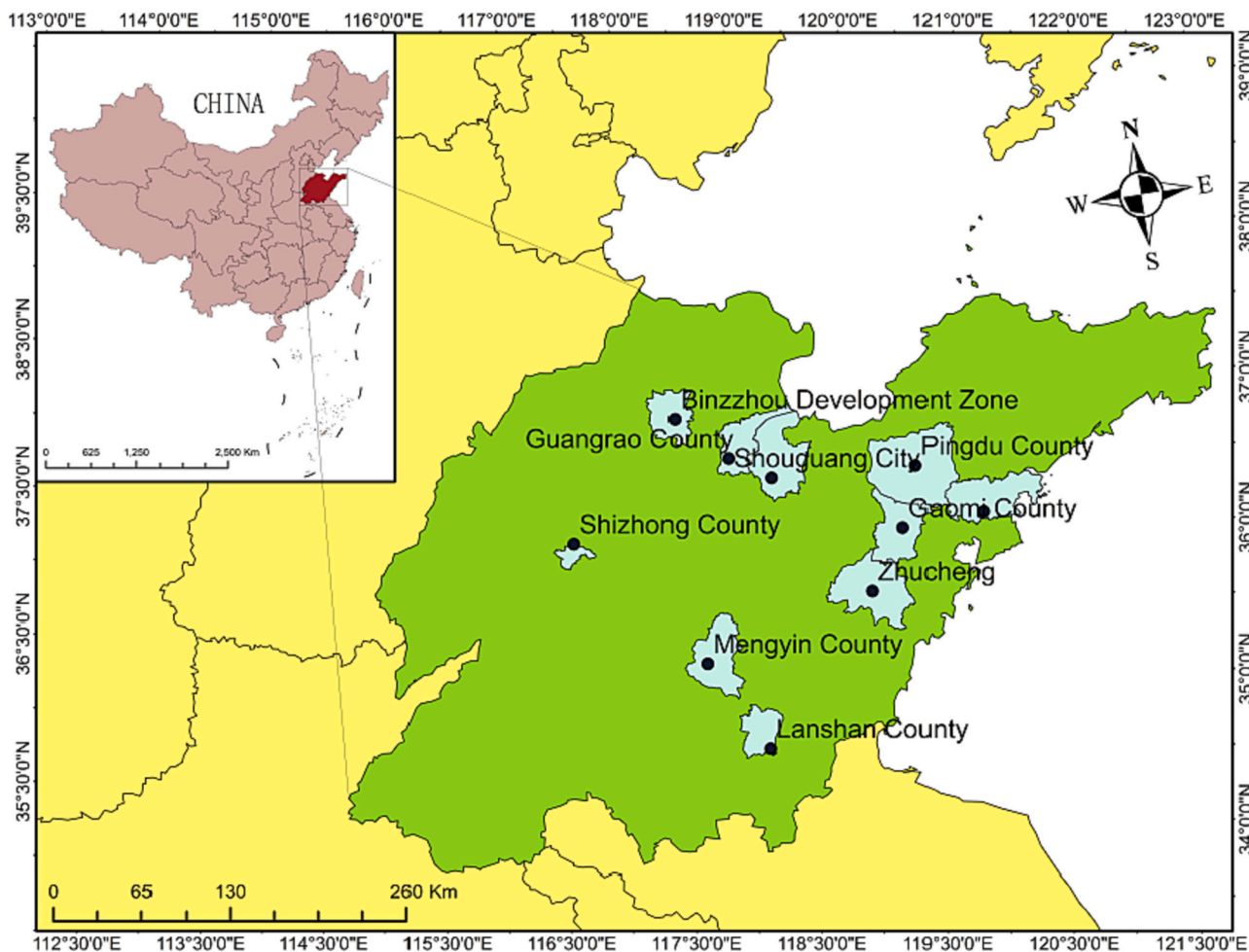


Fig. 1. Study area.

resource endowments that may be influenced by some unobserved factors [103]. Some unobservable variables also influence rural residents' health.

