# Land Reallocation and Its Impacts on Technical Efficiency --Evidence from China's Agricultural Production

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**Abstract:**

China's economic reforms make the farmers face the risk of land reallocation and adjustment, raising the questions about the impact of land reallocation on farm productivity and efficiency. Deep understanding what determines land reallocation, whether and to what extent farm productivity and efficiency are affected by the frequency of land reallocation could help policy makers introduce better targeted rural development policies. The aim of this study is first to explore the determinants of land reallocation, and then analyze how land reallocation influences productivity and efficiency in agricultural production. This study is based on panel data set over 1995-2002 from rural households in Hubei and Yunnan provinces.

Our results indicate that the likelihood of land reallocation is influenced by the opportunity of off-farm employment and the geographic characteristics and location of the village. The development of land rental market is substitute of land reallocation in optimizing the allocation of land resource.

Average technical efficiency was found to be 72%. Farms with high variability in farm revenue were found to be more technically efficient than farms with low revenue variability. The predicted probability of land reallocation was statistically significant among factors affecting farm productivity and efficiency. In other words, we do find the systematic difference in farm productivity and technical efficiency between farmers have been reallocated land or not during the period of land tenure.

**Key words:** Land reallocation, Technical efficiency, Rural China

**JEL classification:** Q12, Q15

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## 1. Introduction

The agricultural reform in the transition economies, such as in China, Vietnam, the former Soviet Union, and Eastern Europe have been witnessed as a process of the change of land institutions. That the political pressure on the land reform differs across the countries and fluctuated over time within the countries, induced to the diversity and dimensions of land institution. The success of Chinese agricultural production has been acknowledged to a series of radical land reform (Fan, 1991; Lin, 1992; Huang and Rozelle, 1995). The core of the reforms is the coexistence of land ownership remained at the village level and the land use right vested in the households. These, on the one hand, motivate the incentive of farmers to invest in the land; on the other hand the rural households still face the potential risk of land allocation, reallocation and adjustment interpreted by the local officials, typical at the village levels.

The land tenure was initially 15 years and has been extended to another 30 years after the expiration of land contract between farmers and local government1. The form of the land tenure is that farmland was allocated equally based on the household size, household labor supply or both. However, change in households' demographics or labor composition happened given the birth and death rates, aging, marriage and family separation, etc. Furthermore, cultivated land per capita has declined due to population growth, urbanization and industrialization over time in China that were already characterized as relatively limited in terms of their land resources. The decline in arable area was exacerbated by a series of land degradation processes. Thus, frequent land reallocation is increasing common in some villages under the pressure of the request of rural households or because local authorities actively take advantage of its rights over land allocation, even though in other village, the land own rights on each plot are formally solidified.

The issues related to land reallocation have aroused special attentions by the economists and policy makers. Some of the existing literature focused on land reallocation policies, associated with land tenure system, and its effects these policies have on land security (Liu, 1998; Brandt et al., 2002; Tan et al., 2006). Liu et al. (1998) use village-level data to analyze the frequency of land reallocation and its

[1] The starting point of the initial land tenure differs significantly across province and even the counties in the same province due to the different process of introducing the Household Responsibility System (HRS).

differences across villages. Brandt et al. (2002) concluded that land tenure security is influenced by the land reallocation through the magnitude and the frequency. Tan et al., (2006) use land reallocation as one sub-group of independent variables to find the determinants of land fragmentation.

Others tend to better understand what determinates land reallocation and to what extent land reallocation occurred, although it is well observed that land has been reallocated or adjusted during the legal contract period of 15 and even later 30 years. Kung (2000) believe that the incidence of land reallocation has been significantly influenced by the demographic change and availability of land, as well as the opportunities of off-farm employment and the development of local rental markets in villages. This conclusion has been mirrored by the finding of Yao (2000), which provided substantial evidences that the interaction of land reallocation in magnitude and frequency with income level and the endowment of local land resources, even though its effect is empirically implicit. Brandt et al. (2002) concluded that the scope and duration dependence of land reallocation is sensitive to the availability of off-farm employment, and thus permit an efficient allocation of land resources across households given the differential capability of participating in job market.

