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The Effect of Internet Information Dependence and Land Transfer on Agricultural Production Technical Efficiency of Households

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Abstract: In this essay, the author studies the relationship between internet information dependence, land transfer, and agricultural production technical efficiency based on the CFPS database, including observations from households from 25 provinces in China. The stochastic frontier approach is adopted to predict the technical efficiency of each household, and then OLS, group regression, and regression under interaction terms are applied, respectively. As a result, leasing land from others and internet information dependence are proven to have a positive impact on technical efficiency, while only in the case that the house owner does not depend on the internet to acquire information, the effect of leasing land from others is significant. Though the interaction term between internet dependence and land transfer is not significantly negative, internet dependence does have a substitution effect on land transfer in terms of improving technical efficiency. The result sheds light on developing countries striving to increase agricultural production efficiency and thus presents possible suggestions for peasants to gain better economic status.

Keywords: land transfer, internet information dependence, technical efficiency

1 Introduction

The allocation of agricultural resources is vital in increasing a country's agricultural industry performance. In the case of China, a series of land reform policies were put forward in the 1980s, marking the end of the Agricultural producer's cooperative system and the begging of the Household contract responsibility system, known as the fourth land reform. In October 2008, the fifth land reform in China officially approved the land transfer in rural parts of China.

Since then, China decided to establish a good market for transferring land contract management rights, allowing farmers to rent, swap, transfer, share cooperation, and other forms of transfer of land management rights, developing various forms of moderate-scale operation. The area of land transfer has increased significantly in past decades. According to the data in 2020 from the Chinese Department of Agriculture, the farmland for households in China was 1,041,108.27 square kilometers. The land area being transferred was 354,792.8 square kilometers, 34.08% percent of farming land, 4.3% higher than the proportion in 2019.

In terms of the construction of internet manufactures, China Internet Network Information Center (CNNIC) released the 49th Statistical Report on the Development Status of China's Internet in Beijing on the 25th. The report shows that as of December 2021, the size of China's Internet users reached 1.032 billion, an increase of 42.96 million over December 2020, and the Internet penetration rate reached 73.0%.

The report shows that the overall scale of China's Internet users will continue to grow in 2021. The gap between urban and rural Internet access continues to narrow, and China's existing administrative villages have fully covered with internet service. Instant messaging, online video, and short video user utilization rates of 97.5%, 94.5%, and 90.5%, respectively.

Like many developing counties all over the world, China keeps working on improving the living standard of low-income groups of people in rural villages. Land transfer has long been an essential factor in peasants' life decisions relating to non-farm payroll, scaled farming, and other events affecting the efficiency of agriculture production. On the other hand, with more internet manufacturers, more people living in rural villages can access various information online, which improves agricultural production efficiency. Considering a correlation between land transfer and acquiring internet information, this essay aims to present the relationship between land transfer, internet dependence, and agriculture production efficiency. The author hopes to make an effort to support people living in rural villages to improve agriculture production efficiency under limited resources.

2 Literature Review

In agricultural and development economics, many studies have focused on discussing the factors influencing agricultural production efficiency, including labor productivity, land productivity, and technical efficiency. Furthermore, land transfer, as a focus of policy encouragement in China and a means of factor allocation to achieve an appropriate scale of operation, has attracted much attention and research from scholars.

2.1 Agricultural Production Efficiency Effects of Land Transfer

Existing studies have followed two main lines of thought to examine land transfer's agricultural production efficiency effects. The first line of thought is to directly verify the effect of land transfer on agricultural production efficiency from the perspective of outcomes. Huang et al. studied the effects of rice farmers' land transfer market participation, plot source (lease in or collective allocation), non-farm employment level, and land fragmentation status as independent variables on the technical efficiency of rice farmers' rice production. It was found that both participation in land transfer and non-agricultural employment had a positive effect on the technical efficiency of rice farmers [1]. Cai et al. introduced a propensity score matching method to analyze the average treatment effect of the effect of participation in land transfer on the technical efficiency of transferring and non-transferring farmers, further confirming that land transfer does increase technical efficiency after matching factors such as age, gender, education level, farming experience, and the number of family members working in agriculture [2]. Shi found that land transfer improves the technical efficiency of agricultural production by correcting labor mismatch, while it has a limited effect on correcting land mismatch status, further explaining the mechanism by which land transfer affects the technical efficiency of agricultural production [3].

The second approach is to start from the process by regressing land transfer on the productive capacity of farmers to examine whether the land is transferred from low-productivity farmers to high-productivity farmers in actual cases, thus optimizing the allocation of land resources and improving production efficiency. Like Deininge, JIN S, JIN S.Q., and Chen, scholars in India, Kenya, and China, respectively, support that the direction of land transfer is consistent with the principle of optimization from efficiency [4-7]. However, some studies have also yielded inefficient results, such as Li [8]. Of

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the two ideas mentioned above, the former one directly verifies the impact of the land transfer on the final agricultural production efficiency. In contrast, the latter indirectly verifies the impact of the land transfer on agricultural production efficiency by verifying whether the land transfer can achieve optimal resource allocation. This paper will focus on the impact of the land transfer on the outcome of agricultural production efficiency, following the first idea to carry out the study.