Moreover, identifying the causal relationship between key variables is also a crucial factor when determining the estimation model [106] since the above setbacks will lead to endogenous problems. For example, if the study neglects or fails to deal with the endogeneity of the cooperative membership variable, it will lead to inconsistent estimates that result in spurious conclusions [107]. Thus, adopting the ESP model is preferable to obtain better results.

The advantages of the ESP model are that the identification variable in the selection equation of the model could not only effectively control for the endogeneity of variables [50], but also consider the unobservable variables that could simultaneously affect a farmer's decision to be a cooperative member and the farmer's health [104]. Hence, the ESP model has been widely used to examine the impact of agricultural programmes on youth engagement in agribusiness in Nigeria [105], whether social capital strengthens the positive effect of land tenure security on family farms' green control techniques adoption [108], how women's participation in the cowpea value chain affect cowpea production, marketing and adoption of improved cowpea varieties, whether cooperative membership impacts farmers' choice of marketing channels [103], the effect of smallholder farmers' access to a formal climate risk transfer mechanism on their risk preferences [109], and whether cooperative membership promote the adoption of green control techniques by farmers [104]. According to previous studies, the ESP model and variable parameters used in this study are as follows.

The ESP model comprises a switching equation used to estimate the factors affecting farmers' participation in agricultural cooperatives in this study (①) and an outcome equation used to estimate the factors affecting farmers' health (②).

$$\begin{cases} C_i^* = a + \gamma_1 R_i + \beta_1 X_i + u_i & \text{①} \\ H_i^* = b + \gamma_2 R_i + \theta C_i^* + \beta_2 Y_i + v_i & \text{②} \end{cases} \quad (6)$$

where C_i^* is the observed value of the cooperative membership decision of farmer i and $C_i^* = 1$ means that farmer i was a cooperative member. H_i^* represents the observed value of the health of farmer i , and $H_i^* = 1$ means that farmer i was healthy. R_i is the relative deprivation value of farmer i , and X_i and Y_i represent the vector of explanatory variables that affect farmer i 's decision to obtain cooperative membership and impact the health of farmer i , respectively. θ , γ_1 , and γ_2 are the coefficients to be estimated, a and b are the constant terms, and u_i and v_i are the residual terms.

In terms of controlling for the potential endogeneity of cooperative membership, the study used a shared random effect ε_i to reduce the dependence between u_i and v_i [110],

$$\begin{cases} u_i = \eta \varepsilon_i + \varphi_i & \text{③} \\ v_i = \varepsilon_i + \tau_i & \text{④} \end{cases} \quad (7)$$

Here ε_i , φ_i , and τ_i are hypothesised to be independently and identically distributed, with a mean of 0 and the same variance of 1; η is the estimated coefficient, which is a factor loading. φ_i and τ_i are the error terms. The covariance matrix of the residual terms u_i and v_i is

$$Cov(u_i, v_i) = \Sigma = \begin{pmatrix} \eta^2 + 1 & \eta \\ \eta & 2 \end{pmatrix} \quad (8)$$

Then, the correlation ρ between u_i and v_i is derived as follows.

$$\rho = \frac{\eta}{\sqrt{2(\eta^2 + 1)}} \quad (9)$$

If $\rho = 0$, C_i^* will be exogenous in the cooperative membership equation, while if $\rho \neq 0$, C_i^* is endogenous, and therefore, an endogenous switching model will be applied.

Finally, the study divided the effects of relative deprivation on farmers' health estimated from the ESP model into direct and indirect

effects to explore whether cooperative membership can alleviate the negative impact of relative deprivation on farmers' health. Consequently, Equation ① in (6) can be consolidated into ②, and the resulting simplified equation is

$$H_i^* = m + (\gamma_2 + \gamma_1 \theta) R + \beta_3 Y + \beta_4 Q + \omega \quad (10)$$

where m is a constant term, Y is the control variable, Q represents the identification variables, β_3 and β_4 are the respective coefficients of Y and Q , respectively, and ω is a random error term. γ_2 and $\gamma_1 \theta$ are the direct and indirect effects of income relative deprivation on farmers' health, respectively. Hence, the total impacts are $(\gamma_2 + \gamma_1 \theta) > 0$, it indicates that the direct effect of relative deprivation on farmers' health is less than the indirect effect; otherwise, the direct impact is greater than the indirect impact.