Others also were willing to explore the impacts of the land reallocation on investment and other factor markets like land rental market. Li et al. (1998) and Jacoby et al. (2002) concluded that land insecurity arisen from the frequency of land reallocation dampened the farmers' investment incentive in land, especially the use of organic fertilizer to improve the soil fertility. Kung (2002) concluded that land reallocation is complementary of land rental market to optimize the land resources, which identify a positive relationship between the size of reallocated land and the demand of land rented.

The goals of transition in agriculture emphasize improvement of productivity and efficiency. The frequency and scope of land reallocation also affects how the land is used. In this sense, land reallocation is linked to productivity and efficiency in several dimensions. Frequent land reallocation and adjustment dampen the incentive of households' investment on land and efficiently organizing the farm structure in a long-run term. Contrarily, land reallocation and adjustment, which is a common means of shifting land between households even in most cases is not voluntary at household level, is a potential instrument to achieve an efficient allocation of land resources. However, few studies have provided an empirical analysis of the impacts of land reallocation on the efficiency and output of their agricultural production in China.

To fill the gap in the literature, the overall goal of this paper is to contribute to the ongoing assessment of land reallocation, with special attentions to its effects on the efficiency and output of agricultural production across the provinces with the obvious different resource endowment and the level of technology. Specifically, based on a panel data of household and village survey conducted in two provinces by Ministry of Agriculture over 1995-2002, we first will statistically describe whether and to what extent land reallocation occur in rural China. Second, we use probit model to identify some of the main determinants of the land reallocation in rural China. Finally, we will examine how the probability of land reallocation influences technical efficiency and productivity at the farm level.

To meet the objectives, the rest of the paper will be organized as follows. In section two, we present the theoretical framework and econometric model. The next section presents the dataset and describes the incidence of land reallocation at the village level. The following section presents the empirical results. The final section concludes.

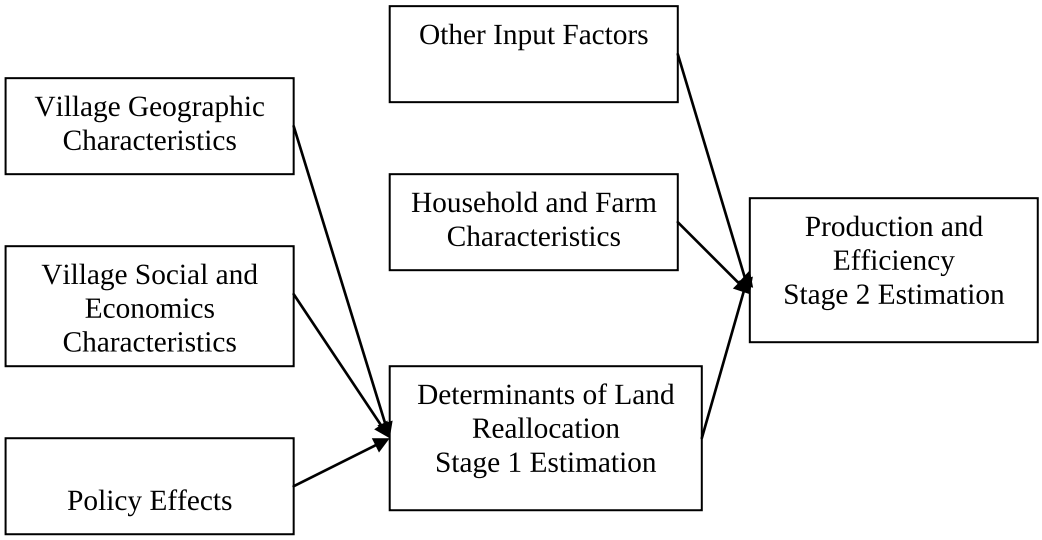
## 2. Theoretical model and econometric estimations

### 2.1 Theoretical model

The existing literatures concerning the determinants of land reallocation, show that the incidence of land reallocation is affected by the location of the village, which influence the process of the urbanlization and industrialization of the village, and the geographic features. The frequency and scope of land reallocation is also affected by the village demographic change, and the differential access to off-farm and self-employment opportunities, the change of land endowment at village like land per capital, the functioning of land rental market and agricultural and special tax targeted to each plot of land (Yao, 2000; Tan et al., 2006). Thus, in the empirical work, we assume that the geographic, social and economics characteristics of the villages will determine the incidence of land reallocation.