2.2 Impact of Internet Information on Agricultural Production Efficiency

On the other hand, there has been a lot of discussion in the academic community about the role of internet information on agricultural production efficiency. A series of empirical essays have verified the positive effect of informatization on economic growth and agricultural production efficiency. For example, using provincial panel data for China from 1990 to 2010 and using changes in the structure of the telecommunications market as an instrumental variable, Zheng finds that the infrastructure development of mobile and fixed telephones jointly promotes economic development in the early period, while in the later period it is mainly the mobile telephone infrastructure that promotes economic development [9].

Specifically in the agricultural sector, however, there is no consensus among existing scholars regarding labor productivity and land productivity. Kiiza shows that ICT (information communication technology) based on market information has a significant positive effect on farmers' choice of better crop seeds, while the adoption of better seeds has a positive effect on production efficiency [10]. Ogutu et al. verified that ICT-based market information had a significant positive effect on seed, fertilizer, land use, and land productivity but negatively on labor use, using the propensity to earn allocation method. Subsequently, ICT has a positive effect on both labor and land productivity [11].

In terms of agricultural technical efficiency, Yin et al. found that the total factor productivity in agriculture was facilitated by the level of agricultural information services by reducing transportation and communication expenditures, using provincial panel data in China [12]. Yu and Zhu’s results also showed that information technology has a catalytic effect on total factor productivity growth in agriculture [13]. Ha and Zhan argued that informatization positively affects agricultural total factor productivity only after the level of rural human capital reaches a certain level [14]. Based on panel data from rural fixed observation sites of the Chinese Ministry of Agriculture, Zhu et al. used cell phone signal, internet, and mobile network connectivity as a measure of informatization. They found that informatization contributes to total factor productivity by promoting agricultural technical efficiency [15]. However, in other studies, such as Li and Yin, who added the degree of informatization (number of telephones per 100 people) as a control variable to the model to study the impact of rural labor migration on total factor productivity in agriculture, the results showed that the impact of informatization on total factor productivity in agriculture was not significant [16].

Overall, existing studies have analyzed the effects of internet information and land transfer on agricultural production efficiency separately in a comprehensive manner. Most scholars have used panel data combined with the PSM method, while some have introduced instrumental variables to investigate the internal mechanisms of the effects. The positive correlation between land transfer and agricultural production efficiency can be confirmed among them. In contrast, the significance of the effect of internet information on agricultural production efficiency has not been consistently concluded.

2.3 The Heterogeneous Effect of Internet Information Impact on Land Transfer

It should be noted that studies have shown that internet information also has a facilitating effect on land transfer. A study by Liu et al. based on data from a 2019 study covering 14 provinces by the

National Institute of Agricultural Development of China Agricultural University showed that farmers' access to agricultural information through the internet significantly promoted rural land transfer and the extent of its effect on leasing land from others was more pronounced than that leasing out land [17]. However, few scholars have jointly considered the effects of internet information and land transfer on total factor production efficiency in agriculture, i.e., whether information technology affects land transfer and thus indirectly impacts agricultural production efficiency. Therefore, based on the CFPS18 survey data, this paper will use an OLS model, regression by groups and regression under interaction terms to sort out the mechanism of information technology and land transfer affecting agricultural production efficiency and make an empirical test of the hypothesis of their paths of action.

3 Theoretical Analysis

3.1 Internet Information and Agricultural Production Efficiency

Considering the literature listed above, internet information may affect agricultural production efficiency in several positive ways, as shown below.

First, it was found that internet information increases agricultural factor inputs, increasing land and labor productivity. Increased internet information in rural areas gives farmers greater access to farming-related information on the Web and influences their farming strategies. Specifically, farmers may tend to increase the inputs used to purchase production factors such as seeds and fertilizers, increasing land productivity and labor productivity. The increase in input costs may be reflected in the increased number of seeds and fertilizers used per unit of arable land, among others [11]. In addition, information technology has a positive effect on the types of crops grown by farmers [18], and access to information can change the allocation of production factors and cropping structure, thereby increasing agricultural production efficiency [19].

Second, increased internet information will reduce barriers to market information flow so that farmers can purchase better quality seeds, fertilizers, and other factors of production, which in turn will lead to greater agricultural production efficiency [10]. The construction of wireless network base stations, the spread of cell phones and computers, and the increased frequency of electronic device use will allow farmers to reach a variety of sellers of production factors through online trading platforms.