3.3. Variables

3.3.1. Income relative deprivation

The study used the Kakwani index to estimate individual income relative deprivation. The Kakwani index has been widely used in empirical studies [22,62,111,112] since it has the properties of non-negative decreasing, dimensionless, normalisation, scale invariance, and additive decomposability [113]. However, it is necessary to provide a reference group for individual comparison before estimating individual income relative deprivation. [114] have found that a reference group based on geographical location is better than other reference groups in China, especially for rural residents. Rural residents live in villages; therefore, they only compare their income with other villages within the geographical scope of the village [25]. Therefore, we take other village members as the reference group to measure the variable of relative deprivation.

Formally, Kakwani's relative deprivation index was developed based on the Yitzhaki index, which is referred to as the function of the Yitzhaki index divided by the average income of the total sample in the reference group [115]. The estimation formula of individual income relative deprivation is

$$R(x, x_i) = \frac{1}{n\mu} \sum_{k=i+1}^n (x_k - x_i) \quad (11)$$

where $R(x, x_i)$ is the relative income deprivation index for the individual farmer i , n is the total sample size in the reference group X , x_i means the income of the individual farmer i , and x_k represents the incomes of all farmers k whose incomes are higher than the income of the individual farmer i 's; μ is the average income of the total samples in the reference group. We calculated the income deprivation value of the interviewed farmers of the sample using Eq. (11), and its value range is [0,1].

3.3.2. Health status

The study selects self-rated health (SRH) to measure the health status of farmers. SRH is used for the following reasons: first, it is considered one of the most widely used subjective indicators of health status among adults [116,117]. Second, it was found to independently predict mortality, even after controlling for objective health measures [118]. Finally, SRH measurements were also easy to implement and have been proven valid in social and cultural contexts [119]. The study used the following question to measure SRH: 'How do you feel about your health?' according to the China Family Panel Studies. A five-point Likert scale (0 = very poor; 1 = poor; 2 = fair; 3 = good; 4 = excellent) was used to answer the question in the field study. However, the final measurement was recoded as a binary variable (0 = fair, poor, or very poor, 1 = excellent, or good) to adjust for its skewed distribution.

3.3.3. Cooperative membership

The cooperative membership variable was measured by asking the

question, ‘whether the smallholder farmer had joined the agricultural cooperative or not?’ It was denoted by C^* . If the respondent answered ‘Yes’, C^* was equal to 1; otherwise, C^* was 0.

3.3.4. Identification variable

To address the possible endogeneity of cooperative membership, at least one identification variable is necessary, included in the switch equation but not in the result equation [120]. In the study, the ‘knowledge of farmers about farmer professional cooperatives’ is selected as an identification variable because many studies have confirmed that the ‘knowledge of farmer professional cooperatives’ is a key factor that affects farmers’ decision to obtain cooperative membership [121–124]. However, there is no evidence that knowledge of farmer professional cooperatives impacts farmers’ health. In the field survey, the interviewed farmers could select from the following five options: ‘no knowledge at all’, ‘not much knowledge’, ‘average’, ‘reasonable knowledge’, and ‘very good knowledge’.

3.3.5. Control variables

Based on the analysis described in Section 2 and existing research, the control variables of this study consisted of basic information from the individuals such as gender, age, and education, and household information, including household size, household income, and social capital. Here, the study measured social capital, considered a multifaceted concept. For example, Jacobs [125] found that social capital can be reflected through a social network, while Putnam, Leonardi [126] considered that social capital included trust, norms, and networks, but the influence of social networks and trust is more conspicuous. However, there is evidence that a social network is the main determinant of farmers’ behaviour in China [127] because Chinese people pay more attention to interpersonal communication, especially in the countryside, which is described as an ‘acquaintance society’. Farmers maintain interpersonal and social interactions by giving gifts (money) for weddings or funerals and other items to each other (relatives, neighbours, and friends). These are referred to as ‘expenditure on social interaction’ [128]. Therefore, the ‘total expenditure of households on social interaction’ was used to measure the social capital variable in the questionnaire.