There are bulk of studies which evaluate productivity and technical efficiency of Chinese agricultural production (Lin, 1992; Huang and Rozelle, 1995; Bruemmer et al., 2006). To our best acknowledge, few of them has empirically assess the influence of land reallocation on the productivity and technical efficiency in China or even other transition countries. In our study, we will use the tradition physical inputs including cultivated land, labor, capital and expense on intermediate inputs including fertilizer, seed etc. As described in Figure 1, the determinants of technical efficiency is estimated simultaneously with the production function, while factors expected to shift the technical efficiency include a predicted probability of the incidence of land reallocation faced by rural households in village attained from stage 1 model, associated with other control variables on the characteristics of households and farm structure.

**Figure 1 Assumed relationship of households, farm and village characteristics on land reallocation, production and technical efficiency.**




To do so, this model allows the incidence of land reallocation make the influence on output but not vice verse (Wang and Schmidt, 2002). In most Chinese villages, the frequency and magnitude of land reallocations are determined at the village level. During this process households are not usually compensated for any investments they have made in the fields that are transferred away from them. So if the frequent reallocation of land is detrimental to output by dampening the incentive of farmers in production, then future reforms should be oriented to guarantee the land security. On the other hand, land reallocation is exogenous to the households' decision but is likely to influence the labor allocation of household between on- and off-farm employments. If the land in the village is reallocated frequently, the farmers may lessen the involvement into production by reducing the working hours on farm, which drive an increase in efficiency. Thus, the direction and magnitude of land reallocation on production and efficiency are worthy of empirical analysis.

## 2.2 Econometric model

According to the conceptual framework listed in Figure 1, we apply the following two-stage model to analyze land reallocation decision and its impacts on farm production in rural China.

**Stage 1: Random-effects probit model**

$$Y_{it}^{p} = \alpha X_{it}^{p} + c_i + \varepsilon_{it}$$

$$\varepsilon_{it} \sim \mathrm{N}(0, \sigma_{\varepsilon}) \qquad c_i \sim \mathrm{N}(0, \sigma_c) \tag{1}$$

$$I_{it} = \begin{cases} 1, & Y_{it}^{p} > 0 \\ 0, & Y_{it}^{p} \leq 0 \end{cases} \tag{2}$$

$$P_{it} = \Pr(I_{it} = 1 \mid X_{it}^{p}, c_i) = \Pr(\frac{\varepsilon_{it}}{\sigma_{\varepsilon}} > \frac{-\alpha X_{it}^{p} - c_i}{\sigma_{\varepsilon}}) = \Phi(-(\alpha X_{it}^{p} + c_i)/\sigma_{\varepsilon}) \tag{3}$$

Here $Y_{it}^{p}$ is a latent or unobserved variable that is related to the observed independent variables by the structural equation (1). $X_{it}^{p}$ is a vector of variables which constitute village geographic, social and economic development characteristics, and relevant state policy; $\alpha$ is the associated vector of parameters to be estimated. $c_i \sim \mathrm{N}(0, \sigma_c)$ represents the unobserved village effects, and $\varepsilon_{it} \sim \mathrm{N}(0, \sigma_{\varepsilon})$ is the random error term. $I_{it}$ indicates the occurrence or not of land reallocation for farm i in year t; cases with positive values of $Y_{it}^{p}$ are observed as $I_{it}$ = 1, whereas cases with negative or zero values of $Y_{it}^{p}$ are observed as $I_{it}$ = 0. As shown in Heckman (1981), the parameters of this model are easily estimated by noting that the distribution of $Y_{it}^{p}$ conditional on $c_i$ are independent normal. Hence the probability of land reallocation in equation (3) could be attained through appropriate likelihood function.

**Stage 2: Normal-halfnormal Stochastic Frontier Production**

$$Y_{it} = f(X_{it}, S_{it}; \beta) + \theta P_{it}^{*} + v_{it} - u_{it} \tag{4}$$

$$u_{it} \sim N^{+}(0,\sigma_{u_{it}}) = N^{+}(0,\sigma_u e^{\rho z_{it}}) \tag{5}$$