Third, internet information has a catalytic effect on farmers' adoption of advanced production technologies. Farmers can adopt more advanced storage technologies, for example, by being informed by other farmers or organizations [20]. In addition, in the case of integrated pest management (IPM), for example, increased internet information has significantly increased farmers' knowledge of this technology. It has increased their adoption of new technologies [21]. In general, increased internet information gives farmers more opportunities to adopt new technologies to improve productivity.

Finally, combined with the experience of the rural revitalization planning research project of the Chinese Academy of Social Sciences in Hunan Province in China, where the author has participated, internet information can help drive the development of local agricultural product-related industries. For instance, farmers in a specific region may plant a unique type of crop collectively. They can take advantage of central planning, scaled production, and more substantial bargaining power, thus improving agricultural production efficiency. Internet information helps farmers to create local brands of particular agricultural products or develop unique agricultural ecology combined with tourism. Eventually, the mature industry will attract more private sector investment or government infrastructure investment while expanding the sales and profits of agricultural products and improving agricultural production efficiency.

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On the other hand, however, internet information may also harm production efficiency. With increased information technology, farmers can learn about more opportunities such as non-agricultural employment and increase non-agricultural employment [15], and therefore harm labor and land productivity [22].

From the above analysis, internet information may impact agricultural production efficiency through multiple paths, and most studies have concluded that the impact is positive. However, there is still room for further analysis and verification.

3.2 Land Transfer and Agricultural Production Efficiency

Many pieces of literature have examined the relationship between land transfer and agricultural production efficiency. Most of the literature reached a relatively consistent conclusion that land transfer can positively affect agricultural production efficiency.

First, farmers can achieve a better allocation of resources through land transfer, which can lead to an increase in productivity. Land can be transferred from farmers with lower productivity to those with higher productivity [23], achieving a more optimal allocation of land resources. Land transfer can also improve the efficiency of arable land use by correcting labor mismatch [24], and the phenomenon of agricultural land desertion due to young laborers going out to work can be alleviated by land transfer, which in turn improves production efficiency.

Second, land transfer can also reduce the degree of land fragmentation. The degree of land fragmentation tends to be inversely proportional to technical efficiency [25], and larger areas of land and unified land managers can facilitate investment in agricultural machinery, adoption of new technologies, and farm infrastructure development, generating economies of scale. This effect is dependent on the degree of development of land transfer markets and the adequate protection of land rights [26].

Based on this literature, this paper hypothesizes that land transfer has a positive contribution to agricultural production efficiency.

3.3 Interaction Between Internet Information and Land Transfer

It is essential to emphasize a significant correlation between internet information and land transfer. Farmers' access to agricultural information through the internet significantly contributes to rural land transfer. The internet has brought farmers more information resources, more convenient information screening mechanisms, and efficient trading platforms. As early as 2009, service platforms with the theme of land transfer service like Landflow.com was used. This website is a vast land transfer information hub covering all provinces in China, with a considerable amount of land transfer information available for farmers to choose from, from farmland to forest land and even rural plants; each piece of land is marked with a specific location, size, planned use, and field photos. Websites such as Landflow.com have even partnered with banks to provide mortgage guarantees for small farmers' land transfers in some pilot counties, further lowering the threshold for land transfers. Internet information has made it possible for the parties to a land transfer transaction to no longer be limited to acquaintances, for the location of the land to no longer be limited to the local area, and for restrictions such as capital to be relaxed. The literature points out that internet information and the use of the internet have also reduced transaction costs for both parties to land transfer, making transactions more likely to occur [17].

From another perspective, the internet has promoted non-agricultural employment, making farmers more willing to lease their land. The internet provides hiring information; meanwhile, with the popularity of the internet, online jobs such as e-commerce have become new options for non-agricultural employment.

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Based on the close correlation between internet information and land transfer, the impact of both on agricultural production efficiency can be considered to make a more accurate judgment on the impact between the three. This paper assumes that there is a positive correlation between internet information and land transfer and that they jointly have a positive impact on agricultural production efficiency.

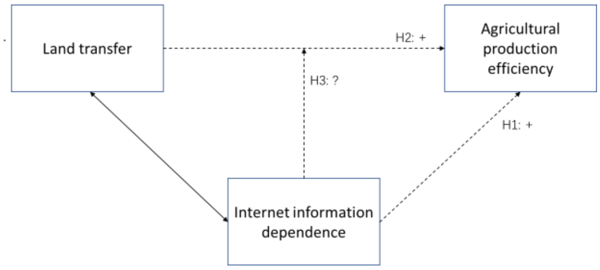

Figure 1: Mechanism of the impact of internet information dependence and land transfer on agricultural production efficiency.

In conclusion, 3 hypotheses are put forward predicting the relationship between internet information dependence, land transfer, and agricultural production efficiency:

H1: Internet information dependence has a positive impact on agricultural production efficiency.

H2: Land transfer has a positive impact on agricultural production efficiency.

H3: Internet information dependence can moderate land transfer's impact on agricultural production efficiency.