3.3.6. Descriptive statistics

The descriptive statistics (mean and standard deviation) for each variable are shown in Table 2. We found that, in general, the mean score of SRH of the sample farmers in the surveyed area was 0.492, indicating

Table 2
Descriptive statistics of variables.

Variables	Description	Mean	SD
Self-rated health	Health = 1, Non-health = 0	0.492	0.500
Cooperative membership	Member = 1, Non-member = 0	0.167	0.374
Income relative deprivation	The specified value measured by the Kakwani index	0.266	0.227
Age	Actual age in 2020	50.24	10.44
Sex	Female = 0, male = 1	0.408	0.492
Degree of education	Never been to school = 1, elementary school = 2, middle school = 3, high school = 4, university and above = 5	2.811	0.941
Number of family members	All the people living together in a house	4.556	1.586
Household income	household income per capita in 2020 (thousand yuan)	1.695	0.894
Social capital	household socialising expenses for relatives, neighbours, and friends, 2020 (thousand yuan)	4.630	5.576
Knowledge of farmer professional cooperatives	No knowledge = 1, not much knowledge = 2, average = 3, reasonable knowledge = 4, very good knowledge = 5	2.755	0.989

that the health of farmers was average. The mean relative deprivation value measured by the Kakwani index was 0.266. Exactly 16.7% of the farmers surveyed had participated in agricultural cooperatives, which was much lower than that indicated by the statistical data (nearly 50%) of the Farmers’ Cooperatives Development Report in 2019. The reason for this gap may be related to the agricultural development of the surveyed area or the existence of ‘empty shell’ farmer professional cooperatives in the surveyed village. The survey statistics showed two phenomena: one is that participation in farmer professional cooperatives was high in developed agricultural areas; the other is that although farmers professional cooperatives were registered in the sample village, smallholder farmers were reluctant to join them. Regarding the variable ‘knowledge of cooperatives’, the mean value was 2.755, indicating that the knowledge of the cooperatives of the respondents was average. Regarding individual information, 40.8% of the interviewees were male, the average age of the interviewees was 50.24 years, and the mean score of education level was 2.8, which indicated that the average degree of education of the respondents was junior high school or below. The above results indicated that the sample farmers were relatively older and less educated in the surveyed area. Regarding household characteristics, the average household size was 4.55 members, the average value of household income per capita in 2020 was 16,954 Chinese yuan, and the mean value of total household expenditure on social interaction in 2020 was 4630 Chinese yuan.

4. Results and discussion

The ESP model in Eq. (6) was used to investigate the factors affecting farmers’ participation in agricultural cooperatives and the determinants of farmers’ health. As can be seen in Table 3, the correlation coefficient ρ of the random error terms in the switching and outcome equations is significant at the 5% level, indicating that the cooperative membership index is an endogenous variable. Consequently, the ESP model is more

Table 3
Results of the endogenous switching probit model.

Variable type	Variable name	①	②
		Switch Equation (The determinants of cooperative membership)	Outcome Equation (The determinants of farmers’ health)
Main independent variable	Cooperative membership		1.126*** (0.408)
	Income relative deprivation	1.443** (0.693)	-1.905*** (0.449)
Control variable	Age	0.009 (0.011)	-0.016** (0.007)
	Sex	0.230* (0.122)	-0.014 (0.171)
	Degree of education	-0.126	0.197**
	Number of family members	0.081 (0.068)	-0.112** (0.053)
	Household income per capita	0.140 (0.299)	0.444** (0.174)
	Social capital	0.780*** (0.131)	0.074** (0.081)
Identification variable	Knowledge of cooperatives	0.477** (0.283)	
	Correlation coefficient ρ	-1.235** (0.617)	
	Constant	-10.390*** (3.171)	6.125*** (2.056)
	Observations	466	466

Note: ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

appropriate for this study than the independent regression models. Furthermore, the identification variable in the selection equation of the ESP model contributes to controlling for the endogenous problem [50]. The estimated results in Table 3 show that 'knowledge of farmers about professional farmer cooperatives' has a significant and positive impact on farmers obtaining cooperative membership at the 5% level, suggesting that the more farmers know about cooperatives, the more likely they are to be cooperative members. This finding is consistent with the previous analysis, in which the identification variables significantly affected the participation behaviour of farmers regarding cooperative membership.

