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Agricultural land marketization and productivity: evidence from China

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ABSTRACT

The marketization of agricultural land affects the average land productivity not only through improving land allocation efficiency but also through reducing land price under the perfect market. The effect of the improvement of land allocation efficiency on the average land productivity is positive. However, when the agricultural land market is imperfect, the effect of the decrease in land price under the perfect market on the average land productivity is negative. By using the China Health and Nutrition Survey (CHNS) database and the empirical framework for the inverse relationship between farm size and land productivity, this paper empirically finds that these two channels improve and reduce average land productivity by 34.4% and 1.4%, respectively, implying that agricultural land marketization in China improves the average land productivity by 32.9%.

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Agricultural land marketization; land productivity; inverse relationship; China

1. Introduction

If the agricultural land market is perfect, for both profit-maximizing agricultural firms and households, less efficient agricultural producers will rent out or sell some of their land at a price higher than the marginal productivity of their land, while more efficient producers will rent in or buy some land at a price lower than the marginal productivity of their land. Finally, when the demand for land equals the supply, the agricultural land is allocated efficiently through the market mechanism (see Barrett, Bellemare, & Hou, 2010; Benjamin & Brandt, 2002; Carter & Yao, 2002; Deininger, Ali, & Alemu, 2008a; Deininger & Jin, 2005, 2008; Deininger, Jin, & Nagarajan, 2008b; Jin & Deininger, 2009; Liu, Carter, & Yao, 1998; Yao, 2000).

However, for many developing countries – especially those in transition from the agricultural to the non-agricultural economy – their agricultural land markets are imperfect. For example, it has been found that there exists an inverse relationship between farm size and land productivity. Specifically, compared to farmers with a large farm size, those with a small farm size have higher land productivity. This phenomenon is closely related to the type of production carried out by farmers with a small land size, that is, the intensive production. The reasons for the existence of this inverse relationship

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include, among others, land market imperfections (see Heltberg, 1998; Lamb, 2003), labor market imperfections (see Frisvold, 1994; Rosenzweig & Wolpin, 1985; Sen, 1966), credit market imperfections (see Carter, 1988; Eswaran & Kotwal, 1986; Feder, 1985), and risk (see Kevane, 1996; Rosenzweig & Binswanger, 1993; Wiens, 1977). This relationship has been found in the countries of Asia (see Bardhan, 1973; Carter, 1984; Chen, Huffman, & Rozelle, 2011; Heltberg, 1998; Lamb, 2003; Lau & Yotopoulos, 1971; Li, Feng, You, & Fan, 2013; Newell, Pandya, & Symons, 1997; Rao & Chotigeat, 1981; Sen, 1962), Africa (see Ali & Deininger, 2015; Barrett, 1996; Barrett et al., 2010; Byiringiro & Reardon, 1996; Carletto, Savastano, & Zezza, 2013; Collier, 1983; Kimhi, 2006; Larson, Otsuka, Matsumoto, & Kilic, 2014), Europe (see Alvarez & Arias, 2004; Chayanov, 1926), and Latin America (see Berry & Cline, 1979; Cornia, 1985).¹ In fact, after excluding the effects of soil quality and climate factors (e.g., temperature and rain), the existence of this inverse relationship may imply the imperfection of the agricultural land market. If the market is perfect, the land will be re-allocated from farmers with a large farm size to those with a small farm size, until the inverse relationship disappears.

The transition to the non-agricultural economy, on the one hand, reduces the amount of agricultural labor significantly and thus decreases the utilization rate of agricultural land. On the other hand, the transition increases the demand for agricultural products in urban areas and consequently further aggravates the balance between the demand and supply of agricultural products. Governments in many countries have attempted to improve the output per unit of land, or land productivity, in order to increase the supply of agricultural products. Then, if agricultural land marketization can improve land allocation efficiency, can it also improve the average output per unit of land, or average land productivity? The conventional answer is affirmative because more land will be re-allocated to producers with high productivity and then the average land productivity will increase.² Nevertheless, if we consider the fact that marketization may reduce the land price under the perfect market, the answer is uncertain. Along with increasing wages for industrial jobs, more and more farmers may leave rural areas and thus the supply of land increases. As marketization facilitates the transaction of land between farmers, the land price under the perfect market (as well as the land prices of renting in and out³) may fall. Due to the fact that the marginal productivity of land equals the equilibrium land price, and that the marginal productivity of land and land productivity change in the same direction, marketization may result in a decrease in land productivity. To summarize, agricultural land marketization affects the average land productivity not only through improving land allocation efficiency but also through reducing the land price under the perfect market.⁴ The improvement of land allocation efficiency has a positive effect on the average land productivity. However, the decrease in land price under the perfect market has a negative effect on the average land productivity. Only when the positive effect of the

¹ Some studies show that in the USA and Japan farm size is positively correlated with land productivity (see Kawasaki, 2010; Sumner, 2014).