The following paper will test these hypotheses through empirical studies using data in the real world and further investigate the mechanism behind it.

4 Data Source and Model Setting

4.1 Data Source

This paper uses the China Family Panel Studies (CFPS) conducted by the China Social Science Survey (ISSS) at Peking University, which focuses on the economic and non-economic well-being of Chinese residents, as well as on several research topics, including economic activity, educational outcomes, family relationships, and family dynamics, population migration, and health. It reflects China's social, economic, demographic, educational, and health changes.

The CFPS tracks data at the individual, household, and community level, with a target sample size of 16,000 households in 25 provinces/municipalities/autonomous regions, and includes all household members in the sample. In addition, CFPS questionnaires are set up with four main questionnaire types and various question types. Therefore, the sample of CFPS has good representativeness and validity.

To analyze the impact of internet information and land transfer on agricultural production efficiency, this paper mainly uses the most current CFPS 2018 individual and household level data. CFPS 2018 database is missing data on the farmland area of the household. Considering the relatively stable land resources owned by farmers, this paper follows the suggestion of CFPS officials and uses the CFPS 2012 land area data to replace the missing data in 2018. This paper first merges and matches the databases of both years and then only retains the information of samples participating in both rounds of questionnaires.

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4.2 Model Setting

Following various references, the primary model is set as follows. In the OLS regression model, techeff represents the technical efficiency of each specific household, which is derived from the Stochastic Frontier Approach, which will be illustrated in detail in the next part of this essay. The independent variables landin and landout are dummy variables representing whether the household is leasing or renting its farmland. The variable int_inf is a variable of the importance that house owners attribute to acquiring information through the internet. From 1, indicating the house owner is indifferent on whether to use the internet to acquire information, to 5, when the house owner attaches great importance to acquiring information online. X stands for a series of controlled variables listed in the following equation. The village is controlled with variable cid, and ε is the random error term.

$$\mathrm{TE} = \beta_1 \times landin + \beta_2 \times landout + \beta_3 \times \mathrm{int_{inf}} + \sum \delta_i \times X_i + cid_j + \varepsilon \qquad (1)$$

Where: $\mathrm{X} = (\mathrm{gender}, \ln(\mathrm{eduy}), \mathrm{health}, \ln(\mathrm{ave\_eduy}), \mathrm{malep}, \ln(\mathrm{finance\_asset}), \ln(\mathrm{nonhousing\_debts}))$

4.3 Variables Setting

Following the theoretical analysis section and essays mentioned in the literature review, the following variables are introduced:

4.3.1 Independent Variables and Controlled Variables

The primary independent variables are land transfer and internet information. Land transfer can be classified into two directions: leasing land from others and leasing land to others, represented by landin and landout, respectively. Internet information is measured by the variable int_inf, which is the importance of the internet as a way to acquire information, rated by the house owner from 1 to 5.

A series of other independent variables are also adopted. At the house owner level, gender and health are dummy variables; eduy is the years of education received by the house owner. On the household level, ave_eduy represents the average education years of all family members, and malep is the percentage of males in the household. Finance_asset and nonhousing_debts reflect the household's aggregated finance assets and debt value, respectively.

In order to exclude the fixed effect of the geography and economic level in different regions, cid, the village number which the household is in, is controlled as a fixed effect in all regressions in the following essay.

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Table 1: Variable list for primary regression.

variable name	variable definition	measurement
landin	whether the household leasing land from others	dummy variable, “1” represents yes, “0” represents no
landout	whether the household leasing land to others	dummy variable, “1” represents yes, “0” represents no
int_inf	the extent that house owners regard the internet as an essential way to acquire information	rated by the house owner from 1, totally unimportant, to 5, extremely important
gender	gender of the house owner	dummy variable, “1” represents male, “0” represents female
eduy	education level of the house owner	years of education received by the house owner
health	health condition of the house owner	dummy variable, “1” represents heathy, “0” represents unhealthy
ave_eduy	average education level of the household	average years of education received by the household
malep	percentage of males in the household	number of males in the household/ number of family members
finance_asset	aggregated finance assets value of the household	aggregated finance assets value of the household (Yuan)
nonhousing_debts	aggregated debts value of the household	aggregated debts value of the household (Yuan)
cid	village number	village number

4.3.2 Dependent Variable: Technical Efficiency

Regarding agricultural production efficiency, technical efficiency is chosen instead of land productivity and labor productivity for two reasons. First, since technical efficiency takes relatively careful consideration of all sources of agricultural input, it can better reflect the agricultural production efficiency. Second, though it had been confirmed by the official staff of CFPS that the missing farmland area in 2018 can be replaced by the corresponding variable in the 2012 database, it is still not accurate enough to measure land productivity.