4.1. Switch equation: the determinants of cooperative membership

The estimated results for the switch equation of cooperative membership are presented in the third column of Table 3. We can see a significant positive correlation between income relative deprivation and being a cooperative member ($p < 0.05$), indicating that farmers with more income relative deprivation are more likely to join farmers' professional cooperatives. Therefore, Hypothesis 1 is supported; that is, farmers with higher relative deprivation are more willing to join agricultural cooperatives to increase their expected income by taking advantage of reducing costs and risks or improving agricultural technical efficiency. This finding is consistent with the results reported by Festinger [129] who found that relative deprivation will enable farmers to raise their expectations of future income and stimulate their desire to urgently change the current economic situation, thereby bringing higher utility. This result is also similar to that published by Jencks and Mayer [130], Turley [77] and Zoogah [78] who found that relative deprivation could stimulate individual competitive consciousness and participation motivation and promote individuals to display some positive achievement behaviours (e.g. employees with low incomes may work harder to be promoted to higher incomes; students with poor academic performance may work harder to catch up to those with good academic performance).

Additionally, in terms of the control variables, the coefficient of the gender variable is significant and positive at the 10% level, which means that male respondents are more willing to join farmers' professional cooperatives. This result is consistent with the findings of He and Liu [131] [131], who revealed that, compared to women, men are more open-minded and receptive to new things, have more opportunities to participate in social networks, and are therefore more likely to be agricultural cooperative members to reduce the production and sales cost of agricultural products. Furthermore, the correlation coefficient of 'knowledge of farmer professional cooperatives' is significant at the 10% level, indicating that the more farmers know about farmers' professional cooperatives, the higher the possibility of farmers joining them. This finding is consistent with that of Lin and Gu [132] who consider that awareness of cooperatives influences farmers' cooperative membership. Finally, the coefficient on social capital is statistically significantly positive at the 1% level, suggesting a significant positive correlation between social networks and farmers' decisions to be cooperative members, which is consistent with the findings of Enander, Melin [133], who revealed that the wider the social network, the greater the possibility of cooperative participation. This interpretation is plausible since the farmers' decisions to be cooperative members will not be completely independent in the countryside described as an 'acquaintance society'; instead, they will be influenced by the decisions (opinions) of the others in the social network [134]. Furthermore, social communication has increased farmers' knowledge of agricultural cooperatives, promoting their participation in cooperatives.

Finally, concerning the variables of age and education level, the estimated results in Table 3 show that both have no impact on farmers' decisions to be cooperative members. The existing research is controversial about their impact. Some studies have indicated that both age and education level are key factors affecting farmers' decision to join

agricultural cooperatives [135], while other studies have shown that joining agricultural cooperatives is usually attributed to the behavioural decision-making of the entire family and does not depend on the age of individual farmers [136].

4.2. Outcome equation: the determinants of farmers' health

The estimated results for the outcome equation of farmers' health are summarised in the first columns on the right-hand side of Table 3. The estimation coefficient of income relative deprivation is statistically significant and negative at the 1% level, indicating that a higher relative deprivation perceived by farmers could lead to worse health status, which is consistent with the findings of Cai, Laporte [21] and Ren, Q [8]. During the field investigation, we found that farmers generally have the psychology of social comparison; that is, they tend to compare themselves with their neighbours (e.g. income, wealth, social position). Therefore, when the income of farmers is much lower than that of others, the sense of relative deprivation is greater, increasing the frequency of farmers' depression and other negative emotions, forming great psychological pressure, and leading to the deterioration of farmers' psychological status and the reduction of their health status [137]. In the long run, it will increase unhealthy consumption behaviours such as smoking and drinking [138] and then increase the probability of disease, which will have an adverse impact on farmers' health.

