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Ekonometrične analize in matematično modeliranje

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PIG FARMS IN MACEDONIA: ASSESSMENT OF THE TECHNICAL EFFICIENCY

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ABSTRACT

The aim of this paper is to analyse the technical efficiency of pig production farms in the Republic of Macedonia. The Macedonian pig production sub-sector become increasingly inefficient during the period of economic transition; the country is net-importer of pig meat from countries that produce at lower production costs. Farmers are faced with the challenge to increase their efficiency of production thus to become more competitive; this is affected by the decisions made with regard to the quantities of utilised inputs and produced outputs. In this study technical efficiency is explained from output oriented perspective, assessing the possibility of farmers to increase the efficiency by producing maximum output quantities. The technical efficiency is estimated by employing the parametric Stochastic Frontier Analysis. An empirical analysis was carried out on the data collected by questionnaires in 2010. The results show altered technical efficiency levels in each decision making unit.

Key words: pig farms, technical efficiency, Stochastic Frontier Analysis

PRAŠIČEREJSKE KMETIJE V MAKEDONIJI: OCENA TEHNIČNE UČINKOVITOSTI

IZVLEČEK

Prispevek poredstavlja analizo tehnološke učinkovitosti prašičerejskih kmetij v republiki Makedoniji. Makedonski prašičerejski sektor je v času ekonomske tranzicije postal naraščajoče neučinkovit in država je neto uvoznik iz držav, kjer redijo z nižjimi proizvodnimi stroški. Kmetje se soočajo z izzivom, da morajo izboljšati učinkovitost svoje proizvodnje, da bi lahko postali bolj konkurenčni. Na dvig konkurenčnosti najbolj vplivata količina porabljenih inputov in obseg proizvodnje. V predstavljeni raziskavi predstavljamo tehnično učinkovitost z vidika outputov in sicer tako, da ocenjujemo možnosti za maksimiranje proizvedenih outputov. Tehnična učinkovitost je ocenjena z uporabo parametrične stohastične analize meja. Empirična analiza je bila izpeljana na podatkih pridobljenih v letu 2010 z anketnim vprašalnikom. Rezultati kažejo spreminjajoče ravni tehnične učinkovitosti v različnih odločevalskih enotah.

Ključne besede: prašičerejske kmetije, tehnična učinkovitost stohastična analiza meja

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1 Introduction

Suggesting for improvements in the decision making practices based on farm efficiency models is a common research practice (Bamiro, 2008; Larue, 2009; Latruffe, et al, 2010). Varieties of models are used to analyse different agricultural sub-sectors, with a purpose to influence on farmers decision making regarding applying certain quantities of different inputs and outputs. In the Republic of Macedonia this methodology is still rarely applied. In this respect, the aim of this paper is to analyse the technical efficiency of Macedonian pig production farms. The analysis estimates the efficiency of production and provides ground for explaining the differences that ultimately could contribute to supporting the farmers in making better decisions for increased efficiency. In this study, farmer's managerial activities are assumed to be key contributors for efficient production. Changes in farmer's behaviour lead the farms to reach the same technical efficiency as the "best" farmers by focusing on the type and quantity of inputs used in the production in respect to the maximum possible output quantities produced at the end of the production process.

The undergoing market globalization processes and the long period of economic transition had significant impact on the Macedonian agricultural sector, including pig production, which has an important role in the domestic economy. The pig production become inefficient and less competitive compared to foreign markets (Dimitrievski et al, 2010). The situation caused an increase of imports from more efficient countries that produce at lower production cost.

Nowadays, farmers are facing challenges to increase their efficiency of production and become more competitive both on domestic and foreign markets. However, they need to meet the new market requirements and regulations, but often found difficulties to adjust quickly to the rapid development of the global market. They lack information and knowledge about producing on the competitive markets (Manevska-Tasevska, 2013). According to MAFWE (2007), attending high production efficiency is a challenge; the current farm management practises are inefficient, followed by inadequate technology and high production costs which additionally increase product prices on the domestic market. In this sense, it is necessary to pay more attention on managerial capacity building and explore activities that influence efficient decision making with regard to the quantities of utilised inputs and produced outputs.