² Empirical evidence is given by, for example, Restuccia and Santaaulalia-Llopis (2017). They use household-level data from Malawi and find that a re-allocation of production factors to their efficient use will result in a higher average total factor productivity (TFP) of farmers: the farm TFP and the output per unit of land are found to be positively correlated across farms because the land allocation is independent of productivity, so a large amount of productive farmers are limited by farm size.

³ The land price of renting in is the sum of the land price under the perfect market and the transaction cost of land, while the land price of renting out is the difference between the land price under the perfect market and the transaction cost of land.

higher land allocation efficiency dominates the negative effect of the lower land price under the perfect market, will marketization finally improve the average land productivity.

Therefore, an empirical study is needed to verify the channels proposed above. The study of the effect of agricultural land marketization on land productivity is essentially a social experiment, which is hard to control and implement. Nonetheless, agricultural land marketization in China provides an opportunity to empirically test those channels. In the collective periods beginning in the 1950s, the Chinese government prohibited transactions in land, labor and rental markets (see Lin, 1995). Since the rural reforms of 1978, a household-based farming system (that is, the household responsibility system) was used, and thus the prohibition on transactions in labor was abandoned. However, the transactions in land were still prohibited. The Constitution of the People's Republic of China (1982) stipulates that no organization or individual may appropriate, buy, sell, or lease land, or otherwise engage in the transfer of land, by unlawful means.⁵ According to the Amendment to the Constitution of the People's Republic of China (1988),⁶ the Law of the People's Republic of China on Land Contract in Rural Areas (2003)⁷ and the Measures for the Administration of Circulation of Rural Land Contracted Management Right (2005),⁸ it appears that even though the constraints on the agricultural land market were gradually relaxed, land transactions were still limited. In 2008, the Decision of the Central Committee of the Communist Party of China on Several Big Issues on Promoting the Reform and Development of Rural Areas decided to strengthen the development of the agricultural land transfer market and improve the transfer rate.⁹ After that, agricultural land marketization improved significantly (see Gao, Huang, & Ji, 2014), and the agricultural land market in China matured.

In this paper, by using the year 2008 as the indicator of agricultural land marketization in China, we empirically test the effect of marketization on the average land productivity by considering the channels of land allocation efficiency and the land price under the perfect market. The empirical framework we use is that used in the study of the inverse relationship (see Assunção & Braidó, 2007; Barrett et al., 2010; Binswanger, Deininger, & Feder, 1995; Carletto et al., 2013), and the data used is from the China Health and Nutrition Survey (CHNS) 2000, 2004, 2006, 2009, and 2011.¹⁰ Finally, we find that the higher land allocation efficiency improves the average land productivity by 34.4% and the lower land price under the perfect market reduces the average land productivity by 1.4%, implying that agricultural land marketization in China improves the average land productivity by 32.9%.

The rest of the paper is organized as follows. Section 2 introduces the hypotheses and the empirical framework. Section 3 explains the data and the relevant descriptive statistics. Section 4 shows the empirical results, and Section 5 concludes.

⁴.Agricultural land marketization affects the average land productivity also through, for example, indirectly influencing the amount of labor input and intermediate inputs. However, in this paper, we focus our discussions on the direct effects of marketization.

⁵.http://www.npc.gov.cn/englishnpc/Constitution/node_2830.htm

⁶.http://www.npc.gov.cn/englishnpc/Constitution/node_2829.htm

⁷.http://www.npc.gov.cn/englishnpc/Law/2007-12/06/content_1382125.htm

⁸.http://www.moa.gov.cn/zwl/m/tzgg/bl/200501/t20050126_311817.htm

⁹.<http://www.lawinfochina.com/display.aspx?lib=law&id=7542&CGid=>

¹⁰.<http://www.cpc.unc.edu/projects/china>.