The cooperative membership indicator is statistically significant and positive at the 1% level, suggesting that cooperative membership could improve farmers' health. Therefore, H2 is supported, which is reasonable because agricultural cooperatives strengthen members' bargaining power, increasing the price of the product they produce and lowering the costs of purchased inputs, thus increasing their income [45]. Farmers with higher incomes are more likely to spend more on food, which could ensure that farmers receive adequate nutrition and improve their health levels. They also have more money to purchase basic medical and other health services to improve their health status over time. Moreover, higher incomes make it easier for farmers to obtain various resources to meet their living requirements, alleviate the life pressure perceived by farmers, and improve their physical and mental health. Another possible reason that cooperative membership improves farmers' health is that agricultural cooperatives, by association, enhance farmers' bargaining power and economic position, reduce costs, and increase income, thus improving their moods and health conditions [84]. Furthermore, agricultural cooperatives as community organisations enable farmers to realise 'reorganisation', which could help them find a sense of belonging, relieve their anxiety, and improve their health. The public platform created by agricultural cooperatives facilitates the exchange of emotions and information among farmers, which meets their emotional requirements [37] and is also beneficial to their physical and mental health.

Regarding the control variables, we found that respondents' education levels and the family's per capita income have significant positive effects on their health levels. In contrast, the respondent's age and the number of family members significantly negatively affect farmers' health. However, the gender of the respondent does not significantly affect their self-related health. Therefore, it is suggested that farmers with higher education levels and household income who are more likely and willing to invest in health will have better health. On the other hand, the older age of farmers and the larger number of family members could lead to a heavier family burden, which could cause a worsening of self-related health.

Regarding the social capital indicator, we found that it has a significant impact on farmers' health, which is supported by many studies. On the one hand, social capital contributes to the circulation and diffusion of health-promoting information or behaviours through widening information channels [139,140]. In rural areas, a social network generates more opportunities for exchange among farmers, which not only provides them with timely and trustworthy health-related information and

knowledge [141], thereby ameliorating the inefficiencies caused by imperfect information [142], but could also improve their healthcare behaviours such as exercise patterns, eating habits [143]. These health-promoting information or behaviours could improve their health self-defence ability and reduce the risk of disease. On the other hand, social networks and trust can reduce the harmful physiological effects of stress by alleviating anxiety and fear about the behaviour of others [144]. In addition, the affective support and acts provided through social capital can cultivate self-esteem and mutual respect for each other [145]. Moreover, social capital provides various forms of social support, such as social aid in dealing with stressful life events [143], which beneficially affects mental health.

4.3. The inhibitory effect of cooperative members on the adverse effects of relative deprivation on farmers' health

Table 4 presents the estimated results of the switch equation and the outcome equation of Eq. (6). It can be seen that $\gamma_2 = -1.905$, $\gamma_1 = 1.126$, $\theta = 1.443$. Hence, the impacts of income relative deprivation on farmers' health were divided into two parts. The direct effect of income relative deprivation on farmers' health is -1.905 ; the indirect effect is 1.625 ($\gamma_1\theta = 1.126 \times 1.443$), and the total impact is $(\gamma_2 + \gamma_1\theta) = (-1.905 + 1.625) = -0.28$. This result suggests that cooperative membership contributes to alleviating the negative impact of income relative deprivation on farmers' health, although the direct impact of income relative deprivation on farmers' health is greater than the indirect impact. H3 is supported because being a cooperative member could contribute to increasing farmers' income, which not only narrows income differences, reduces income-related relative deprivation, and thus alleviates psychosocial stress, but is also helpful for farmers in obtaining local health-related resources to meet their livelihood requirements, thus improving their health conditions. Hence, being members of cooperatives could help deprived farmers alleviate the adverse effects of relative deprivation on their health caused by psychological pressure.