Where $Y_{it}$ = planting[2] output for farm i in year t; $f(X_{it}, S_{it}; \beta)$ is a suitable production function form, here a translog specification in our model. $X_{it}$ is the vector of inputs, $S_{it}$ is a vector of control variables (farm characteristics affecting production) and $\beta$ is the associated vector of technology parameters and parameters associated with the control variables to be estimated. $P_{it}^{*}$ is the probability of land reallocation and $\theta$ is the associated parameter to be estimated. $v_{it}$ is a random error term assumed to be i.i.d. $N(0,\sigma_v)$; the error terms $u_{it}$ are non-negative random variables that account for technical inefficiency in production, which follow half-normal distribution with mean zero and variance $\sigma_{u_{it}}^2$. Here we allow the systematic error term $u_{it}$ to be heteroscedastic by modeling a multiplicative relationship between the variables responsible for heteroscedasticity and the distribution parameter $\sigma_u$ of the systematic error term, which is shown in equation (5). $z_{it}$ is a vector of exogenous variables used to explain variation in technical inefficiency, including the predicted probability of land reallocation we have obtained in stage 1 model.

## 3. The frequency of land reallocation and Data description

The database used in this study is drawn from fixed-point survey data series across Hubei and Yunnan provinces in China, conducted annually by rural survey teams. The two provinces covered were chosen to reflect the diversity of China's agricultural production. In our analysis, we identify the behavior of land reallocation by means of comparing the difference of arable land within the year as well as the changes in number of plots with different size, taking into account the incidence of land rental activity or not[3]. Our data indicated almost all of the sampled villages conducted the land reallocation or adjustment more than once over 1995-2002.

[2] Planting output includes (1) cropping: grain crops, cash crops and other crops; (2) fruits, silkworm cocoon and tea orchards.

[3] In the theoretical framework, we assume that the incidence of land reallocation make the influence on output but not vice verse; however, the land reallocation at the village level is weakly endogenous at the household level because rural households could affect land reallocation by lobbying village leaders; as a result households that benefit from the intensive use of land will lobby leaders for favorable reallocation or adjustment (Brandt et al., 2002).

Land reallocation depends on demographic change, land availability, income level, off-farm employment, quota on the land, and the functioning of land rental market (Kung, 2000; Yao, 2000). The $X_{it}^{p}$ variables in equation (1) consist of: geographic type of location of the village (plain, hilly and mountain area); dummy with value 1 if the village is located in a city suburb; birth rate of the village control for effects of demographic change; annual net income per capita; area of arable land per capita; share of people who migrated into the village within the year; share of households doing business outside of the village; share of arable land rented-in during the year is used as the proxy of land rental market in local village; agricultural and special taxes per arable land; Furthermore, one of important policy change on land was to extend the land tenure to 30 years after the first round expiration of land contract and the onwards land contract should not be changed even with the change of family structure. To capture the policy impact on land reallocation, we will include a dummy variable equalized to 1 from the start point of the second round of contract onwards and 0 otherwise[4].

For the stage 2 model, the production function is specified with four conventional input variables: labor, land, intermediate input and capital. Labor input is the total annual working days allocated to agricultural production. Total sown areas for grain crops, cash crops and other crops are used as a proxy for land use. Intermediate input sums up the purchase value of seeds, fertilizer, agricultural diesel oil, plastics and pesticides involved in agricultural production. Capital is the total original value of assets for production by year end, including draught animals, production tools, machinery and agricultural production buildings. All the value variables are normalized at 1995 constant prices.

Variables explaining the variation in technical inefficiency consist of: dummy with value 1 if any of the household members is a township or village cadre, otherwise 0; share of rural laborers with primary education, secondary education, high school education and above (share of illiteracy rural laborers as reference) to total rural laborers; share of rural laborers licensed with professional titles; share of plots

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[4] Accompanied by the implementation of HRS, land use right was granted to farmers initially for 15 years, and then extended to another 30 years in early 1990s. HRS completed for Hubei province in 1981, for Yunnan province in 1983 roughly. So the new land use right contract coming into effect for Hubei province since 1997, for Yunnan province since 1999 could be expected. Hence we introduce a dummy with value 1 for Hubei province since 1997 and for Yunnan province since 1999.

with size between 0.5-1 mu, 1-2 mu, 2-3 mu, 3-4 mu, 4-5 mu, and larger than 5 mu (share of plots with size smaller than 0.5 mu as reference); dummy with value 1 for Hubei province control of regional difference; predicted value of probability of land reallocation attained from stage 1 estimation.