2 Method

Farmers can influence farm technical efficiency by rational use of inputs and producing the most economically beneficial outputs (Coelli et al, 2005; Farrell, 1957; Petrovska, 2013). Farmer's decision making can influence the efficiency in a short-term due to the frequent changes that are possible to appear on daily-base, in uncertain production field like the agriculture (Johansson and Ohlmer, 2007). The relationship between inputs and outputs, with the emphases on maximum possible output obtained by a certain level of inputs describes the production frontier function (Coelli et al, 2005). Farms that operate on the production frontier line face full technical efficiency and have efficiency score equal to 1. Efficiency scores range between 0 and 1, and all farms having efficiency score below 1 are less efficient;

additional increase of their technical efficiency requires changes in the production quantities and/or the inputs use.

The farm technical efficiency in this study is given through a two stage analysis. The first stage solves input and output optimisation problems (Coelli et al., 2005; Farrell, 1957), whereas, factors influencing the efficiency scores are observed in the second stage. In this paper the technical efficiency scores of pig farm production are obtained by using the parametric Stochastic Frontier approach (SF). The main characteristic of the parametric models and difference when compared to non-parametric models is the error term (Coelli 1996). SF approach has two error components: the first component includes statistical noise or random effects, while the second component represents the inefficiency. The involvement of random effects improves the specification of production function, while non-parametric models are criticised to assume all deviations from the frontier as inefficiency (Manevska-Tasevska, 2013). According to Coelli (1995) SF model is more suitable for measuring the efficiency in agricultural production, since there are many other factors that influence on the efficiency of such a risky production environment. The Stochastic Frontier analysis is performed by using the computer programme FRONTIER version 4.1 (Coelli, 1996). SF is employed to estimate a Cobb-Douglass production function explaining the maximum output possible by a given set of inputs (output-oriented efficiency). SF uses the following equation to estimate technical efficiency (Coelli, 1996):

$$Y_i = X_i\beta + (V_i - U_i) \quad (1)$$

In the equation (1) Y_i is the logarithm of the output of the i^{th} farms in the sample. Since the sampled data refers to only one year the time period component in this paper is assumed to be 1. X_i is the input variable, β is the marginal effect of the input that needs to be estimated, V_i represent the statistical noise and U_i is the technical inefficiency component.

Technical efficiency coefficients obtained in (1), are regressed with factors selected to explain sources of farm inefficiency. Simplified mathematical formulation for the regression analysis is given in (2) (Coelli et al, 2005; Coelli, 1996):

$$m_i = z_i * \delta \quad (2)$$

Here, z_i is the second stage variable that influences the technical efficiency of pig farm production m_i and δ is a parameter that explains the variable’s influence on efficiency and needs to be estimated.

3 Data and variables

The analysis is based on survey data, collected by face to face interviews with 21 farmers throughout the country. Due to the lack of data and poor record-keeping by farmers, data are collected only for the production activities in 2010. Most of the collected pig farms are located in the Eastern region, while only one farm is located in the Western region of the country. This reduction of farms in the Western region appears due to the environmental conditions and demographics.

3.1 Technical efficiency variables

Figure 1 depicts the concept of technical efficiency (TE) in respect to the production inputs and the output obtained as a final product. One output and two input variables are used in the econometric (parametric) SF model to analyse technical efficiency.

The output comprises of total number of piglets, pigs and sows produced in the analysed period. To aggregate in one output, each category of livestock is collected in total number produced during the analysed period and then converted to standard Livestock Units (LU) (EUROSTAT, 2011). Then all input variables are normalized per LU to avoid the farm size problem.

Two variables are selected to explain the input use on the farm: feed and other inputs. Feed is given separately since it represents the most important input in pig production taking up almost 50% of the total costs of production. The feed input is measured in total kilograms of feed spent per LU in the analysed period.

The other input variable represents aggregation of the remaining inputs used in the production, collected according to CLEMS approach: capital, labour, energy, materials and services (Coelli et al, 2005). Materials consist of vaccines, insemination doses, hygiene and disinfection products and fuel. Services provided for pig production consists of insemination activities, veterinary, accounting and other services. They are aggregated in one input measured in costs per LU.

Costs sometimes may results in failure to express technical efficiency and refer to allocative or economic efficiency (Thomas and Tauer, 1994). According to Farrell (1957) sometimes it is quite difficult to distinguish between allocative and technical efficiency. However, costs are more available for simplifying complex data and can make inputs to be more accessible for further analysis (Manevska-Tasevska, 2013).

