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EFFICIENCY OF WHEAT AND COTTON PRODUCING FARMS IN UZBEKISTAN: A STOCHASTIC FRONTIER APPROACH

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1 PROBLEM STATEMENT

In the recent decades agricultural production in Uzbekistan has been facing problems in relation to environment and agricultural management systems especially with regard to the efficiency and the productivity of agricultural enterprises. The sharp decrease of total factor productivity after independency in 1990 can be traced back to inefficiency and misallocation of resources (Djalalov, 2006, p.122). Although statistical data shows steadily increasing partial productivity of land and labor since 1996 land degradation, low level of mechanization, partial water scarcity and the use of low-productive labor appear to prove the opposite. An increase in agricultural production by increasing area is not possible since the irrigated area itself is decreasing and not able to keep up with population growth. Further irrigation expansion due to increasing budget constraints and marginal quality of new reclaimed areas for agricultural use has been exhausted (Lerman, 2008, p.483). Agriculture plays a very important role in the economy of Uzbekistan. Besides the fact majority of population lives in rural areas and roughly one forth of labor force is employed agriculture contributes 20% to the GDP of Uzbekistan (State Committee of the Republic of Uzbekistan on Statistics (2013).

The productivity of wheat and cotton producing farms can be raised either by adoption of improved production technologies or increasing technical efficiency or both. Due to non-availability of information on farm level efficiency in wheat and cotton production in Uzbekistan this study is designed to provide estimates of technical efficiency and its main determinants using data obtained from a significant sample of farms.

The costs of input resources such as land, labor and capital especially fuel and mechanization in the past years have significantly increased. High population growth and associated decrease of irrigated land per capita require policy makers to provide incentives for farms to obtain maximal output at the given input level (technical efficiency) and furthermore to use them in right proportion in order to produce at the lowest possible cost (allocative efficiency). In the light of the above it is also to be discussed whether “optimization” i.e. increasing of farm size per decree in 2008 were justified and reasonable (scale efficiency). Agricultural production can be increased by increasing above mentioned efficiencies which can be caused as result of economic, social and ecological factors.

The specific feature of the current study is to estimate impact of environmental factors such as water availability and provision, soil quality on technical efficiency level of farms.

2 RESEARCH QUESTIONS

The main question of the study is how efficient are wheat and cotton producing farms in Uzbekistan and what are the main sources of inefficiency?

Other specific questions of the study are:

How do ecological factors such water scarcity, soil salinity and other farm- specific, farm-size specific and region-specific factors affect farm efficiency?

What is the pattern of input use and production output for wheat and cotton producing farmers?

How is the production of state-ordered commodities organized?

3 METHODOLOGICAL APPROACH

Stochastic frontier approach bases on a non-deterministic frontier which imposes the assumption that any deviation from the frontier is the result of random error and error term representing technical efficiency (Aigner, Lovell and Schmidt, 1977; Meeusen and van den Broeck, 1977). If we formulate these in stochastic frontier function it can be written as:

$$Y_i = f(X_i, \beta) + \varepsilon_i$$

or

$$Y_i = f(X_i, \beta) + V_i - U_i$$

Where Y- observed output, i, β- vector of parameters, ε_i - error term for observation which consist of two parts in his turn: V_i - two sided symmetric, normally distributed random error representing usual statistical noise, identical independent and identically distributed; and U_i – one sided error term representing technical inefficiency.

In the current study we are interested in the stochastic frontier of input oriented production function. It is more of importance as the farmers in Uzbekistan are obliged to fulfill fixed state-order quotas for wheat and cotton. Concerning parametric form of production function Cobb-Douglas and Translog are mostly used and well known functions which can be applied within their abilities and limitations.

In order to separate technical efficiency of each decision making unit from composed error term assumption on the distribution of errors representing technical inefficiency should be made. There is a number of error distributions with respect to the one sided error (inefficiency): Half-normal, exponential and truncated distributions are considered as the most used ones in the literature. Jondrow et al. (1982) developed a method for decomposing the total error term for the half-normal case. The expected value of technical inefficiency u_i conditional on the composed error term ε_i is:

$$E(u_i|\varepsilon_i) = \frac{\sigma\lambda}{(1+\lambda^2)}\left[\frac{\varphi(\varepsilon_i \lambda / \sigma)}{\Phi(-\varepsilon_i \lambda / \sigma)} - \frac{\varepsilon_i \lambda}{\sigma}\right]$$

Where:

φ (.) – Density of the standard distribution Φ(.) – Cumulative density function

$\lambda = \sigma_u / \sigma_v$

$\sigma = (\sigma_u^2 + \sigma_v^2)^{1/2}$

The objective of conducting a stochastic frontier model is not only to determine technical efficiency scores, but also to investigate the key factors of efficiency differences. In singe stage inefficiency effects model proposed by Battese and Coelli (Battese, Coelli, 1995) inefficiency levels are defined to be exogenous factors' explicit functions. It uses also ML estimation and specified as:

$$\mu_i = \delta_0 + \delta_j Z_{ij}$$

μ_i – mean technical inefficiency

Z_{ij} – matrix of exogenous variable assumed to have influence the farmers decision δ_j – vector of parameters to estimate β and δ, together with the variance parameters:

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$

Maximum likelihood approach is based on the estimation of β and δ, together with the variance parameters $\sigma 2 = \sigma u2 + \sigma v2$ and $\gamma = \sigma u2 / (\sigma u2 + \sigma v2)$

The marginal effect of a Zij variable on the technical efficiency is calculated as follows (Olsen and Henningsen, 2011):

$$\frac{\partial TE}{\partial Z_{ij}} = (1-\gamma)\left(\frac{\phi\left(\frac{\mu_*}{\sigma_*}-\sigma_*\right)e^{-\mu_*+\frac{1}{2}\sigma_*^2}}{\sigma_*\phi\left(\frac{\mu_*}{\sigma_*}\right)} - \frac{\phi\left(\frac{\mu_*}{\sigma_*}-\sigma_*\right)e^{-\mu_*+\frac{1}{2}\sigma_*^2}}{(\sigma_*\phi\left(\frac{\mu_*}{\sigma_*}\right))^2}\right)\frac{\partial \mu}{\partial Z_{ij}}$$

4 EXPECTED RESULTS

Preliminary results show that factors experience of farmers, number of workers, car (dummy) positively affect on farm efficiency in cotton production. Age, education and manure seem to have negative effect on efficiency. The negative impact of education can be reasoned by the fact that the most of educated farmers in the surveyed area have another educational background than agricultural sciences.

In wheat production there are few studied factors that could explain the farm inefficiency. They are water scarcity and car (dummy). Matter-of-course water scarcity has negative effect of farm efficiency. Owning car by farmers positively influences farm efficiency.

There are many other factors such soil salinity; distance to the local market, to the field and to main water source, region, family structure – studying their impact currently is in progress. It is expected that generally, distances, soil salinity have negative impact on farm efficiency.

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