In table 1 the descriptive statistics of the variables are listed for stage 1 and stage 2 model. For the estimation by maximum likelihood and easy explanation of coefficients, output and four inputs variables are divided by their respective sample means, time trend variable is scaled to have 0 mean.

**Table 1: Descriptive statistics (N = 9871)**

| **Variable** | **Symbol** | **Mean** | **Std. Dev.** |
|---|---|---|---|
| *Stage1 model* | | | |
| Land reallocation (Dummy variable, 1=yes, otherwise 0) | Rland | 0.19 | 0.39 |
| Hilly area (Dummy variable, 1=yes, otherwise 0) | Hill | 0.38 | 0.49 |
| Mountainous area (Dummy variable, 1=yes, otherwise 0) | Mountain | 0.40 | 0.49 |
| City suburb (Dummy variable, 1=yes, otherwise 0) | Suburb | 0.17 | 0.37 |
| Net income per capita (Yuan/person) | Nipc | 1540.32 | 921.55 |
| Birth rate (%) | Birth | 1.04 | 0.55 |
| Ratio of migration into village (%) | Migrate | 0.66 | 0.48 |
| Ratio of household doing business outside village (%) | Business | 0.05 | 0.06 |
| Arable land per capita (mu/person) | Landpc | 1.24 | 0.99 |
| Ratio of land rented in to total arable land (%) | Rentl | 0.02 | 0.03 |
| Agricultural and special taxes per arable land (Yuan/mu) | Tax | 0.43 | 0.55 |
| Dummy for policy (1 if year>=1998, otherwise 0) | Policy | 0.66 | 0.47 |
| | | | |
| *Stage 2 model* | | | |
| Planting output (Yuan) | Output | 3568.90 | 2480.26 |
| Labor (Day) | Labor | 296.92 | 161.76 |
| Land (Mu) | Land | 9.24 | 7.48 |
| Intermediate input (Yuan) | Inter | 611.86 | 617.55 |
| Capital (Yuan) | Capital | 2878.37 | 9337.59 |
| Hubei province ( Dummy variable, 1=yes, otherwise 0) | DHubei | 0.67 | 0.47 |
| Predicted probability of land reallocation [a] | PreRland | 0.17 | 0.12 |
| Share of plots with size between 0.5-1mu | Plot1 | 0.30 | 0.25 |
| Share of plots with size between 1-2 mu | Plot2 | 0.22 | 0.24 |
| Share of plots with size between 2-3 mu | Plot3 | 0.05 | 0.14 |
| Share of plots with size between 3-4 mu | Plot4 | 0.01 | 0.07 |
| Share of plots with size between 4-5 mu | Plot5 | 0.01 | 0.05 |
| Share of plots with size larger than 5 mu | Plot6 | 0.00 | 0.02 |
| Cadre household (Dummy variable, 1=yes, otherwise 0) | Cadre | 0.06 | 0.23 |
| Share of labor with primary schooling (%) | Element | 0.42 | 0.35 |
| Share of labor with Secondary schooling (%) | Second | 0.31 | 0.32 |
| Share of labor with high and above schooling (%) | High | 0.06 | 0.17 |
| Share of labor with skill training (%) | Skill | 0.03 | 0.11 |

[a] The predicted value of probability of land reallocation from stage 1 model is used as an explanatory variable for inefficiency in stage 2.

## 4. Empirical results

### 4.1 Random-effects probit model

To examine the determinants of land reallocation decision, we use a random-effects probit model similar to that developed by Butler and Moffitt (1982). Random effect probit model holds constant unobserved heterogeneity among individuals regardless of time dependence, but it also allows that values of all regression coefficients vary randomly over individuals as simple pooled probit model does. Table 2 presents estimated coefficients and marginal effects at the multivariate point of means. The negative sign of dy/dx indicates the negative effects of this variable on the probability of land reallocation, and hence benefits land security of farm households. In almost all respects, the multivariate regression model performs well. The majority of the coefficients of the basic variables in the model have the expected signs and statistically significant at the traditional accepted level.