4.3.2.1 Measurement of Technical Efficiency: Stochastic Frontier Approach(SFA) Production Function.

Technical efficiency reflects the ratio of the actual production of the household and theoretical maximum production under a specific input and output structure. SFA is commonly used to estimate technical efficiency, especially in multiple input and output conditions. A specific production function is predicted using the given input and output data. Thus the frontier of production can be derived. The predicted frontier serves as a standard to measure the technical efficiency of each household. The specific expression of the SFA production function is:

$$\mathrm{Y}_i = \mathrm{f}(\mathrm{X}_i, \beta) + v_i - u_i \tag{2}$$

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In the above equation, $f(X_i, \beta)$ represents the production frontier predicted by a series of input variables from family i, X_i. β is the parameter reflecting the technical efficiency, the efficiency of converting input to output, of family i. $v_i \sim N(0, \sigma_v^2)$ is the normal random disturbance term, while $u_i \sim N^+(0, \sigma_u^2)$ is the technical inefficiency term. By adopting the MLE (Maximum Likelihood Estimate) method, technical efficiency can be predicted as:

$$Y_i = f(X_i, \beta) + v_i - u_i \tag{2}$$

4.3.2.2 Input and Output Variables Were Chosen for the SFA Production Function

The input and output variables for predicting technical efficiency above are chosen as following:

The output variable is set to be the aggregated value of agricultural products for a specific household in 2018. The input variables consist of agricultural land area, the number of laborers in a family, and other agricultural costs, including the expenditure on purchasing seeds, fertilizer, pesticides, the value of agricultural machines, and hiring labor.

4.3.2.3 Prediction Result of Technical Efficiency

The production frontier is predicted by taking agricultural product yield as the output variable and farmland area, agricultural labor number, seed cost, hiring labor cost, agricultural machine cost, irrigation cost, and other input variables. After acquiring the predicted techeff, the author multiply it by 10^9 for better readability in later regression (otherwise, the estimators will be too small). The final technical efficiency variable is named TE, and the descriptive statistics are listed below.

Table 2： Statistical summary of TE.

variable	N	mean	sd	min	p50	max
TE	3753	946171672	72	946170880	946171648	946172864

5 Regression Result and explanation

5.1 Descriptive Statistics and Correlative analysis

Basic descriptive statistics and correlation matrix for independent variables are listed below. The minimum number of observations not omitted is 5102, greater than the number of observations that allow for predicting the technical efficiency. Land leasing from others happens in 631 observations, 11.23% of the sample; Land leasing to others happens in 1,042 observations, 20.42% of the sample. Households who attribute no internet information importance account for 2,755 observations, 49.85% of the sample; the remaining 4 importance values are rated 389, 863, 577, and 943 times respectively. No series collinearity among independent variables is detected in the correlation matrix.

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Table 3: Statistical summaries of variables in primary regression.

variable	N	mean	sd	min	p25	p50	p75	max
landin	5619	0.110	0.320	0	0	0	0	1
landout	5102	0.200	0.400	0	0	0	0	1
int_inf	5527	2.380	1.570	1	1	2	4	5
gender	5622	0.560	0.500	0	0	1	1	1
health	5599	0.640	0.480	0	0	1	1	1
eduy	5471	6.410	4.250	0	3	6	9	19
ave_eduy	5551	6.430	3.440	0	4.500	6.670	9	19
malep	5622	0.500	0.220	0	0.400	0.500	0.600	1
finance_asset	5578	39960	100000	0	0	7000	40000	3.000e+06
nonhousing_debts	5593	15182	62606	0	0	0	0	1.500e+06

5.2 Main regression

Using Stata17 to regress on equation (1), significant positive impacts of leasing land from others and internet dependence on technical efficiency are detected. The regression results for including different sets of controlled variables are shown in regressions (1), (2), and (3). Leasing land from others remains significant at a 1% level, while internet dependence is significant at a 1% level in regression (1) and a 2% level in regression (2) and (3). Both the two variables have a positive estimator.

By contrast, leasing land to others is always insignificant in all the 3 regressions. It can be concluded that leasing land to others does not affect the technical efficiency of households significantly.

Based on the regression result, Hypothesis 1 is proven correct, while Hypothesis 2 is also sound in leasing land from others.

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Table 4: Main regression result.

	(1)	(2)	(3)
	TE	TE	TE
landin	12.723***	12.995***	10.457***
	(3.74)	(3.69)	(3.75)
landout	-4.323	-4.802	-3.571
	(4.32)	(4.29)	(4.36)
int_inf	2.414***	2.142**	1.908**
	(0.87)	(0.91)	(0.92)
gender		2.413	2.235
		(2.71)	(2.93)
health		1.619	1.190
		(2.69)	(2.72)
eduy		0.617*	0.422
		(0.36)	(0.47)
ave_eduy			0.049
			(0.58)
malep			5.009
			(7.08)
finance_asset			0.000*
			(0.00)
nonhousing_debts			0.000***
			(0.00)
_cons	946171677.203***	946171672.394***	946171663.921***
	(21.46)	(21.01)	(22.18)
R^2	0.182	0.191	0.204
adj. R^2	0.049	0.057	0.070
F	1.372	1.426	1.518
N	3573	3482	3424

5.3 Heterogeneity Analysis

In the last section, it has been shown that both land leasing and internet information positively impact technology. In order to gain more insight into the relationships between land leasing, internet information, and technical efficiency, 2 methods are adopted in this essay to perform heterogeneity analysis.