Additionally, various activities, such as training sessions or technical exchange meetings held by cooperatives, are conducive to farmers' communication and interaction with others more frequently and broadly. These activities help farmers to meet their social interaction requirements, deepen interpersonal trust and social trust, and, in turn, expand their social capital. Therefore, being members of cooperatives could help deprived farmers alleviate the adverse effects of income relative deprivation on their health caused by social capital.

The finding of this study is different from the previous studies showing that the adverse impact of negative income deprivation on farmers' health can be effectively alleviated by improving the level of farmers' absolute income [8] and increasing social capital [5]. Based on these studies and the multi-functional characteristics of cooperatives, this study proposed and confirmed the path to alleviating the negative impact of income relative deprivation on rural residents' health from the perspective of cooperative participation, providing a new pathway to improve the health status of rural residents.

5. Conclusion

Rural residents' health status is related to their happiness and welfare, their socioeconomic status, their personal development, and the ideals of living, but individual income relative deprivation has a negative impact on their health. Hence, this study aimed to examine how to

Table 4
Effect of income-related relative deprivation on farmers' health.

The impact type of income relative deprivation	Calculation	Results
Direct impact	γ_2	-1.905
Indirect impact	$\gamma_1\theta$	1.625
Total impact	$\gamma_2 + \gamma_1\theta$	-0.28

alleviate the negative impact of income relative deprivation on rural residents' health. We applied ESP models to conduct an empirical analysis using survey data from 466 farm households in Shandong Province, China. Compared with the extant research, this is the first study to investigate the effects of relative deprivation on the membership of farmers' cooperatives and consider its contribution to alleviating the adverse effects of relative deprivation on rural residents' health. The results show that relative deprivation has a positive effect on the farmers' membership in a cooperative but a negative impact on their health. This finding contributes to expanding the application field of relative deprivation theory, provides novel evidence for further promotion of specialised farmer cooperatives in China, and provides a new pathway towards improving the health status of rural residents. Therefore, the following policy recommendations are proposed.

First, according to the analysis presented, income-related relative deprivation has an adverse effect on farmers' health; an alleviating factor is farmers' membership in a cooperative. Hence, more comprehensive discussions on the research application field of relative deprivation theory are required to fully understand the effects of relative deprivation. Furthermore, the analysis also shows that membership in cooperatives contributes to an increase in farmers' income, the expansion of their social capital, and the improvement of their health, thus alleviating the adverse effect of relative deprivation related to income on their health. Hence, the local government should encourage the development of 'multi-functional' farmer professional cooperatives that offer a variety of production services along with a greater focus on providing a diversity of public services, such as health counselling with farmers and cultural training (sessions), to play a greater role in improving the health of farmers. Finally, we also suggest that closer interest linkage mechanisms should be fostered to further guide and encourage small farmers to join cooperatives to resist the risks of external markets, increase their income, enhance their social capital and health, increase the degree of organisation of farmers, and improve their material and spiritual lives.

It is agreed upon that income relative deprivation negatively impacts individual health. Like China, other developing countries are also actively developing agricultural cooperatives and encouraging small farmers to join agricultural cooperatives [137]. Therefore, the analytical framework of this study applies to other developing countries, and its conclusions have reference significance for these countries to propose ways to improve the health of rural residents. However, one potential limitation of this study is that we used cross-sectional data for analysis; however, a cross-sectional study explains a phenomenon at a specific point in time [146]. Agricultural cooperatives are constantly developing, and their functions are also continuously improving. Whether there will be new ways to alleviate the relative deprivation of farmers' health requires study in the future. Therefore, future studies should consider collecting survey data from different periods for analysis to improve the robustness of the results.

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Author statement

I would like to declare on behalf of my co-author that the work described is original research that has not been published previously, and not under consideration for publication elsewhere, in whole or in part. I confirmed that no conflict of interest exists in the submission of this manuscript, and is approved by all authors for publication in your journal.

Declaration of Competing Interest

All authors declare that there is no conflict of interest.

Data availability

Data will be made available on request.

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