Three geographic types are classified for villages in the sample: plain, hilly and mountain area. Compared with the implicit reference of plain area, hilly area is not significant while villages located in the mountainous reduce the probability of land reallocation by 16 percent. This could be explained that households in the mountainous area generally take advantage of its location to specialize in forestry or gardening, which are more likely to demand the provision of long-term land use right without adjustment. It has been proved that the demand for land in some regions is adversely correlated with the availability of off-farm employment and the increased rural income per capita, and thus land use right is secure (Brandt et al., 2002). Our results are consistent with this conclusion that the marginal effect of net income per capita on land reallocation is negligible and the sign of migrates out of village is negative. The impact of villages located in the suburb of a city on land reallocation is theoretically implicit. On one hand, land per capita is reducing in the process of industrialization if a village is located in the suburb of a city. As a result, the land reallocation occurs more frequently to ensure the equal allocation of land resource among households. On the other hand, in the suburb of a city, that households are more likely to access to off-farm job market with less transaction cost reduce household’s dependence on land as income source. Thus, the incidence of land reallocation should be reduced accordingly. The negative sign of the suburb on land reallocation imply that the impact of off-farm employment overweigh the influence of industrialization. The multivariate analyses also demonstrated that the importance of demographic change indicated by the birth rate in determining a land reallocation decision in a village. However, the increased migrates has the negative effect on land reallocation because land allocation in rural China is aligned with household registration system and it is hard for migrates to officially register in the village.

Given the more land endowment per capita, the village leaders are more likely to increase the frequency of land reallocation because they extract benefits through the control over the village land and periodic reallocation of land (Rozelle and Li, 1998). Our result demonstrated that the functioning land rental market is the substitute of land reallocation in optimizing the land resource among households, which contradicted to the results by Kung (2002). Our results imply that the land reallocation happen more frequent even though land tenure has been extended to 30 years. This could be explained that village leaders may seek to small adjustment rather than village-wide reallocation to accommodate the demographic change and the change of land resource in a village (Brandt et al., 2002)

**Table 2: Determinant of land reallocation behavior from random-effect Probit model**

| Variable | Coefficients | | Std. Err. | dy/dx |
|---|---|---|---|---|
| Hill | 0.03 | | 0.05 | 0.01 |
| Mountain | -0.80 | *** | 0.06 | -0.16 |
| Suburb | -0.37 | *** | 0.06 | -0.07 |
| Nipc | 0.00 | *** | 0.00 | 0.00 |
| Birth | 0.17 | *** | 0.04 | 0.04 |
| Migrate in | -0.18 | *** | 0.05 | -0.04 |
| Migrate out | -0.03 | * | 0.01 | -0.01 |
| Landpc | 0.10 | *** | 0.03 | 0.02 |
| Rentl | -0.04 | *** | 0.01 | -0.01 |
| Policy | 0.51 | *** | 0.04 | 0.10 |
| Log likelihood | -4208.71 | | | |

Note: Coefficients reported are odds ratio; Standard errors are in parentheses; ***, ** and * indicates significance at 1%, 5% and 10% level of confidence; The partial derivative is calculated by the means for continuous variable and captures the difference from 0 to 1 for dummy variables.

### 4.2 The SFA production function

The stochastic frontier production function is estimated in the stage 2 model. Several specified hypothesis have been test statistically. The hypothesis that a Cobb-Douglas frontier is an adequate representation of efficient production is rejected, as well as the one that farm households are fully technically efficient. Table 3 presents estimates of the parameters in the translog frontier production function.

In general, the estimation performed well. All first-order coefficients have the expected signs and can also be interpreted as the production elasticities, evaluated at the sample means. Over the studied period, a deceleration of technical regress in the two provinces could be observed, i.e. an increase of the agricultural production possibilities after 2002. The most important factors are labor, land and intermediate inputs. This structure of labor elasticities is consistent with the level of regional development of the two provinces. It can be expected that opportunity costs of labor are relatively low in these regions, which in turn implies, that farms allocate comparatively more labor to agricultural production than farms in relatively developed coastal regions. Our results indicate that land contributed to about 27 percent to agricultural production, and thus. The lowest production elasticity of capital is observed. However, contrary to labor this not an indicator that capital is abundant but scarce. Since an elasticity is the ratio of marginal and average product, a small elasticity can also be attributed to a high average factor productivity. This will be the case, when the factor is scarce like capital in Chinese agriculture. In addition, the sum of the input elasticities provides information about scale economies and is roughly 0.88, indicating that the technology exhibits moderately decreasing returns to scale at the sample mean. This imply that the potential driving of productivity could be achieved through the improved scale efficiency, like land consolidation of the small farm size.