5.3.1 Group Regression

Firstly, households are divided into two groups.

The house owner in the first group does not depend on the internet to acquire information, and other households belong to the second group. This paper regress technical efficiency on independent variables as equation (1) except int_inf (internet information dependence), aiming to test the difference between internet-relier households and other households.

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Table 5: Group regression result.

	(4)	(5)
	Internet Independent Group	Internet Dependent Group
	TE	TE
landin	17.270***	4.960
	(4.75)	(6.31)
landout	-4.621	1.236
	(5.44)	(7.58)
gender	0.680	2.293
	(3.79)	(4.88)
eduy	-0.106	0.669
	(0.59)	(0.80)
health	3.496	4.616
	(3.33)	(4.80)
ave_eduy	0.560	0.150
	(0.71)	(1.02)
malep	9.496	5.921
	(8.50)	(12.52)
finance_asset	0.000*	0.000
	(0.00)	(0.00)
nonhousing_debts	0.000***	0.000***
	(0.00)	(0.00)
_cons	946171666.455***	946171665.939***
	(26.83)	(34.94)
R^2	0.294	0.329
adj. R^2	0.093	0.086
F	1.465	1.355
N	1774	1682

Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

As a result, shown in table x, the parameter of land leasing becomes even higher, and the significance also rises in the first group, in which internet information is not critical for the house owner. By contrast, land leasing turns insignificant in the second group in which house owners do not rely on internet information. The result implies a substitution effect between land leasing and internet information dependence. Though internet dependence and land leasing have been proved to have positive and significant contributions to improving households' technical efficiency, land leasing may boost the technical efficiency only if the house owner is not an “internet learner."

This effect can be explained by the independent effect of acquiring helpful information online on increasing agricultural-related skills, including improving irrigating systems, adopting new farm managing methods, finding high-quality seeds online, searching for cooperative opportunities with nearby villages, and so on. In the above cases, land leasing may not be a deterministic variable that can guarantee the rise and fall of technical efficiency. While in the case that house owner does not rely on the internet to acquire information, there are not many alternative methods that can improve technical efficiency. Land leasing can be detected as an effective and deterministic way to enhance technical efficiency by achieving optimal resource allocation and scaled agriculture when house owners do not depend on online information.

5.3.2 Interaction Term.

By applying the group regression method, this paper has detected a significant difference in terms of the effect of land leasing on technical efficiency among internet-dependent households and other households. In the following essay, an interaction term between internet dependence and land leasing is introduced to test whether this negative effect is significant among different levels of internet dependence.

Table 6: Regression with interaction term.

	(6)
	Interaction term analysis
landin	13.550**
	(6.49)
landout	-3.612
	(4.36)
int_inf	2.132**
	(1.00)
landinxint_inf	-1.308
	(2.24)
gender	2.282
	(2.93)
eduy	0.423
	(0.47)
health	1.129
	(2.72)
ave_eduy	0.051
	(0.58)
malep	4.862
	(7.08)
finance_asset	0.000*
	(0.00)
nonhousing_debts	0.000***
	(0.00)
_cons	946171663.436***
	(22.20)
R^2	0.204
adj. R^2	0.069
F	1.515
N	3424

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

The interaction term is significant when internet dependence has leveled impacts on the slope of land leasing, implying that each unit change of internet dependence has a fixed effect on the impact of land leasing on technical efficiency. The significance of an interaction term implies a stricter

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hypothesis on the relationships between internet dependence, land leasing, and technical efficiency. However, by the regression result, the interaction term is not statically statistically significant. It may be because the impact of internet dependence is not fixed across different internet dependence levels. Instead, the subsistent effect between internet dependence and land leasing may only be significant when comparing zero internet-dependent households and other households.

The limitation of data may also account for the insignificant interaction term. For instance, in terms of internet dependence, there are few available variables, most of which are subjective variables rated by the responses. The grading of internet information importance is subjective, so that reverse causality may exist. Higher technical efficiency achieved by adopting agricultural skills and other information online makes house owners more likely to rate higher on the importance of acquiring information online; the possible existence of reverse causality may lead the measure of internet dependence inaccurate to some degree. The author hope more studies can be done in this aspect using data that measures internet information in other ways.

In a nutshell, hypothesis 3 can be verified through the above two regressions. Though leasing land from others and internet dependence do not have a significant interaction term, in the equation that they are regressed on technical efficiency, a clear difference when samples are grouped by internet dependence can be detected.

