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Can Land Circulation Improve the Health of Middle-Aged and Older Farmers in China?

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Abstract: Compared with the urban aging population, the rural aging population in China is larger, and is subject to a lower per capita income, lower social security coverage, and insufficient security capacity. Therefore, ensuring the health of middle-aged and older farmers is an inevitable requirement for maintaining the stability of rural areas and society. This study uses data from the China Health and Retirement Longitudinal Survey (CHARLS) 2018, an ordered probit model and instrumental variable approach to empirically analyze the effect of land circulation out on the physical health of middle-aged and older farmers over 45. The results indicate that land circulation out positively and significantly affects farmers' health. Again, farmer's non-agricultural work and household income play a significant role in this positive relationship between land circulation out and farmers' health. Thus, the promotion of non-agricultural work for farmers and household income enhancement could alleviate household budget constraints while increasing health investment. The findings provide policies advocating for rural health development from land circulation perspectives.

Keywords: farmland circulation; health; budget constraints; IV ordered probit model

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1. Introduction

According to the National Bureau of Statistics of China, in 2019, China's population of people aged 60 and above is about 253.88 million, accounting for 18.1% of the total population, including 176.03 million people aged 65 and above, accounting for 12.6% of the total population. Both exceed the age standard of the United Nations for an aging society [1], indicating that population aging will be a major problem facing China in the coming decades. Unlike the population aging of developed countries, "aging before wealth accumulation" is an important feature of population aging in China, which will pose huge challenges to China's medical and older care services. Meanwhile, because of its dual urban–rural system, China has extremely uneven development in urban versus rural areas, which, when coupled with the large-scale urban–rural mobility of labor, results in more severe population aging in rural areas than in urban areas. Compared with the urban aging population, the rural aging population in China is larger, subject to a lower per capita income, lower social security coverage, and insufficient security capacity. Therefore, ensuring the health of middle-aged and older farmers is an inevitable requirement for maintaining the stability of rural areas and society. It is also an obligation to build a harmonious society, enhance people's happiness, and allow the general public to share the benefits of reform.

Because of the late start of medical care, older care, and other social security services in rural areas and the low level of social security, land has become an important form of informal security for farmers [1]. Consequently, the security function of land is far greater than the value of agricultural production itself. "Planting for food, working for expenditure" has become common. Although it is difficult to accumulate wealth by planting crops, especially through the decentralized management of food crops, agricultural production

can still provide necessary food for farmers to survive. For farmers who do not have employment skills, land is the last protective barrier for earning a living. Once land is lost, the foundation for survival is lost. Farmers' dependence on land is an important cause of China's slow-level dilemma of land circulation. Relevant studies have revealed that land circulation [2] is an effective way to realize large-scale agricultural operations and promote agricultural modernization in rural China [2,3]. Farmers transferring land also effectively increase their total household income [4], thus allowing them to invest more in household welfare, including health.

China's current agricultural production is still labor-intensive. Thus, agricultural production is intense and demanding, which imposes a high burden on farmers' physical health. Although proper labor within a certain period may have similar effects on physical health to those of exercise, the physical actions involved in agricultural production are often repetitive. Furthermore, long-term agricultural production increases the physical burden of farmers and causes hidden health risks. Long-term agricultural production involving contact with pesticides, chemical fertilizers, and other chemicals harms farmers' physical health seriously and is likely to cause chronic diseases that have irreversible effects [5]. Existing research has found that land circulation and agricultural mechanization supplement each other [6,7]. Improving the degree of agricultural mechanization through land circulation can help reduce the usage of pesticides [8], thereby reducing the harm of pesticides to farmers' health. Given the above scenario, a potentially positive relationship may exist between land circulation and farmers' health levels to a certain extent. However, there are some obstacles to land circulation in China. As the phenomenon of young people leaving rural areas to work in urban areas gradually increases in China [9], middle-aged and older farmers are becoming the main actors in agriculture production, in which the willingness for land circulation is relatively low [10]. If a positive correlation between land circulation and farmers' health levels does exist, it contradicts the conduct and the original intention of middle-aged and older farmers retaining their own land. Although there may exist a positive relationship between land circulation and mechanization, let us also note that mechanization, which normal involves fuel usage, can could lead to a climate change problem if not applied properly [11,12]. Thus, as nations seek remedies for healthy living among older farmers, it is essential for these nations to use agricultural machinery based on climate conditions and guide mechanization following a requirement to control carbon emissions while ensuring healthy living [13].

Land is not just retained simply because of economic value but more so because of the informal security that land provides for farmers. In other words, despite land circulation improving farmers' health, concern about future security makes farmers less willing to transfer their land. This dilemma has many causes. First, property rights or land use rights are not clear. Incomplete and unstable property rights increase the transaction costs and risks associated with land circulation, making it unpredictable and reducing land circulation scale and efficiency. Second, the effects of land circulation on farmers have not been extensively studied. Currently, the relevant research on land use is focused on the macro level. For instance, some researchers find that industrial structure optimization exhibits a positive linear correlation with urban land use efficiency [14]. Additionally, a study found that land misallocation significantly aggravated environmental pollution [15], which may have indirect adverse factors on people's health. What needs to be noted is that little attention has been paid to other effects of land circulation on farmers, such as those on health, education willingness, and trust in government. This results in incomplete knowledge of the positive effects of land circulation, preventing the further upscaling of land circulation.