2. Hypotheses and empirical framework

2.1. Hypotheses

Agricultural land marketization affects the land market mainly through the transaction cost of land (see Carter & Yao, 2002; Deininger & Jin, 2005). This marketization may significantly reduce the transaction cost and make the land price closer to that under the perfect land market. Assuming that the land price under the perfect market is r and that the transaction cost of both renting in and out is T , the prices of renting in and out land are $r + T$ and $r - T$, respectively. The higher level of the agricultural land marketization, the lower the transaction cost T , implying the price of renting in land $r + T$ becomes lower, and the price of renting out land $r - T$ becomes higher. In this way, the willingness of farmers to rent land in and out becomes stronger.

According to the producer theory, if the marginal productivity of the initial land endowment is no less than the full price of renting in land $r + T$, renting in land until the marginal productivity of operational land equals the full price of renting in land is the optimal strategy for these farmers. Similarly, if the marginal productivity of the initial land endowment is no greater than the full price of renting out land $r - T$, renting out land until the marginal productivity of operational land equals the full price of renting in land is the optimal strategy for these farmers. As agricultural land marketization reduces the transaction cost T , the full price of renting in land $r + T$ will decrease, and the full rent of renting out land $r - T$ will increase. Then, along with agricultural land marketization, there will be more land available to be transferred from farmers with a low marginal productivity to those with a high marginal productivity, which makes the land allocation closer to that under the perfect land market. Therefore, marketization may improve the agricultural land allocation efficiency.

As the elasticity of land productivity equals the ratio of the marginal productivity of land and land productivity, when this elasticity is positive, the marginal productivity of land and land productivity change in the same direction. If the land allocation efficiency improves, more land will be transferred from farmers with a low marginal productivity to those with a high marginal productivity, and thus the average marginal productivity of farmers will increase. In this way, the improvement of land allocation efficiency may increase the average land productivity.

Based on the above mechanisms, we propose Hypotheses 1 and 2.

Hypothesis 1: *Agricultural land marketization may improve the land allocation efficiency.*

Hypothesis 2: *The improvement of land allocation efficiency may increase the average land productivity.*

Besides reducing the transaction cost, agricultural land marketization may also decrease the land price under the perfect market r . Along with the increasing wages of industrial jobs, more and more farmers leave rural areas, which may increase the supply of agricultural land. As marketization reduces the transaction cost, it facilitates the transactions between farmers. In this way, the land price under the perfect market may fall. Therefore, marketization may help to reduce the land price under the perfect market, and subsequently the land prices of renting in and out. Due to the fact that the marginal

productivity of land equals the equilibrium land price, and that the marginal productivity of land and land productivity change in the same direction, agricultural land marketization may result in a decrease in land productivity. Based on the above mechanism, we propose Hypotheses 3 and 4.

Hypothesis 3: *Agricultural land marketization may reduce the land price under the perfect market.*

Hypothesis 4: *The decrease of the land price under the perfect market may reduce the average land productivity.*

To summarize, the mechanism behind Hypotheses 1 and 2 shows a positive effect of marketization on land productivity, while the mechanism behind Hypotheses 3 and 4 shows a negative effect. Consequently, the effect of agricultural land marketization on land productivity is the sum of these two opposing channels. Then, we propose Hypothesis 5.

Hypothesis 5: *The effect of agricultural land marketization on land productivity is the sum of the improvement of land allocation efficiency and the decrease of land price under the perfect market.*

2.2. Empirical framework

Measuring agricultural land marketization and transaction cost is a challenge in our empirical analysis. As we cannot obtain data for the level of marketization and transaction cost, we use the variation of the coefficient of the inverse relationship to indirectly estimate agricultural land marketization.

It has been found that there exists an inverse relationship between farm size and land productivity in China (see Benjamin & Brandt, 2002; Chen et al., 2011; Li et al., 2013). According to the relationship among the elasticity of land productivity, the marginal productivity of land and land productivity, there also exists an inverse relationship between farm size and the marginal productivity of land, as shown in Figure 1. When the agricultural land market is perfect, the operational farm size of farmers is A^* , where the marginal productivity of land equals the land price under the perfect market. When the agricultural land market is imperfect, the land prices of renting in and out are $r + T$ and $r - T$, respectively. Farmers operating a small farm size have a high marginal productivity of land, and thus a willingness to rent in land. They obtain the maximized profit when the marginal productivity of land equals the land price $r + T$. In this case, the operational farm size is A_1 . Farmers operating a large farm size have a low marginal productivity of land, and thus a willingness to rent out land. They obtain the maximized profit when the marginal productivity of land equals the land price $r - T$. In this case, the operational farm size is A_2 .