5.4 Robustness Check: Regression in Logarithm Terms

In the following part, considering some variables have an extensive range in distribution. Some extreme values in observation may result in higher error in estimation. In order to check whether the mechanism above derived by the regression is robust, numerical variables are replaced by their corresponding logarithm terms. Considering the relatively small variation in technical efficiency, a similar contraction in the logarithm term of technical efficiency is taken in this section.

Firstly, define $LN(\text{techeff}) = 10^9 * \ln(\text{techeff})$, where techeff is the variable representing technical efficiency. Then variable techeff in the original equation is substituted with $LN(\text{techeff})$.

Numerical variables including eduy, ave_eduy, finance_asset, and nonhousing_debts are also taken logarithm after adding by one to avoid being omitted in the cases that any of the above variables equal to zero in an observation. Denote these variables $\ln(\text{eduy})$, $\ln(\text{ave\_eduy})$, $\ln(\text{finance\_asset})$, and $\ln(\text{nonhousing\_debts})$, respectively. The final regression model in logarithm is defined as follows:

$$LN(\text{techeff}) = \beta_1 \times landin + \beta_2 \times landout + \beta_3 \times \text{int\_inf} + \sum \delta_i \times X_i + cid_j + \varepsilon \quad (3)$$

Where: $X = (\text{gender}, \ln(\text{eduy}), \text{health}, \ln(\text{ave\_eduy}), \text{malep}, \ln(\text{finance\_asset}), \ln(\text{nonhousing\_debts}))$

Like the primary regression, the logarithm regression is presented below, where controlled variables are added to the regression gradually. The regression manifests that leasing land from others and internet dependence remain significant in terms of the effect on the percentage change of technical efficiency.

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Table 7: Primary regression in logarithm terms.

	(7)	(8)	(9)
	LN(techeff)	LN(techeff)	LN(techeff)
landin	13.299***	13.154***	12.526***
	(3.88)	(3.82)	(3.93)
landout	-4.256	-4.841	-4.806
	(4.49)	(4.44)	(4.56)
int_inf	2.579***	2.446***	2.411**
	(0.90)	(0.93)	(0.96)
gender		2.840	2.311
		(2.80)	(3.04)
ln(eduy)		2.134	1.446
		(1.57)	(2.07)
health			1.341
			(2.85)
ln(ave_eduy)			0.105
			(2.76)
malep			5.286
			(7.39)
ln(finance_asset)			0.727**
			(0.35)
ln(nonhousing_debts)			0.533*
			(0.32)
_cons	-55331259.186***	-55331263.677***	-55331273.555***
	(22.31)	(21.83)	(23.31)
R^2	0.179	0.187	0.192
adj. R^2	0.046	0.054	0.055
F	1.350	1.401	1.406
N	3573	3491	3424

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Then, the group regression is also rewritten under logarithm terms. According to the new regression, leasing land from others only positively impacts technical efficiency significantly only in the independent internet group. In conclusion, it is manifested that all results derived from primary regression and group regression remain solid under the logarithm setting.

6 Conclusion

This essay focuses on the relationship between land transfer, internet information, and the technical efficiency of agricultural production. Using household-level data from the CFPS database, technical efficiency is predicted with the SFA method. Then primary regression, group regression, regression with interaction terms, and regression under logarithm terms are done respectively to test the 3 hypotheses put forward in the theoretical analysis part.

All 3 hypotheses are proven correct throughout the essay. For the first two hypotheses, leasing land from others and internet dependence significantly affect technical efficiency. For the third hypothesis, the effect of leasing land from others only remains significant when the internet independence group.

The last hypothesis can be explained by the fact that internet information is a powerful way for households to acquire agricultural-related skills, including improving irrigating systems and adopting new farm managing methods. Also, a higher internet information exposure may lead households to find high-quality seeds online, search for cooperation opportunities with nearby villages, and so on. These effects brought by internet information may be a good substitution for the effect of leasing land from others, which implies advantages including scaled farming and better agricultural resources allocation.

This essay sheds light on how land transfer and internet dependence improve agriculture's technical efficiency from the perspective of a single household that relies mainly on agriculture for a living. For those families who do not have enough budget to rent extra land but are willing to make better use of their existing resources, it is manifested that acquiring more information online to search for advanced skills, ideas, and other opportunities is a wise idea.

Due to limitations in the dataset, there are still some possible directions that can be carried on revising by future researchers. First, there might be a better indicator for internet information dependence. The variable used in this essay is a subjective rating for the importance of acquiring information online rated by the house owner, which implies a possible reverse causality. The lagged term of technical efficiency may impact the rating for internet importance. The reverse causality can be ruled out by either finding an objective variable on internet dependence or using panel data with a lagged term as an independent variable in the regression.