To further enrich the research on the effect of land circulation and promote the rational transfer of land, this study uses the China Health and Retirement Longitudinal Survey (CHARLS) 2018 data to empirically analyze the effect of land circulation on the health of middle-aged and older farmers. Again, the mechanism existing in the relationship between the two components is examined. The contribution of the study is threefold. First, we

extend the literature on rural healthcare development by examining the determinants of the health of middle-aged and older farmers from the perspective of land circulation in China, a country striving to promote rural health development while ensuring sustainable agriculture. Second, an appropriate model that can alleviate selection bias in the study's findings is applied. In most cases, the endogeneity issue is ignored by scholars, but this study considers this issue and deals with it. Finally, using income and time allocation as potential pathways, the study explores the action mechanism through which land circulation out affects the health of middle-aged and older farmers further.

2. Literature Review

By combing the relevant literature, it is found that the existing research mainly focuses on the influencing factors of farmers' health and the income of land circulation.

There is a plethora of studies on the factors that influence farmers' physical and mental health. Beard et al. emphasize the importance of socioeconomic and cultural factors, including, e.g., individual socioeconomic status, sex, and race in individual-level dimensions, population composition, social environment, and physical environment in neighborhood-level dimensions [16]. Mitchell et al. conclude that individual and area characteristics influence health [17]. Marmot emphasizes the importance of income, which directly affects the material conditions necessary for biological survival, social participation, and the opportunity to control life circumstances. In addition to analyses of the objective factors that influence farmers' physical health, scholars have begun to pay more attention to the effects of subjective factors such as social relations, health behaviors, and psychological factors on farmer's physical health [18]. Cohen and Sheldon find that three variables that assess different aspects of social relationships, including social support, social integration, and negative interaction, influence health through different mechanisms [19]. Additionally, researchers assert that psychological factors such as shame, respect, and self-esteem impact individual health status [20]. Hartley (2004) finds that medical care contributes less to health compared to social and societal factors, environmental factors, health behaviors, and genetics [21].

The benefits brought about by land circulation are first reflected in income increase. In the context of a large surplus of rural labor flowing to cities and agricultural production gradually undergoing mechanization, agricultural production in the form of intense and demanding farming activities is no longer suitable for the development of productivity. Under the premise that the land contract period is long, land circulation can help to break the fragmented production pattern and lay the foundation for moderate-scale operations, thereby improving agricultural production efficiency and increasing farmer income. Li et al. and Wang et al. find that the transfer of agricultural land significantly alleviates rural poverty by improving saving behaviors and increasing income [22,23]. Specifically, Jin et al. find that Kenya's land rental markets significantly raise farm households' incomes by promoting farm productivity [3]. Some researchers have also found that in addition to the productive income effect, land transfer also has a relatively large impact on non-productive income, which can further reduce poverty [24]. Peng et al. find that land circulations increase the total income of both land circulation in and transfer out households, and further analyses reveal that land flow-out farmers and land flow-in farmers have different main sources of income growth [4]. However, Chen et al. show that though the total income of all rural households transferring in farmland increased significantly, the income of households transferring out of farmland decreased [25]. Yang et al. find that transfer of farmland can affect the key natural capital changes and livelihood strategy adjustments of rural households, which has a positive and significant promoting effect on the consumption level of rural households. Compared to farmers who do not participate in farmland transfer, farmers who participate in farmland transfer have higher consumption enthusiasm [26]. Yao et al. find that China's land conversion program accelerates the transfer of farming labor and improves the income growth from off-farm opportunities [27].

Land circulation is not only conducive to increasing farmer income, but also has a promotional effect on land use efficiency, agricultural production efficiency and modernization. Koirala et al. think that land ownership significantly impacts technical efficiency [28]. The results of Liu et al. indicate that many households in China are using land inefficiently, and it is renting in lands that increase land use efficiency [29]. Fei et al. find that while land circulation improves agricultural land use efficiency, the efficiency is higher in provinces that transfer land in than in provinces that transfer land out [30]. Luo et al. identify that moderate-scale operation through land transfer is beneficial for achieving economies of scale, thereby reducing average production costs and improving technological efficiency [31]. The research of Wang et al. finds that the transfer of land use rights, especially in the form of renting land from other households, is beneficial to both total labor productivity (TLP) and agricultural labor productivity (ALP) [32]. Zhang et al. find that there is a significant nonlinear relationship between land transfer and new-type urbanization [33].

Despite the extensive in-depth studies on farmers' physical health and land circulation, the two issues are seldom addressed simultaneously in the same study. In fact, among the factors that influence farmers' physical health, farmer income is an extremely important factor. An increase in income can alleviate household budget constraints, which can not only affect the health investment farmers are willing to make in daily life but also affect farmers' medical behaviors and medical expenses during sickness. An important role of land circulation is to increase farmer income. Some scholars identify that the transfer out of farmland has brought a richer income structure and higher subjective income level to rural households, gradually reducing basic food consumption and increasing non-food consumption of goods and services to meet personal enjoyment and development needs [34], which means land circulation can at least affect farmer health expenditure levels by affecting farmer income. In addition, it is worth studying other pathways through which land circulation affects health. Qin et al. conducted a study similar to this one, but they mainly analyzed the effect of urbanization-driven land requisition on farmer health in China, pointing out that the low level of compensation for land requisition is not favorable enough for farmers to invest effectively in health, which harms farmer health [35]. Land circulation is quite different from land requisition. Land circulation refers to leasing land use rights and sustainably obtaining benefits rather than receiving a one-time compensation payment, as is the case in land requisition. Therefore, this study is innovative and may add to the existing body of relevant literature.

