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Economic Efficiency and Land Rights
--A Stochastic Frontier Analysis of Agricultural Production in China

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Introduction

The rural reform started in the late 1970s improved farmers' incentives and had great impacts on China's agricultural production and productivity growth. Interested in China's dramatic agricultural development since the reform, numerous authors have made efforts to explain changes in productivity and explore the growth sources behind it, including Lin (1992), Fan (1997, 1999), Lambert and Parker (1998), Brümmer et al. (2006), Zhang and Brümmer (2007) and so on. These studies convey some core messages: While productivity improvement and technological progress have been spectacular over the last two decades, the performance in terms of efficiency change is not so inspiring.

The negligible changes in allocative efficiency during the whole observation period might be caused by frequent adjustments of the market conditions, and missing land transfer rights. These unstable and uncertain conditions lead to increasing adjustment costs which in turn might hinder farmers to discover economically efficient production plans (Brümmer et al., 2006). There are also consensuses that technical efficiency has improved greatly over the whole period of the 80s due to a series of institutional arrangements, especially the implementation of household responsibility system (HRS). Entering the 1990s, the situation of technical efficiency has deteriorated gradually and the reasons behind it may be more involved. Compared with the former period of the reform, there seems to be lack of greater institutional incentives to arouse farmers' enthusiasm for agricultural production, for instance the remaining ambiguity over land tenure and related rights.

Land rights and economic efficiency

As an institutional arrangement, land tenure and related property rights will naturally be connected with the efficiency of agricultural production, through the introduction of the concept of institutional efficiency. For transition economies, we adopt Leibenstein's theory of X-efficiency as our theoretical foundation to explain the existing efficiency gap between perfectly competitive market and real market. Together with the addition of institutional efficiency, the traditional Farrell's measures of economic efficiency can be applied to estimate efficiency score and its components. The theoretical framework of the study is illustrated in Figure 1.

For the case of China's agricultural production, as already discussed in the introduction session, the remaining ambiguity over land tenure rights seem to show a robust explanation power for the source of unexpected efficiency performance. Considering the currently hot dispute about institutional reform related to land issues in China, the question whether it is the suitable choice and right timing for the creation of new institutions will also be an interesting topic to explore.