References

[1] *Huang, Wang & Chen. (2014). The effects of non-farm employment, land transfer, and land fragmentation on the technical efficiency of rice farmers. China Rural Economy (11),4-16.*

[2] *Cai, Zhu, Liu & Yi. (2018). The effect of land transfer on the technical efficiency of farm households. Resources Science (04), 707-718.*

[3] *Shi, Zhan & Zhu. (2020). Land transfer, factor allocation, and agricultural production efficiency improvement. China Land Science (03),49-57.*

[4] *Deininger, K., Jin, S., & Nagarajan, H. K. (2008). Efficiency and equity impacts of rural land rental restrictions: Evidence from India. European Economic Review, 52(5), 892-918.*

[5] *Jin, S., & Jayne, T. S. (2013). Land rental markets in Kenya: implications for efficiency, equity, household income, and poverty. Land Economics, 89(2), 246-271.*

[6] *Jin & Klaus Deininger. (2004). The development of rural land rental markets in China and their implications for land use equity and efficiency. China Economic Quarterly (03),1003-1028.*

[7] *Chen, Shi & Gu. (2014). Is Farmers' Land Transfer Efficient? -- A case study of Shanxi. China Rural Economy (07),61-71+96.*

[8] *Li, Gu & Shi. (2015). A study on the distortion of agricultural land allocation and transfer efficiency - empirical evidence based on a sample of Zhejiang from 1995-2007. Economic Science (03),42-54.*

[9] *Zheng, Zhou & He. (2014). Telecommunications infrastructure and economic growth in China. Economic Research Journal (05), 77-90.*

[10] *Barnabas Kiiza & Glenn Pederson. (2012).ICT-based market information and adoption of agricultural seed technologies: Insights from Uganda. Telecommunications Policy, 36(4), 253-259.*

[11] *Sylvester Ochieng Ogutu, Julius Juma Okello & David Jakinda Otieno. (2014). Impact of Information and Communication Technology-Based Market Information Services on Smallholder Farm Input Use and Productivity: The Case of Kenya. World Development, 64, 311-321.*

[12] *Yin, Jiang & Li. (2010).The growth effect of the agricultural information services on agricultural TFP. (eds.)Proceedings of International Conference on Engineering and Business Management （EBM2010)(5060-5064).Scientific Research Publishing, USA*

[13] *Yu & Zhu. (2011). Measurement of the level of agricultural informatization and its relationship with total factor productivity in agriculture. Journal of Shandong Agricultural University (Social Science Edition) (03), 31-36.*

[14] *Han & Zhang. (2015). Analysis of the threshold effect of agricultural informatization on total factor productivity growth in agriculture. China Rural Economy (08),11-21.*

DOI: 10.54254/2754-1169/4/2022984

[15] *Zhu, Bai, Peng & Zhu. (2019). Has information technology improved agricultural productivity?. China Rural Economy (04),22-40.*
[16] *Li & Yi. (2017). Analysis of the impact of rural labor migration on total factor productivity in agriculture in China. Journal of Agrotechnical Economics (09),4-13.*
[17] *Liu, Xin & Lu. (2021). Does Internet agricultural information access promote farmers' land transfer. Journal of Agrotechnical Economics (02), 100-111.*
[18] *Jenny C. Aker & Christopher Ksoll. (2016). Can mobile phones improve agricultural outcomes? Evidence from a randomized experiment in Niger. Food Policy, 60, 44-51.*
[19] *Nakasone, E., Torero, M., & Minten, B. The Power of Information: The ICT Revolution in Agricultural Development "Power of Information".*
[20] *Adegbola, P., & Gardebroek, C. (2007). The effect of information sources on technology adoption and modification decisions. Agricultural Economics, 37(1), 55-65.*
[21] *Catherine Larochelle, Jeffrey Alwang, Elli Travis, Victor Hugo Barrera & Juan Manuel Dominguez Andrade (2019) Did You Really Get the Message? Using Text Reminders to Stimulate Adoption of Agricultural Technologies, The Journal of Development Studies, 55:4, 548-564.*
[22] *Qian & Hong. (2016). Non-farm employment, land transfer and agricultural production efficiency change - An empirical analysis based on CFPS. China Rural Economy (12), 2-16.*
[23] *Mao & Xu. (2015). Agricultural land system, land management rights transfer, and farmers' income growth]. Management World (05), 63-74+88.*
[24] *Yang & Li. (2015). A study on farming land transfer and farming land utilization efficiency from the perspective of household division of labor--a sample of farming households in the farming area of Gan-Fu plain. China Land Science (09),50-57.*
[25] *Huang, Wang & Chen. (2014). The effects of non-farm employment, land transfer, and land fragmentation on the technical efficiency of rice farmers. China Rural Economy (11),4-16.*
[26] *Shi, Zhan & Zhu. (2020). Land transfer, factor allocation, and agricultural production efficiency improvement. China Land Science (03), 49-57.*