3. Theoretical Analysis and Model Setting

3.1. Grossman Model

Research on health needs dates back to when Grossman (1972) proposed a model to analyze health needs [36]. The model assumes that the lifetime utility function of individuals is as follows:

$$\mathrm{U} = \mathrm{U}(\varphi_0 H_0, \ldots, \varphi_n H_n, Z_0, \ldots Z_n) \tag{1}$$

where H_i is the health stock in period i, φ_i is the service flow brought by a unit of health stock, $h_i = \varphi_i H_i$ is the total health service enjoyed in period i, and Z_i is the consumption of other goods.

The change in the health stock is, by definition, equal to the total investment minus depreciation.

$$H_{i+1} - H_i = I_i - \delta_i H_i \tag{2}$$

where I_i is the total investment in health, and δ_i is the health depreciation rate. The production of individual health investments and the production of other goods are determined by the following formulas:

$$I_i = I(M_i, TH_i, E_i) \tag{3}$$

$$Z_i = Z(X_i, T_i, E_i) \tag{4}$$

where M_i and X_i are the input for medical services and production goods (Z_i), respectively; TH_i and T_i are the respective time inputs; and E_i represents the level of other human capital, i (e.g., education capital).

In the meantime, individuals face two budget constraints:

$$TW_i + TL_i + TH_i + T_i = \Omega \tag{5}$$

$$\sum \frac{P_i M_i + V_i X_i + W_i(TL_i + TH_i + T_i)}{(1+r)^i} = \sum \frac{W_i \Omega}{(1+r)^i} + A_0 \tag{6}$$

where Formula (5) presents a time constraint in which TW_i denotes working hours, TL_i denotes the lost time due to health damage, and Ω is the total time (Ω = 365 days if calculated on an annual basis). Formula (6) represents a budget constraint in which the left term of the formula is the present value of total lifetime income, P_i is the price of medical services, V_i is the price of input X_i, W_i is the wage rate, and A_0 is the initial wealth.

Formulas (1)–(6) constitute the basic Grossman model. Under budget constraints (5) and (6), individual utility is to be maximized. The model is extended by adding the variable of land circulation, LO_i, which is not directly involved in the utility function but affects the individual optimization decision in two ways. First, land circulation affects the health depreciation rate. In general, land circulation out can reduce farmers' time on agricultural production, reduce the harm to health from chemicals such as pesticides, and decrease the depreciation rate. Therefore, the health depreciation rate is expressed as in Cropper [37]:

$$\delta_i = \delta_0 e^{\hat{\delta} i} LO_i G_i \tag{7}$$

In Formula (7), δ_0 is the initial health depreciation rate; i is the age, which affects the health through a constant depreciation rate, $\hat{\delta}$; and G_i is a lifestyle variable.

Second, land circulation affects time allocation and, in turn, budget constraints. land circulation out reduces agricultural production time, which directly reduces the time, TL_i, that would otherwise be lost because of health damage. However, the effect on work time, TW_i, is uncertain. If agricultural production time decreases but non-agricultural work time increases, the overall change in TW_i is uncertain. In addition, reduction in agricultural production time may lead to increased physical exercise and social time, which is beneficial to health. The reduction in income caused by the reduction in agricultural production time and the increase in income caused by land leasing cause changes in budget constraints, which affect individual health investment decisions.

3.2. Basic Econometric Model (Ordered Probit)

The explained variables of interest in this study are mainly related to the physical health status of middle-aged and older farmers. The assessment indicators of physical health status are mainly divided into two categories. First, certain objective, comprehensive indicators such as the body mass index (BMI) [38], the quality of well-being (QWB) [39], the instrumental activities of daily living (IADL) and the mini-mental state examination (MMSE) are used to assess physical health status [40]. Such indicators are relatively objective and can reflect the overall health status of an individual. The second type of health assessment indicators are relatively subjective, namely self-assessed health indicators. Self-assessed health indicators are susceptible to the individual's surrounding environment and thus may be different in different populations; however, they have prominent advantages. First, health self-assessment is an individual's overall evaluation of his or her health and may reveal many issues in physical and psychological status. Self-assessed health indicators cover a wider scope and are more refined than objective indicators, with objective indicators likely reflecting a narrower scope of health status. Second, although physical health self-

assessment is relatively simple to perform, existing studies have shown that it can be used to predict individual life expectancies effectively, and the prediction is very close to professional measurement results. Therefore, it has been widely used [41].

In view of data availability, this study adopts self-assessed health indicators. Self-assessed physical health status is presented as sorted data, with values ranging from 1 to 5 corresponding to "very poor", "poor", "fair", "good", and "very good" physical health status, respectively. Given that the variable is discrete and its values are ordinal, the traditional ordinal least squares (OLS) method is not applicable. Instead, an ordered probit model may be a natural choice, which is an extension of the ordinary probit model and dedicated to dealing with explained variables whose values are ordinal. Therefore, the following basic model is introduced:

$$y_i = \alpha + \beta \times landout_i + X_i \times \gamma + \varepsilon_i \quad (8)$$

where y_i is a self-assessed physical health status; $landout_i$ is a dummy variable describing whether or not the land is leased—with the value of 1 representing leased land and 0 representing unleased land; X_i is a series of control variables, including demographic characteristics, family characteristics, and provincial dummy variables; and ε_i is a random error term.