The line ab in Figure 1, connecting A_1 and A_2 , shows the linear relationship between farm size and the marginal productivity of land. The slope of line ab is the coefficient of the inverse relationship. When the line ab becomes steeper, the increase in the marginal productivity of land will be greater for a one-unit decrease in the farm size, and the willingness of farmers with a large farm size to transfer land to farmers with a small farm

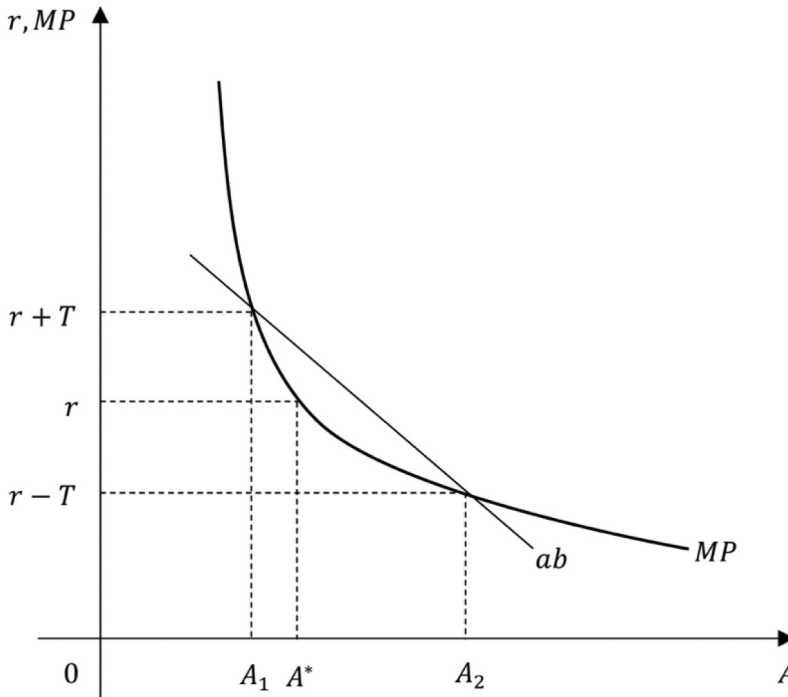


Figure 1. Farm size and the marginal productivity of land. Notes: r is the land price under the perfect market; T is the transaction cost of renting in and out; MP is the marginal productivity of land; and A is the operational farm size.

size will be stronger. Then, this shows a higher transaction cost in the market and a lower level of marketization. When the line ab becomes smoother, the increase in the marginal productivity of land will be less for a one-unit decrease in farm size, and the willingness of farmers with a large farm size to transfer land to farmers with a small farm size will be weaker. Then, this shows a lower transaction cost in the market and a higher level of marketization.

To summarize, the stronger the inverse relationship is, the lower the level of marketization will be. Therefore, the change in the strength of the inverse relationship shows the direction and magnitude of the variation in agricultural land marketization.

Based on the above identification strategy, our empirical specification is as follows. Referring to the framework for the study of inverse relationship (see Assunção & Braido, 2007; Barrett et al., 2010; Binswanger et al., 1995; Carletto et al., 2013), the empirical model is:

$$\ln \frac{Y_i}{A_i} = \alpha + \beta \ln A_i + \gamma_k CV_{ki} + u_i. \quad (1)$$

In Equation (1), Y_i/A_i is the output value per unit of land, that is, land productivity, of the farmer i . A_i is the operational farm size of farmer i . α is the constant, implying the price-adjusted technological level of agricultural production. CV_{ki} are control variables, including other agricultural production inputs, characteristics of household head, characteristics of household, variables capturing climate and soil quality, and time fixed effect.