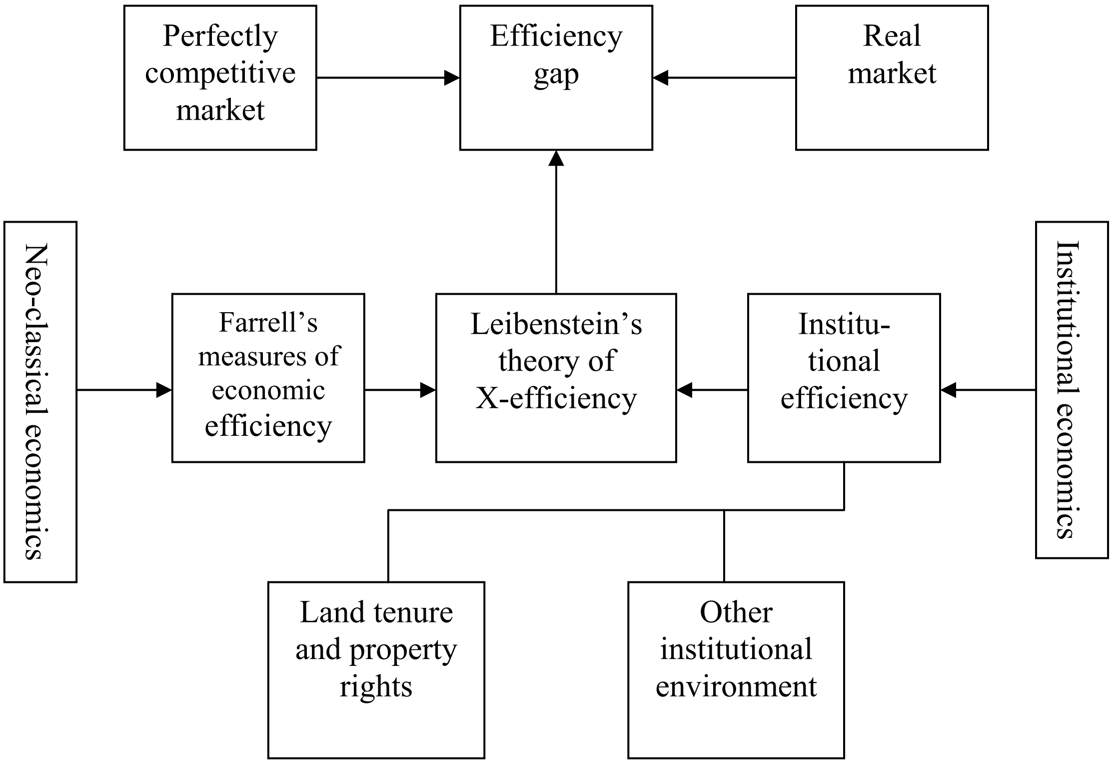

Figure 1: economic efficiency and land rights in transition economies

Source: own figure

The history of land issues in rural China

Land ownership was feudal in China before the 1949 Revolution, with only 10% of landlords controlling 70-80% of agricultural land. Since 1949, the government implemented large-scale land reform confiscating those landlords' land without compensation and redistributing to peasant farmers (Fan et al., 2002). Under the background of adoption of the heavy industry-oriented development strategy, where a large amount of grain and other agricultural products are demanded to support the urban industrialization, the government began to organize large collective production system since 1953. The land was collective owned and the production cooperative organization evolved to greater scale of People's Commune in the Great Leap Forward (1957-1960) period. But afterward the production was decentralized into smaller units of so called production teams due to the Great Famine (1959-1961) disaster. This collective-based system of agricultural production implicating collective ownership of land remained nearly 3 decades until 1979.

Due to the main problem of incentive structure of collectivization policy, the government started to address a series of reform in the late 1970s. The reforms dismantled the commune system, and implemented household responsibility system (HRS) attempting to introduce private property incentives while leaving formal ownership of the land in state hands or collectively owned. Land use rights and residual income rights were granted to individual farm households between 1979 and 1983 (see Brandt et al., 2002). According to Lin and Zhang (1998), the duration of the initial land allocation was 15 years and extended to another 30 years after existing contracts expired in 1993.

As the growth rate of grain output slowed down in late 1980s, there is a need to inspect the ongoing reform policy. Lin and Zhang (1998) point out that the current household responsibility system for land is actually a village-based communal land tenure system, and the individual farm households do not have the legal titles to land. They further argue that the restrictions on land markets, frequent land redistribution according to population changes and small scale landholdings rooted in this village-based land tenure system have become the major hindrance to the efficiency of resource allocation and the improvement of agricultural productivity.

The SFA distance functions

Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977) independently proposed the SFA models. A number of comprehensive reviews of literature on stochastic frontier estimation are available, including Førsund et al. (1980), Schmidt (1986), Bauer (1990), Greene (1993) and Murillo-Zamorano (2004). The basic idea is that, the production frontier has an error term with two components, one for random effects beyond the control of the producer (weather, etc.) and another for technical inefficiency, which is under the firm's control.

When multiple inputs are used to produce multiple outputs, Shephard's (1953, 1970) distance functions provide a functional characterization of the structure of production technology. Distance functions are particularly useful for analyzing agriculture in transition for the reasons of data availability and behavioral assumptions: output and input data are often more readily available and often of better quality, and agriculture in transition is neither competitive nor are all farm decision makers profit-maximisers. An output distance function takes an output-expanding approach to the measurement of the distance from a producer to the boundary of production possibilities. It gives the minimum amount by which an output vector can be deflated and still remain producible with a given input vector (Kumbhakar and Lovell, 2000, p30). Kumbhakar and Lovell (2000, p49) provides us a measurement of technical efficiency with $TE_O(x,y) = D_O(x,y)$. A stochastic distance function model is given as

$$1 = D_O(x_i, y_i; \beta) \bullet \exp\{u_i - v_i\} \tag{1}$$

Appelbaum (1979) and Berndt and Khaled (1979) generalized the application of the Box-Cox transformation function, which integrates a variety of functional forms and provides comparison by parametric tests. The generalized quadratic Box-Cox model, assuming input-biased technical change, can be written as