3.3. Endogeneity and the Instrumental Variable Ordered Probit Model (IV-Ordered Probit Model)

It is evident that physical health status and land circulation decisions may have endogeneity issues due to missing variables or mutual causality. Because agricultural production requires a large workforce, it has a high requirement for labor health. Farmers in poor health and who are unable to carry out agricultural production may be prompted to lease their land. If this is the case, land leasing is the "effect" rather than the "cause" of health. Therefore, instrumental variables are introduced into the ordered probit model to solve the endogeneity issue caused by mutual causality.

This study selects two instrumental variables [3], one being the village land circulation rate—namely the proportion of land subcontracted or leased out in the village the subject is affiliated with, and the other being the number of households moving out of the village permanently. The two instrumental variables affect the endogenous explanatory variable, namely land lease out, through different pathways. First, the higher the proportion of land subcontracted or leased in a village, the more active the land circulation market. The active market influences the individual decision of land leasing in two aspects. On the one hand, the more active the land circulation market, the more likely farmers will be affected by neighbors who conduct land circulation; that is, there is a peer effect, which increases the willingness for land circulation [1]. On the other hand, land circulation includes leasing out land and leasing in land, and the mere willingness to lease land out does not necessarily result in actual land lease out, as land lease out also requires a corresponding demand. The more active the land circulation, the bigger the supply and demand of land, thereby reducing the cost of land circulation and increasing the possibility of it Second, the more households migrate from the village, the larger the village's land stock, and the larger the average amount of farmland per household, thereby increasing the possibility of land circulation. Finally, both instrumental variables are village-level variables. Although they can influence individual land circulation decisions through the above pathways, they do not affect individual physical health; therefore, the instrumental variables meet the exogeneity requirement. To sum up, the above two instrumental variables fulfill the requirements. A more detailed instrumental variable test is given below.

An endogeneity-corrected IV-ordered probit model is introduced as follows:

$$y_i = \alpha + \beta \times \widehat{landout}_i + X_i \times \gamma + \varepsilon_i \quad (9)$$

where $\widehat{landout}_i$ is the fitted value of $landout_i$ regressed on the instrumental variables and the other control variable, X_i, and the estimate of the coefficient, β are valid and unbiased.

4. Data and Descriptive Statistics

4.1. Data

The data used in this study are from the China Health and Retirement Longitudinal Survey (CHARLS) 2018. The survey uses four-stage probability proportional to the size sampling to ensure that the samples are unbiased and representative. The survey data were collected from 19,000 people over 45 years of age from approximately 12,400 households in 450 village-level units of 150 county-level units. The survey content includes not only variables relating to demographic characteristics, work, and family characteristics, but also the health status-related variables necessary for this study, making the survey results a high-quality data source.

4.2. Descriptive Statistics

The core explanatory variable of interest in this study is land lease, which is a dummy variable. The land lease variable is set to 1 for farmers who own land and 0 for farmers who do not. Considering the Grossman health demand model and previous research, other control variables are selected to include demographic characteristic variables, individual social security and behavior characteristic variables, family characteristic variables, and provincial dummy variables. Their definitions and descriptive statistics are shown in Table 1.

As shown in Table 1, only 23.4% of farmers conduct transfer out; that is, land is leased out. In contrast, the calculation shows that the proportion of farmers leasing in land is also low, at only 11.4%. Both the supply and demand of land are relatively low, indicating that China's land circulation is still in the initial stage and is facing a "low-level dilemma". The low level of land circulation causes fragmentation of land operation, which prevents the land from being operated on a moderate scale and in turn results in low agricultural production efficiency, creating obstacles to the modernization of agricultural production and the increase in farmer income. Therefore, further study of the advantages of land circulation and its effect on farmer income is of great practical significance.

As shown by the descriptive statistics in Table 1, the health status of farming households without land circulation out is better than that of farming households with land circulation out, namely with an average value of 3.051 versus that of 2.960, respectively. The descriptive statistics alone imply that land circulation out would be conducive to farmer health. This is because the impact of land circulation out on health level is mainly realized by increasing family income and alleviating family mobility constraints; that is, the reduction in land increases farmers' non-agricultural employment, which has a positive impact on health by increasing family income.

Other control variables also have certain characteristics. The average household age of farmers with land circulation out is high, which is consistent with this group of farmers' aforementioned poor physical health. Generally, the older the farmers, the poorer their physical health, and the greater their willingness to lease the land. In addition, compared to the farming households without land circulation out, those with land circulation out have a higher rate of participation in old age care insurance. This indicates that land does provide informal security in rural areas. If security is improved in other aspects (i.e., number of children, medical care, and old age care insurance), the informal security function of land would be weakened. In turn, the farmer's willingness to lease land out would be enhanced. Of course, the relationship between the above-mentioned variables and land circulation needs to be quantitively analyzed in detail. Finally, the two instrumental variables have significantly higher means for the farmer households with land circulation out than for those without. For example, the proportion of land circulation in the villages of farmer households transferring land is as high as 16.46%, and the average number of households permanently moving out of the villages is 13.06, in contrast to that of 9.63% and 7.078, respectively, in the villages of farmer households without transferring land. Therefore, the village land circulation rate and the number of households permanently moving out of the village have a positive correlation with land circulation out.