The other agricultural production inputs include labor input (*Labor*) and intermediate inputs (*Raising*), both of which have a positive effect on land productivity. Following the relevant literature (Barrett et al., 2010; Benjamin & Brandt, 2002; Chen et al., 2011; Heltberg, 1998), the characteristics of household head include age (*Age*), gender (*Gender*), education level (*Edu*), and marriage situation (*Marriage*). In fact, an older household head may imply a richer agricultural production experience, which is conducive to higher land productivity. However, it is also possible that a younger household head has the spirit of innovation and entrepreneurship and thus improves the land productivity by adopting new technology. Meanwhile, an older household head may use an old technology and a traditional way to produce and thus result in low land productivity. In terms of gender, education level and marriage situation, it is possible that, for example, a divorced, single or female household head may bring lower land productivity and a household head with a higher education level may imply a richer knowledge of agricultural production, which is conducive to improving land productivity. Following Assunção and Braido (2007), Barrett et al. (2010) and Chen et al. (2011), the characteristics of household include household size (*Hsize*) and dependency ratio (*Dratio*). For example, a household with a large size may tend to use internal labor instead of hiring external labor, and a household with a high dependency ratio may use more labor input in order to feed dependants.

In addition, following Bhalla and Roy (1988), Chipanshi (1989), Benjamin (1995), and Kimhi (2006), we use province and village dummies to control the effects of average temperatures and soil quality. We also use whether a household has a pump to control irrigation factors related to rainfall (Assunção & Braido, 2007; Barrett et al., 2010; Kimhi, 2006). Finally, we use year dummies to control the time fixed effect.

Denoting the periods before and after the agricultural land marketization in 2008 by the subscripts “before” and “after”, the equations before and after the marketization are, respectively:

$$\ln \left(\frac{\overline{Y_{before}}}{\overline{A_{before}}} \right) = \overline{\alpha_{before}} + \beta_{before} \ln \overline{A_{before}} + \gamma_{k,before} \overline{CV_{k,before}}, \quad (2)$$

$$\ln \left(\frac{\overline{Y_{after}}}{\overline{A_{after}}} \right) = \overline{\alpha_{after}} + \beta_{after} \ln \overline{A_{after}} + \gamma_{k,after} \overline{CV_{k,after}}, \quad (3)$$

in which $\overline{Y_j/A_j}$, $\overline{\alpha_j}$, $\overline{A_j}$, and $\overline{CV_{k,j}}$ ($j = \text{before, after}$) denote the sample means of the land productivity, the constant, the operational farm size, and control variables before and after the marketization, respectively.

Next, Equation (3) minus Equation (2) equals:

$$\begin{aligned} \ln \left(\frac{\overline{Y_{after}}}{\overline{A_{after}}} \right) - \ln \left(\frac{\overline{Y_{before}}}{\overline{A_{before}}} \right) &= \left[\beta_{after} (\ln \overline{A_{after}} - \ln \overline{A_{before}}) + \ln \overline{A_{before}} (\beta_{after} - \beta_{before}) \right] \\ &\quad + (\gamma_{k,after} \overline{CV_{k,after}} - \gamma_{k,before} \overline{CV_{k,before}}) + (\overline{\alpha_{after}} - \overline{\alpha_{before}}) \end{aligned} \quad (4)$$

Then, we test the five hypotheses based on Equation (4).

First, we use the value of $\beta_{after} - \beta_{before}$ to test Hypothesis 1. We use the coefficient of the operational farm size β to measure the level of agricultural land marketization. When β equals 0 and is statistically significant, there do not exist farmers with the willingness to rent in or out land, and the land market is perfect. When β is negative and statistically significant, land allocation does not reach the optimum. We use the value of $\beta_{after} - \beta_{before}$ to measure the direction and magnitude of the improvement of the land allocation efficiency. The positive $\beta_{after} - \beta_{before}$ implies that land allocation efficiency improves after marketization.

Second, we use the value of $\ln \overline{A_{before}} (\beta_{after} - \beta_{before})$ to test Hypothesis 2. $\beta_{after} - \beta_{before}$ shows the change of land allocation efficiency after marketization. $\ln \overline{A_{before}}$ is the average operational farm size before marketization, showing that farmers retain the same operational farm size after marketization. The same farm size implies the equilibrium supply and demand does not change in the land market, or the land price under the perfect market r does not change. Hence, $\ln \overline{A_{before}} (\beta_{after} - \beta_{before})$ implies that when the land price under the perfect market r does not change, how does the change of land allocation efficiency, caused by marketization, affect the average land productivity? If $\ln \overline{A_{before}} (\beta_{after} - \beta_{before})$ is positive, the improvement of land allocation efficiency increases the average land productivity.