$$Y_{it}^{(\delta)} = \alpha_0 + \sum_{j=1}^{J} \alpha_j X_{jit}^{(\lambda)} + \frac{1}{2}\sum_{j=1}^{J}\sum_{k=1}^{J} \alpha_{jk} X_{jit}^{(\lambda)} X_{kit}^{(\lambda)} + \beta_1 t + \frac{1}{2}\beta_2 t^2 + \sum_{j=1}^{J} \gamma_j X_{jit}^{(\lambda)} t + \varepsilon_{it}$$

$$i = 1,2,\dots,N, \quad t = 1,2,\dots,T \tag{2}$$

where the variables $Y_{it}^{(\delta)}$ and $X_{it}^{(\lambda)}$ are the Box-Cox transformations of output and inputs, respectively, defined as (Box and Cox, 1964)

$$Y_{it}^{(\delta)} = \frac{Y_{it}^{2\delta} - 1}{2\delta} \quad \text{and} \quad X_{jit}^{(\lambda)} = \frac{X_{jit}^{\lambda} - 1}{\lambda} \tag{3}$$

where δ and λ are the transformation parameters to be estimated. Under appropriate parametric restrictions for the values of δ and λ, the generalized quadratic Box-Cox transformation yields the four locally flexible functional forms (i.e., translog, generalized Leotief, normalized quadratic, squared-root quadratic) as well as the non-homothetic CES and Cobb-Douglas specifications (Giannakas, Tran and Tzouvelekas, 2003).For multiple outputs case, applying linear homogeneity property of output distance functions, our specified SFA distance function can be written as

$$\tau^{-1} = (\alpha_0 + \sum_{p=1}^{P} \omega_p \frac{Y_{pit}^{(\delta)}}{\tau} + \sum_{j=1}^{J} \alpha_j X_{jit}^{(\lambda)} + \frac{1}{2} \sum_{p=1}^{P} \sum_{q=1}^{P} \omega_{pq} \frac{Y_{pit}^{(\delta)}}{\tau} \frac{Y_{qit}^{(\delta)}}{\tau}$$
$$+ \frac{1}{2} \sum_{j=1}^{J} \sum_{k=1}^{J} \alpha_{jk} X_{jit}^{(\lambda)} X_{kit}^{(\lambda)} + \sum_{p=1}^{P} \sum_{j=1}^{J} \varphi_{pj} \frac{Y_{pit}^{(\delta)}}{\tau} X_{jit}^{(\lambda)} + \beta_1 t + \frac{1}{2} \beta_2 t^2 \quad (4)$$
$$+ \sum_{p=1}^{P} \kappa_p \frac{Y_{pit}^{(\delta)}}{\tau} t + \sum_{j=1}^{J} \gamma_j X_{jit}^{(\lambda)} t) \bullet g(l, \theta) \bullet \exp\{u_{it} - v_{it}\}$$

where τ, the normalization variable, could be one of the outputs, or the Euclidean norm of the output vector; $Y_{\bullet it}^{(\delta)}$ (p, q = 1,…, P) are the Box-Cox transformation of multiple outputs; the other definitions are the same as in equation (2) and (3).

$g(l, \theta)$ measures the institutional effects of land tenure and related property rights. l is a vector of variables expected to explain the situation of land rights with respect to individual households. The proxies of l could be alternatives reflecting the extent of land tenure and the expanded tenure security, as the survey results of enormous heterogeneity at village level suggested by Brandt et al. (2002). Their work shows some farmers have more freedom to dispose farm land, which is closer to a private property regime. While in other villages, land use is strictly restrained.

The vits are random errors assumed to be i.i.d. N(0, σ_v^2), and independent of the uits. uits are non-negative random variables that account for technical inefficiency in production and satisfy the scaling property (see Wang and Schmidt, 2002), which means u equals a function of z times a one-sided error u* whose distribution does not depend on z. Here u* is assumed to be i.i.d. truncated (at zero from below) normal distribution and u is written as

$$u = h(z, \delta) u^* \quad (5)$$

where z is a vector of exogenous variables (firm characteristics) used to explain variation in technical efficiency. δ is a vector of unknown parameters to be estimated.

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