Table 1. Major variables and descriptive statistics.

Variable	Description	Total	Leased Out	Not Leased Out
Health	The self-assessed physical health status; "very poor" = 1, "poor" = 2, "fair" = 3, "good" = 4 and "very good" = 5	2.981	3.051	2.960
		(1.015)	(1.038)	(1.006)
Landout	Whether or not the land is leased; leased = 1, not leased = 0	0.234		
		(0.423)		
Age1	Age of the respondents	60.78	61.42	60.59
		(9.340)	(9.435)	(9.302)
Sex	man = 1, woman = 0	0.482	0.475	0.484
		(0.500)	(0.499)	(0.500)
Elementary	Dummy variable; primary education = 1, others = 0	0.239	0.241	0.238
		(0.426)	(0.428)	(0.426)
Middle	Dummy variable; junior high school education = 1, others = 0	0.204	0.212	0.201
		(0.403)	(0.409)	(0.401)
High	Dummy variable; high school education = 1, others = 0	0.0673	0.0838	0.0623
		(0.251)	(0.277)	(0.242)
College	Dummy variable; college degree or above = 1, others = 0	0.00289	0.00340	0.00273
		(0.0537)	(0.0582)	(0.0522)
Marriage	Marital status; married = 1, others = 0	0.808	0.779	0.816
		(0.394)	(0.415)	(0.387)
Pension	Dummy variable; having old age care insurance = 1, others = 0	0.0608	0.0812	0.0546
		(0.239)	(0.273)	(0.227)
Cigar	Dummy variable; smoking = 1, others = 0	0.0307	0.0349	0.0294
		(0.172)	(0.183)	(0.169)
Drink	Dummy variable; alcohol consumption = 1, other = 0	0.268	0.282	0.264
		(0.443)	(0.450)	(0.441)
House	Dummy variable; owning a home = 1, others = 0	0.849	0.815	0.859
		(0.358)	(0.388)	(0.348)
Lnexp	The logarithm of household monthly spending	8.300	8.463	8.250
		(2.107)	(2.094)	(2.109)
Iv_percentage	Instrumental variable; the proportion of transferred land in the village	11.23	16.46	9.631
		(15.75)	(18.08)	(14.61)
Iv_migration	Instrumental variable; the number of households that have permanently moved out of the village	8.480	13.06	7.078
		(28.60)	(39.04)	(24.37)
Observations		10045	2352	7693

Note: Standard deviations are shown in parentheses.

5. Results and Discussions

5.1. Effect of Land Circulation out on Farmer Health

Table 2 presents the regression results of the ordered probit model and the endogeneity-corrected IV-ordered probit model. First, the regression results of the ordered probit model, as listed in column (1) of Table 2, reveal that land circulation out does not improve farmer health levels. The above-mentioned poor status of physical health in rural households transferring land is not consistent with the regression results. The reason could be attributed to the endogeneity problem. Columns (2) and (3) of Table 2 present the IV-ordered probit model's first- and second-stage regression results, respectively. The results indicate that after correction for endogeneity, land circulation out shows a promotional effect on farmer's physical health ($p < 0.01$). This proves that including instrumental variables in a model can overcome the endogeneity problem, and thus, the estimates will be more effective.

Table 2. Effect of land circulation out on farmer health status.

	Ordered Probit	IV-Ordered Probit	
Variable	**(1) Health**	**(2) First-Stage**	**(3) Second-Stage**
Land out	9.81×10^{-5}		0.0717 ***
	(0.0346)		(0.0243)
Age1	−0.0292 ***	−0.0423 ***	−0.0496 ***
	(0.0117)	(0.0122)	(0.0128)
Age2	0.000127	0.000226 **	0.000269 ***
	(9.56×10^{-5})	(9.67×10^{-5})	(0.000102)
Gender	0.144 ***	0.0795 ***	0.0756 ***
	(0.0312)	(0.0237)	(0.0243)
Elementary	0.0581 **	−0.00714	0.0121
	(0.0267)	(0.0258)	(0.0264)
Middle	0.118 ***	0.139 ***	0.162 ***
	(0.0308)	(0.0292)	(0.0292)
High	0.173 ***	0.174 ***	0.198 ***
	(0.0485)	(0.0440)	(0.0417)
College	0.443 **	0.492 ***	0.397 **
	(0.212)	(0.169)	(0.155)
Marriage	−0.0367	0.0500 *	0.0490 *
	(0.0290)	(0.0265)	(0.0266)
Pension	0.0107	0.100 **	0.117 ***
	(0.0383)	(0.0407)	(0.0389)
Cigar	−0.0814 ***	−0.0602	−0.0131
	(0.0299)	(0.0610)	(0.0619)
Drink	0.241 ***	0.192 ***	0.224 ***
	(0.0271)	(0.0247)	(0.0259)
House	0.0845 **	0.0383	0.0182
	(0.0396)	(0.0291)	(0.0284)
Lnexp	−0.0285 ***	−0.0482 ***	−0.0529 ***
	(0.00560)	(0.00480)	(0.00490)
Iv_percentage		0.0134 ***	
		(0.000969)	
Iv_migration		0.00238 ***	
		(0.000486)	
Province dummy	Yes	Yes	Yes
Observations	10045	10045	10045

Note: The numbers in parentheses are standard deviations; *, **, and *** indicate statistical significance at the 0.1, 0.05, and 0.01 levels, respectively, and hereinafter.