Third, in order to test Hypothesis 3, we use the change of the average operational farm size before and after marketization $\ln \overline{A_{after}} - \ln \overline{A_{before}}$ to infer the change of land price under the perfect market r . Marketization facilitates farmers to be able to leave rural areas and rent out land. Accordingly, the supply of land in the market may increase, and then the land price under the perfect market may decrease. Based on this reasoning, when $\ln \overline{A_{after}} - \ln \overline{A_{before}}$ is positive, the land price under the perfect market may decrease after marketization.

Fourth, in order to test Hypothesis 4, we use $\beta_{after} (\ln \overline{A_{after}} - \ln \overline{A_{before}})$ to show the effect of the change of the land price under the perfect market on the average land productivity. $\ln \overline{A_{after}} - \ln \overline{A_{before}}$ shows the change of the land price under the perfect market, and β_{after} shows agricultural land allocation after marketization. We use β_{after} instead of β_{before} , in order to exclude the change of land allocation efficiency caused by marketization.

Finally, for Hypothesis 5, we combine the channels of land allocation efficiency and the land price under the perfect market in order to evaluate the effect of marketization on the average land productivity. If

$\beta_{after} (\ln \overline{A_{after}} - \ln \overline{A_{before}}) + \ln \overline{A_{before}} (\beta_{after} - \beta_{before}) > 0$, the agricultural land marketization improves the average land productivity.

3. Data and descriptive statistics

The data we use is from the China Health and Nutrition Survey (CHNS) database, which is created by the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health (NINH, former National

Institute of Nutrition and Food Safety) at the Chinese Center for Disease Control and Prevention (CCDC). The CHNS database allows us to conduct a panel data analysis, in which, however, the sample size is limited. Therefore, we pool observations in different years and conduct a cross-sectional data analysis. Specifically, we use a sample of 6,604 observations in five years. The data description is in [Table 1](#).

Moreover, [Table 2](#) provides the summary statistics of different samples. According to [Table 2](#), for the sample 2000–2011, the average household size (*Hsize*) is 2.742; the average dependency ratio (*Dratio*) is 0.297; and the household head's marriage rate (*Marriage*) is 98.7%, implying that a typical household consists of a married couple and a dependant. For the household head, male (*Gender*) accounts for 91.1%; the average age (*Age*) is 51.886 years old; and the average education level (*Edu*) is 6.425 years, implying that household heads are mainly male and relatively old, with a relatively low education level. The average operational farm size (*A*) is 7.039 mu,¹¹ implying a small

Table 1. Data description.

Variables	Description
Dependent variable	
<i>Y/A</i>	Land productivity. This paper uses the output value per unit area to represent land productivity. The unit is yuan/mu. Considering the effects of price levels in different years, we use the agricultural production price index in the China Statistical Yearbook (2011 price = 100) to adjust.
Independent variable	
<i>A</i>	Farm size operated by a household. The unit is mu.
Control variables	
<i>Labor</i>	Total working time of a household in a year. The unit is month/household.
<i>Raising</i>	Intermediate inputs, such as seeds, chemical fertilizers, pesticide, and costs to machines. The unit is yuan.
<i>Age</i>	Household head's age. The unit is year.
<i>Gender</i>	Household head's gender. "1" denotes male and "0" denotes female.
<i>Edu</i>	Household head's education level. Primary school, junior high school, senior high school, secondary specialized school, undergraduate, postgraduate or above correspond to 6, 9, 12, 14, 16, and 19 years of education, respectively. The unit is year.
<i>Marriage</i>	Household head's marriage situation. "1" denotes married and "0" denotes unmarried.
<i>Hsize</i>	Size of a household. The unit is person.
<i>Dratio</i>	Ratio of the number of people under 16 or above 60 years old to the total number of people in a household.
<i>Pump</i>	Whether a household has a pump. "1" denotes yes and "0" denotes no.

Data Source: China Health and Nutrition Survey database 2000, 2004, 2006, 2009, and 2011.

Table 2. Descriptive statistics of sample 2000–2011 (Number of obs. = 6,604).