**Table 3: Estimates of the parameters in the translog production function**

| Variable | Coef. | | Std. Err. |
|---|---|---|---|
| *Frontier function* | | | |
| t (time trend index) | -0.06 | *** | 0.00 |
| a (log of labor) | 0.23 | *** | 0.01 |
| l (log of land) | 0.27 | *** | 0.01 |
| i (log of intermediate input) | 0.36 | *** | 0.01 |
| k (log of capital) | 0.02 | *** | 0.01 |
| t*t | 0.02 | *** | 0.00 |
| a*a | 0.00 | | 0.02 |
| l*l | -0.07 | *** | 0.02 |
| i*i | 0.05 | *** | 0.01 |
| k*k | 0.01 | ** | 0.00 |
| t*a | 0.02 | *** | 0.00 |
| t*l | -0.02 | *** | 0.00 |
| t*i | 0.01 | ** | 0.00 |
| t*k | 0.00 | | 0.00 |
| a*l | 0.03 | | 0.02 |
| a*i | -0.03 | * | 0.01 |

| | | | |
|---|---|---|---|
| a*k | 0.03 | *** | 0.01 |
| l*i | 0.03 | ** | 0.01 |
| l*k | 0.00 | | 0.01 |
| i*k | -0.02 | *** | 0.01 |
| PreRland | 0.84 | *** | 0.06 |
| DHubei | -0.04 | * | 0.01 |
| intercept | 0.18 | *** | 0.02 |
| *Inefficiency model* | | | |
| PreRland | 1.13 | *** | 0.31 |
| Plot1 | 0.41 | *** | 0.09 |
| Plot2 | 0.28 | ** | 0.09 |
| Plot3 | -0.25 | | 0.17 |
| Plot4 | -0.92 | ** | 0.35 |
| Plot5 | -1.28 | * | 0.61 |
| Plot6 | -3.71 | * | 1.76 |
| Cadre | -0.21 | * | 0.10 |
| Element | -0.41 | *** | 0.08 |
| Second | -0.51 | *** | 0.09 |
| High | -0.88 | *** | 0.15 |
| Skill | 0.72 | *** | 0.17 |
| DHubei | -0.54 | *** | 0.07 |
| intercept | -1.18 | *** | 0.09 |
| *Variance parameter* | | | |
| sigma_v | 0.30 | *** | 0.01 |
| Log likelihood | -5058.12 | | |

Note: Standard errors are in parentheses; ***, ** and * indicates significance at 1%, 5% and 10% level of confidence.

### 4.3 Technical efficiency

After the estimation of stochastic frontier production function, we calculate technical efficiency for each farm household the whole observation period. Here in Table 4 is the level of technical efficiency for Hubei province, Yunnan province and as a whole from 1995 to 2002, which is also plotted in Figure 2.

The average technical efficiency is 0.740 for Hubei province, 0.680 for Yunnan province, and thus 0.720 for the whole sample over the observed period. The average technical efficiency of farm households of Hubei province keeps a relatively consistent level around 0.74, except two obvious drops in 1996 and 1999. The farm households in Yunnan province are technically less efficient than those in Hubei province for all the observed years from our estimate results. On the contrary to Hubei province, the level of technical efficiency for Yunnan province fluctuates strongly the whole sample period, from 0.625 (the lowest) in 1995 to 0.746 (the highest) in 1998. Longitudinally, the average level of technical efficiency for Yunnan province presents an increasing trend and nearly approaches the level of Hubei province in 1998. As a result, the efficiency gap between these two provinces has diminished over time.

In the lower part of Table 3 we present the determinants for the variation of farm households' inefficiency. The parameters indicate the direction of the effects these variables have upon inefficiency level, where a negative parameter estimate means a positive effect of that variable on efficiency.

The parameter of predicted probability of land reallocation is positive, which indicates that frequent reallocation of farm land will reduce technical efficiency level of production. The result corroborates our judgment that frequent reallocation of land is detrimental to production by dampening the incentive of rural households.

Here we introduce 6 variables of share of plots with different size (see Table 3), using share of plots with size smaller than 0.5 mu as reference to capture the effects of land fragmentation on efficiency. Even though plot1 and plot2 have positive coefficients, the variable group presents information that the larger the plot size, the more efficient the production. The implication is that land fragmentation could be hindrance to the improvement of technical efficiency.