The prerequisite for using instrumental variables is that the model does have an endogeneity problem. Therefore, it is necessary first to test whether or not the model has endogenous variables before using instrumental variables, namely whether or not land circulation out is an endogenous variable. Previous studies using IV-ordered probit models often adopt two-stage least squares (2SLS) regression to analyze the variable endogeneity problem and the effectiveness of instrumental variables [42]. This method is also adopted here to test the validity of instrumental variables. First, the model variables are tested for endogeneity using a Durbin–Wu–Hausman test. The test statistic is 25.10 ($p = 0.000$), therefore rejecting the hypothesis at the 1% significance level that land circulation out is an exogenous variable; that is, the model has an endogeneity problem. Second, the correlation condition of the instrumental variables is tested. Multiple tests are performed to determine whether or not there is a weak instrumental variable problem. The Kleibergen–Paap rk LM statistic is 193.829 ($p < 0.01$), rejecting the hypothesis that the instrumental variables are not identified at the 1% significance level. The Kleibergen–Paap rk Wald F statistic is 97.104 and the Cragg–Donald Wald F statistic is 127.99, both higher than the Stock–Yogo critical value of 19.93 of the weak instrument variable test at the 10% significance level. Therefore, there is no weak instrumental variable problem. Finally, the instrumental variables are tested for exogeneity, using an overidentification test. The Hansen J statistic has a *p*-value of

0.9464, indicating that the overidentification hypothesis for instrumental variables cannot be rejected at the 10% significant level; the instrumental variables are exogenous and valid. In summary, the instrumental variables in this study meet the requirements, and accordingly, the model results are valid.

The results of other control variables are basically in line with the expectations. The health level of farmers declines with age and does not show the inverted U-shaped pattern observed in previous studies. This is because the subjects in this study are over 45 years old, whereas the apex of the inverted U-shaped pattern is at 30–35 years in previous studies [43]. The data points of the subjects are distributed to the right of the vertex; thus, there is a negative correlation between age and farmer health level, which agrees with the findings of previous reports. Moreover, gender significantly affects farmer health, with male farmers having a higher health level than female farmers do, which is consistent with the findings of previous studies. Education has a significant promotional effect on farmer health, with a higher degree of education having a greater effect. Education affects the health level of individuals mainly by changing their health behaviors and socioeconomic conditions [44]. The higher the education level, the fewer the harmful health behaviors, such as smoking and alcohol consumption, and the more the healthier behaviors, such as physical exercise and leisure. Moreover, the higher the education level, the higher the income, and the greater the ability to invest in health with relatively high investment efficiency. Old age care insurance has a positive and significant effect on farmers' health. Smoking and alcohol consumption have very different health effects because old age insurance can improve health by ensuring income. Smoking hurts farmer health, and it has been widely accepted that smoking harms health. However, alcohol consumption has a positive effect on farmer health, which is attributed to the fact that, in general, a small amount of alcohol consumption has certain benefits to the body, although alcohol abuse causes significant damage to health. The relevant variable used in this study is "alcohol consumption" rather than "alcohol abuse," which may explain why the above positive effect is observed. Owning a home has positive effects on farmer health, but it is not significant. Again, monthly consumption expenditure has a negative effect on farmer health, which may be attributed to the fact that the expenditure includes health care costs and thus is subject to self-selection bias.

5.2. The Underlying Mechanism of the Effect of Land Circulation out on Farmer Health

According to the Grossman model, the effect of land circulation out on farmer health can be realized through multiple pathways. First, a direct effect is that land circulation out reduces the amount of farmland farmers cultivate, thereby reducing labor time investment and, in turn, the depreciation rate of health. Second, with the reduction in agricultural time, farmers can allocate more time to leisure and entertainment, thereby improving their physical health. Last, the reduction in agricultural production gives farmers more time to engage in non-agricultural production to increase income; therefore, the household budget constraints are alleviated, and farmers can increase their investment in medical care and old age care, thereby promoting farmer health levels. As the health depreciation rate cannot be directly estimated, the underlying mechanism governing the land effect on farmer health is explored mainly from two aspects: time allocation and household income.

5.2.1. Effect of Land Circulation out on Income

One pathway through which land circulation out affects farmer health is to increase farmer income and alleviate household budget constraints. Table 3 presents the effects of the land circulation on farmers' agricultural, and non-agricultural wages, business, and lease income [4]. The results show that land circulation out reduces agricultural income. However, land circulation out increases not only farmers' non-agricultural wage income but also business and lease income. The increase in non-agricultural wage income and business income is caused by the increase in time allocated to non-agricultural work and business operations as a result of the reduction in agricultural time after land circulation

out. The increase in land lease income largely contributes to the increase in lease income. Calculations based on the sample data reveal that each household owns 5.79 Chinese mu (1 Chinese mu = 666.67 m^2) of land on average, and the average lease price per Chinese mu of land is CNY 582. If all the land is leased out, the total lease income is CNY 3370, accounting for 23.06% of the rural per capita net income in 2018 [5]. An increase in the scale of land circulation will effectively promote the scale production of agriculture and in turn increase the lease price of land, which will further increase the land lease income of farmers [4,45]. In addition, with the increase in the amount of land lease out, the proportion of non-agricultural work will increase, which in turn will increase the wage income of farmers [46]. The result is in line with the findings of Hong and Lou [47], and Li et al. [22] who showed that household income enhancement plays significant roles in household welfare development, including quality health services.