Variables	Full sample (2000–2011)	Before (2000–2006)	After (2009–2011)	Difference between before and after
<i>Y/A</i>	1252.246	1080.574	1530.133	449.559
<i>A</i>	7.039	6.966	7.166	0.200
<i>Labor</i>	16.135	14.514	18.742	4.228
<i>Raising</i>	1277.601	1026.927	1682.255	655.328
<i>Age</i>	51.886	50.006	54.901	4.895
<i>Gender</i>	0.911	0.918	0.901	−0.017
<i>Edu</i>	6.425	6.468	6.362	−0.106
<i>Marriage</i>	0.987	0.982	0.993	0.011
<i>Hsize</i>	2.742	2.812	2.630	−0.181
<i>Dratio</i>	0.297	0.275	0.331	0.056
<i>Pump</i>	0.217	0.187	0.264	0.077

Data Source: China Health and Nutrition Survey database 2000, 2004, 2006, 2009, and 2011.

¹¹One mu equals 1/15th of a hectare.

scale of agricultural production. Comparing the sample means before and after agricultural land marketization (samples 2000–2006 and 2009–2011, respectively), we can find that the average land productivity (Y/A) after marketization is 1530.133 yuan/mu,¹² which is 449.559 yuan/mu higher than that before marketization. Moreover, there are significant changes in labor input (*Labor*) and intermediate inputs (*Raising*). In particular, after marketization, the average operational farm size is 7.166 mu, which is 0.200 mu higher than that before marketization.

4. Empirical results

According to the estimation results of the full sample, sample 2000–2006 and sample 2009–2011 in Table 3, the operational farm size is negatively correlated with land productivity, statistically significant at the 1% level, implying the imperfection of agricultural land market and the existence of an inverse relationship between farm size and land productivity in China. Specifically, for the full sample, the coefficient of operational farm size ($\ln A$) is -0.642 , statistically significant at the 1% level, implying the existence of an inverse relationship. The coefficient of intermediate inputs ($\ln Raising$) is 0.303 , statistically significant at the 1% level, implying the positive effect on land productivity. The coefficients of the household head's gender (*Gender*) and marriage situation (*Marriage*) are 0.060 and 0.104 , respectively, which are statistically significant at the 5% and 10% levels, respectively. In addition, the coefficient of household size (*Hsize*) is 0.018 , statistically significant at the 1% level. Further, the coefficients of operational farm size of samples 2000–2006 and 2009–2011 are -0.683 and -0.506 , respectively, both statistically significant at the 1% level, also implying the imperfection of the land market and the existence of an inverse relationship.

Estimation results show that agricultural land marketization significantly improves the land allocation efficiency and increases the average land productivity, verifying Hypothesis 1. According to Table 3, comparing the results before and after marketization (2000–2006 and 2009–2011, respectively), the coefficient of the operational farm size after marketization is greater than that before marketization by 0.177 , which is statistically significant at the 1% level, implying that marketization improves land allocation efficiency.

We find that the improvement of land allocation efficiency increases the average land productivity by 34.4%, verifying Hypothesis 2. According to Table 4, the average operational farm size before marketization $\ln \bar{A}_{before}$ is 1.941 , and the change of land allocation efficiency is 0.177 , implying that $\ln \bar{A}_{before}(\beta_{after} - \beta_{before})$ equals 0.344 .

We also find that agricultural land marketization increases the average operational farm size, implying that marketization reduces the land price under the perfect market (Hypothesis 3). According to Table 4, the average operational farm size before and after marketization $\ln \bar{A}_{before}$ are 1.941 and 1.969 , respectively, implying that marketization increases the average operational farm size by 0.028 .

¹²At the time of surveys, approximately 6.5–8.2 Chinese yuan can be exchanged for 1 US dollar.

Table 3. Estimation results for existence of inverse relationship.