A dummy variable whether any of the household members is a township or village cadre is used here as a proxy for management capability of farm households. And the negative value indicates a consistent estimate of its effect.

Share of rural laborers with primary education, secondary education, high school education and above (share of illiteracy rural laborers as reference) all have negative signs. In addition, the higher the education level, the more effects it has on the improvement of efficiency scores.

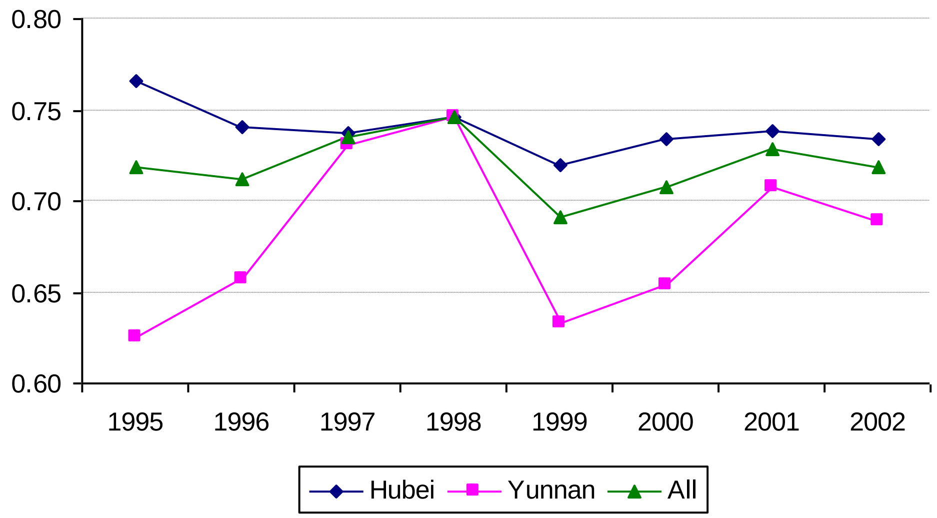
The coefficient of Share of labor with skill training is positive, which could be explained as the skill training increases the probability of finding job in urban area, hence a disincentive of effort to conduct agricultural production.

Not surprising, the negative sign of coefficient of dummy for Hubei province is conformed to the discussion above about average level of efficiency, farm households in Hubei province are more efficient than those in Yunnan province, which implicate there are still space for farmers of Yunnan province to improve their technical efficiency.

**Table 4: Level of technical efficiency over the observation period**

| | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | Average |
|---|---|---|---|---|---|---|---|---|---|
| Hubei | 0.766 | 0.741 | 0.738 | 0.747 | 0.720 | 0.734 | 0.739 | 0.734 | 0.740 |
| Yunnan | 0.625 | 0.657 | 0.730 | 0.746 | 0.633 | 0.653 | 0.708 | 0.689 | 0.680 |
| All | 0.719 | 0.712 | 0.735 | 0.746 | 0.692 | 0.708 | 0.729 | 0.719 | 0.720 |

**Figure2: Level of technical efficiency over 1995-2002**




## 5. Conclusion

China's economic reforms make the farmers face the risk of land reallocation and adjustment, raising the questions about the impact of land reallocation on farm productivity and efficiency. Deep understanding what determines land reallocation, whether and to what extent farm productivity and efficiency are affected by the frequency of land reallocation could help policy makers introduce better targeted rural development policies. The aim of this study is first to explore the determinants of land reallocation, and then analyze how land reallocation influences productivity and efficiency in agricultural production. This study is based on panel data set over 1995-2002 from rural households in Hubei and Yunnan provinces.

Our results indicate that the likelihood of land reallocation is influenced by the opportunity of off-farm employment and the geographic characteristics and location of the village. The development of land rental market is the substitute of land reallocation in optimizing the allocation of land resource.

Average technical efficiency was found to be 72%. Farms with high variability in farm revenue were found to be more technically efficient than farms with low revenue variability. The predicted probability of land reallocation was statistically significant among factors affecting farm productivity and efficiency. In other words, we do find the systematic difference in farm productivity and technical efficiency between farmers have been reallocated land or not during the period of land tenure.

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