Table 3. Land circulation out and farmer income (2SLS).

	Agricultural		**Non-Agricultural**		**Business**		**Lease**	
	First	**Second**	**First**	**Second**	**First**	**Second**	**First**	**Second**
Land out		−1.233 ***		0.731 **		0.939 **		0.674 ***
		(0.349)		(0.320)		(0.444)		(0.236)
iv_percentage	0.003 ***		0.004 ***		0.007 ***		0.004 ***	
	(0.000)		(0.000)		(0.001)		(0.000)	
iv_migration	0.001 ***		0.001 ***		0.003 ***		0.001 ***	
	(0.000)		(0.000)		(0.000)		(0.000)	
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−0.341 ***	7.153 ***	0.0144	10.98 ***	−0.213	9.786 ***	−0.172	0.141
	(0.164)	(0.693)	(0.256)	(1.286)	(0.681)	(2.586)	(0.146)	(0.199)
Observations	7057	7057	2460	2460	682	682	10,045	10,045

Note: The numbers in parentheses are standard deviations; ** and *** indicates statistical significance at the 0.05 and 0.01 level, respectively.

5.2.2. Effect of Land Circulation out on Time Allocation

Table 4 shows the effect of land circulation out on the time allocation of middle-aged and older farmers, analyzed from multiple aspects, which mainly includes whether or not they are engaged in agricultural production, the number of months spent on agricultural production each year, the status of their social activities within the last month as of the survey date [6], and whether or not they are engaged in non-agricultural work. The results show that land circulation out significantly reduces the possibility of engaging in agricultural production. However, for farmers still engaged in agricultural production, land circulation out does not significantly reduce their annual agricultural production time. The main concern here is how the time originally devoted to agricultural production is allocated after the land has been transferred. The regression results in columns (3) and (4) of Table 3 present the effect of land circulation out on social activities and non-agricultural work, respectively. As is shown above, land circulation out has not improved farmer health by increasing social activities, leisure, or physical exercise. Therefore, farmer health level improvement may be attributed to non-agricultural work increasing household income and alleviating household budget constraints, thereby allowing farmers to invest more in health to improve their health levels. The result is in line with that of Paggi et al. who showed that allocating some time for other activities aside from work improves individuals' healthy living [48].

Table 4. Land circulation out and time allocation by farmers.

	(1) Binary Probit	(2) 2SLS	(3) Binary Probit	(4) Binary Probit
Variable	**Agricultural Production**	**Months to Agriculture**	**Social Activities**	**Non-Agricultural Work**
Land out	−0.875 ***	0.069	0.0085	0.040 ***
	(0.177)	(1.014)	(0.014)	(0.005)
Other controls	Yes	Yes	Yes	Yes
Observations	10,045	6609	10,045	10,035

Note: The numbers in parentheses are standard deviations; *** indicate statistical significance at the 0.01 level. Because of space limitations, only the estimated coefficients of land circulation out are listed; the regression results of other variables are available on request.

5.3. Robustness Test

Other measures of health levels are also used to verify the effect of land circulation on farmer health, and the gender differences in the effect are also analyzed. The regression results are shown in Table 5. Given the availability of data, the activities of daily living (ADL) scale is adopted to measure the health level. The ADL scale consists of six activities: feeding, dressing, getting in or out of bed, bathing, toileting, and continence. Each activity is assessed in terms of four difficulty levels: easy to complete, difficult but completable by the farmers on their own, difficult but completable with the assistance of other people, and incompletable, with the first level being scored 0 and other levels each being scored 1; that is, the higher the total score, the more severe the damage to the ADL. The regression results based on the ADL scores are presented in column (1) of Table 5, revealing that land circulation out leads to a reduction in the damage possibility of farmer ADL, namely leading to an improvement in farmer health levels; therefore, the conclusion of this study is relatively robust.

Table 5. Different measures of farmer health levels and robustness test.

Variable	(1) ADL	(2) Health	(3) ADL
Land out	−0.178 ***		
	(0.0640)		
Land in		−0.0248	−2.041 *
		(0.135)	(1.134)
Other controls	Yes	Yes	Yes

Note: The numbers in parentheses are standard deviations; * and *** indicate statistical significance at the 0.1, and 0.01 levels, respectively. The results in column (1) and (3) are obtained using the 2SLS estimation method, and the results in columns (2) are obtained using the IV-ordered probit model.

Land circulation includes two aspects: land circulation out and land circulation in. Columns (2) and (3) of Table 5 present the effect of land circulation in on farmers' health results. It is observed that no matter which assessment indicator is used, land circulation in has no significant effect on farmer health. This may be attributed to China's low land circulation levels and thus land lease in is hardly able to meet the minimum requirement for scale production. That is, the fragmentation of agricultural production still fails to be effectively resolved, resulting in low production efficiency and a limited promotional effect on farmer income.