Variables	Full sample	Before	After	Difference between
	(2000–2011)	(2000–2006)	(2009–2011)	before and after
Dependent variable: $\ln(Y/A)$				
Variable of interest				
$\ln A$	−0.642*** (0.018)	−0.683*** (0.022)	−0.506*** (0.025)	0.177*** (0.034)
Control variables for other production inputs				
$\ln Labor$	0.013 (0.011)	−0.004 (0.012)	0.028 (0.020)	0.001 (0.024)
$\ln Raising$	0.303*** (0.009)	0.304*** (0.011)	0.210*** (0.013)	0.007 (0.017)
Control variables for characteristics of household head				
<i>Age</i>	0.000 (0.001)	0.000 (0.001)	−0.003** (0.001)	0.000 (0.002)
<i>Gender</i>	0.060** (0.028)	0.041 (0.034)	0.057 (0.039)	0.001 (0.052)
<i>Edu</i>	0.000 (0.002)	0.001 (0.003)	−0.003 (0.003)	0.000 (0.004)
<i>Marriage</i>	0.104* (0.064)	0.115** (0.067)	0.118* (0.135)	0.003 (0.151)
Control variables for characteristics of household				
<i>Hsize</i>	0.018*** (0.007)	0.023*** (0.009)	0.016 (0.012)	0.001 (0.015)
<i>Dratio</i>	−0.023 (0.026)	0.032 (0.033)	−0.023 (0.038)	0.001 (0.050)
Control variables for climate and soil quality				
Yes	Yes	Yes	Yes	
Province dummies	Yes	Yes	Yes	
Village dummies	Yes	Yes	Yes	
<i>Pump</i>	0.062*** (0.020)	0.079*** (0.026)	0.053* (0.029)	0.002 (0.039)
Time fixed effect				
Year dummies	Yes	Yes	Yes	
<i>Cons</i>	5.884*** (0.135)	6.116*** (0.156)	6.461*** (0.238)	0.180 (0.284)
Number of obs.	6,604	4,071	2,533	
R^2	0.443	0.548	0.387	

Data Source: China Health and Nutrition Survey database 2000, 2004, 2006, 2009, and 2011.

Notes: 1. The standard deviation is inside the parenthesis; 2. *, ** and *** denote the significant level of 10%, 5% and 1%, respectively; 3. The standard deviation of the difference between the coefficients before and after the agricultural land

marketization is calculated by $\sigma_\beta = \sqrt{(Std.Err.2000-2006)^2 + (Std.Err.2009-2011)^2}$ and the test statistic is $Z = \frac{(\beta_{2009-2011} - \beta_{2000-2006})}{\sigma_\beta}$ (Clogg, Petkova, & Haritou, 1995).

Next, the decrease of land price under the perfect market reduces the average land productivity by 1.4%, verifying Hypothesis 4. According to Table 4, the level of land allocation after marketization β_{after} is −0.506, and the change of the average operational farm size $\ln \overline{A_{after}} - \ln \overline{A_{before}}$ is 0.028, implying that $\beta_{after}(\ln \overline{A_{after}} - \ln \overline{A_{before}})$ equals −0.014.

Finally, as the improvement of land allocation efficiency increases the average land productivity by 0.344, and the decrease of land price under the perfect market reduces the average land productivity by 0.014, the sum of these two channels $\beta_{after}(\ln \overline{A_{after}} - \ln \overline{A_{before}}) + \ln \overline{A_{before}}(\beta_{after} - \beta_{before})$ is 0.329. This result shows that the positive effect of increasing land allocation efficiency dominates the negative effect of the decreasing land price under the perfect market, and thus agricultural land marketization in China improves the average land productivity by 32.9%.

Table 4. Factor decomposition of improvement of average land productivity.

Variables	ln \bar{X}			β			$\ln \bar{X}_{before} (\beta_{after} - \beta_{before})$	$\ln \bar{X}_{before} (\beta_{after} - \beta_{before})$	Contribution
	Before	After	Difference	Before	After	Difference			
ln (Y/A)	6.985	7.333	0.348	-	-	-	-	-	0.348
ln A	1.941	1.969	0.028	-0.683	-0.506	0.177	-0.014	0.344	0.329
Others	-	-	-	-	-	-	-	-	0.019

Data Source: China Health and Nutrition Survey database 2000, 2004, 2006, 2009, and 2011.
Notes: \bar{X} , β and ln denote the sample means of variables, coefficients and natural logarithm, respectively.

5. Conclusion

This paper proposes that, besides improving land allocation efficiency, agricultural land marketization can also affect the average land productivity through reducing the land price under the perfect market.

By using the agricultural land marketization reform in China in 2008 as the indicator of marketization and the CHNS database 2000, 2004, 2006, 2009, and 2011, based on the empirical framework for the inverse relationship between farm size and land productivity, this paper empirically finds the following.

First, the agricultural land market in China is imperfect, and there exists a significant inverse relationship between farm size and land productivity. Second, marketization in China decreases the magnitude of the inverse relationship, improves land allocation efficiency and increases the average land productivity by 34.4%. Third, marketization in China increases the supply of land and the average operational farm size, decreases the land price under the perfect market and reduces the average land productivity by 1.4%. Finally, agricultural land marketization in China improves the average land productivity by 32.9%.

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