6. Discussion

China has experienced large-scale rural–urban population migration in the past decade or so, with a significant number of young rural laborers moving to cities to seek non-agricultural employment, resulting in farmland being mostly cultivated by older farmers [9]. The issue with small-scale farming is that it is not conducive to the adoption of agricultural technologies such as machinery, leading to lower production efficiency. Moreover, with the trend of family transfer in China, the phenomenon of land abandonment has become increasingly prominent [49]. At the same time, China's agricultural land is decreasing year

by year. In order to alleviate the land shortage dilemma and improve land use efficiency, the Chinese government has successively introduced various policies to encourage the transfer of farmland management rights [30]. The reason for the low willingness to transfer land is the uncertainty in expectations regarding land and its associated rights and interests. For that reason, it is necessary to promote further the determination of rural land rights to provide an institutional basis and guarantee for land circulation. An improvement of land circulation levels would be conducive to promoting the appropriate large-scale operation of agricultural production, improving agricultural production efficiency. Insufficient awareness of the benefits of land transfer is also an important reason for the inadequate level of land transfer. Farmers overly focus on the income from land transfer while neglecting other aspects, such as health benefits. When middle-aged and older farmers are liberated from heavy physical labor, they face the issue of time allocation. This time allocation is also an important mechanism affecting labor health. On the one hand, they can engage in non-agricultural employment. On the other hand, participating in leisure and sports activities is beneficial to physical health [48]. However, the research findings of this article do not support this mechanism. A possible reason is the lack of leisure and entertainment facilities in rural areas and the absence of a conducive atmosphere.

In China, farmers have a strong dependence on land, considering it not only as a means of production but also as a guarantee of their livelihood. Therefore, it is necessary to improve the level of medical care and old age care in rural areas, as an increase in the level of formal social security such as medical care and old age care would directly affect the health level of farmers, and more importantly, would have an indirect promotional effect on farmer health by promoting land circulation [48]. Rural land serves as a means for farmers to obtain agricultural income from agricultural production. More importantly, it provides informal social security, which is one of the reasons for the low level of land circulation in China [30]. Establishing and improving formal social security, such as medical and old age care, would weaken the security effect of land and promote China's land circulation.

7. Conclusions

At present, China's land circulation is experiencing a "low-level dilemma". Simultaneously, rural population aging is becoming increasingly severe and thus, protecting the health of the middle-aged and older rural population is an essential countermeasure for aging. This study uses the China Health and Retirement Longitudinal Survey (CHARLS) 2018 data to empirically analyze the effect of land circulation out on the physical health of farmers and resolves the endogeneity problem in the model by introducing instrumental variables. The main conclusions drawn are as follows. First, after correction for endogeneity, land circulation out shows a promotional effect on farmer health, improving the self-assessed health status of farmers and reducing the possibility of ADL damage. Second, the positive effect of land circulation out on farmer health levels is mainly attributed to the fact that land circulation out promotes the probability of non-agricultural work and increases farmer income, thereby alleviating household budget constraints and increasing health investment. Although land circulation out makes some farmers no longer work in agriculture, there is no evidence that land circulation out increases farmers' time engaging in social and leisure activities. Third, land circulation in has no significant effect on farmer health.

The limitations of the study are as follows. First, the study focuses mainly on the middle-aged and older rural population due to data availability. However, the health status of these selected household populations affects other household members; therefore, future studies can expand the focal population to an entire household in such a study if data are made available. Second, the study used the self-reported health status of the farmers. We encourage subsequent studies to use a medically reported health status when carrying out a similar analysis for deeper understanding. Finally, other potential channels aside from time allocation and household income can be explored when examining the relationship

between land circulation out and the health status of the middle-aged and older rural population if data are available.

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Notes

[1] The traditional standard of the United Nations for aging is that older people over 60 in a region account for 10% of the total population. The new standard states that when older people over 65 account for 7% of the total population in a region, that region has an aging society.

[2] Land circulation is divided into land circulation out and land circulation in. This study focuses on land circulation out, that is, land being leased out.

[3] The selection of instrumental variables needs to satisfy two requirements, namely correlation and exogeneity. The correlation requirement requires that the selected instrumental variables have a strong correlation with the endogenous explanatory variables, whereas the exogeneity requirement requires that the instrumental variables are not related to the explained variable; that is, the effect of the instrumental variables on the explained variable can only be realized through endogenous explanatory variables.

[4] Business income refers to household self-employment or private enterprise income, and lease income refers to income obtained by leasing land out, real estate, and other assets. All incomes have been converted to logarithmic values.

[5] According to the 2018 National Economic and Social Development Statistical Bulletin, China's rural per capita net income is CNY 14,617.

[6] This variable is derived from the question in the questionnaire: "Have you performed the following social activities in the past month?" The answer options are: "visiting and socializing with friends"; "playing mahjong, chess, and cards, or going to the community clubhouse"; "providing free help to your loved ones, friends, or neighbors"; "going to the park or other places to dance, exercise, or practice qigong, etc."; "participating in community activities"; "participating in volunteer activities or charity activities"; "providing free care for patients or people with disabilities who do not live with you"; "going to school or taking training courses"; "speculating stocks (funds and other financial securities)"; and "using the Internet." This variable scores 1 if at least one activity is conducted, otherwise it scores 0.

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