3.2 Sources of inefficiency

Deviations in the input and the output oriented TE, are explained by environmental factors (birth, technology, distance and mortality) and managerial characteristics (formal and informal education, experience, marketing and bookkeeping). Factors influencing technical efficiency on the farms are graphically presented in Figure 2.

Birth of pigs and years of farmers' experience are given in digits. The distance to the closest market or big city is measured in kilometres. The mortality of piglets is measured in numbers of piglets died per annum per sow and then presented in three-grade scale: 1 for those farms that have more than 10 piglets died, 2 is for farms that have between 6 and 10 piglets died and 3 is for farms with less than 6 piglets died.

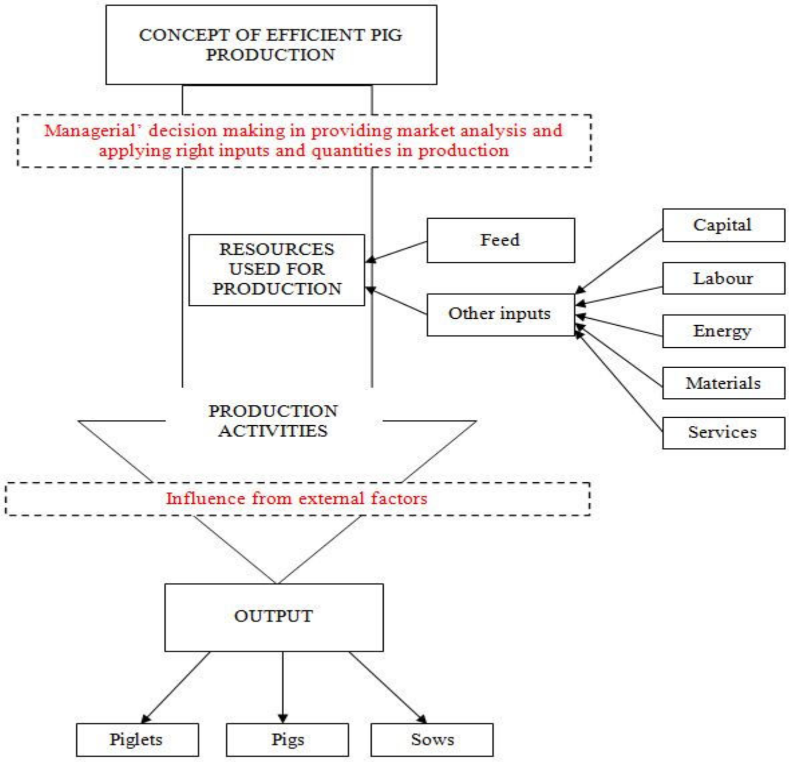

Figure 1: Variables that influence the technical efficiency

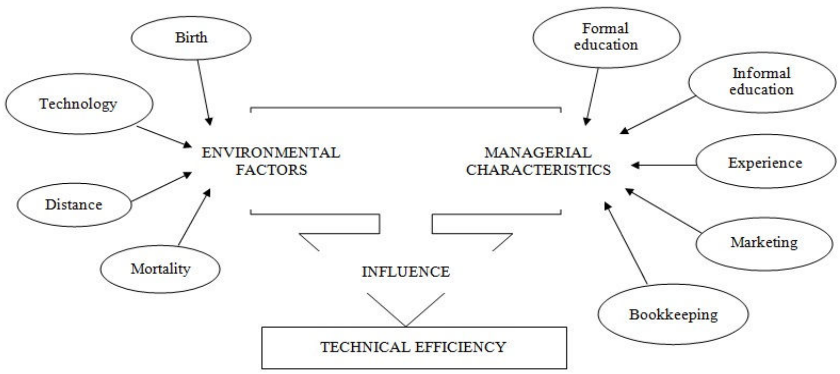

Figure 2: Factors influencing technical efficiency on the farms

The technology used in the production activities is also presented as a three-grade scale, where: 3 is for farms applying new technology, 2 for farms that start changing the production technology and 1 for farms operating with old technology.

Dummy variables are used for measuring bookkeeping, marketing and access to informal knowledge; where 1 is used for farmers performing such activities and 0 otherwise.

Access to informal knowledge is explained by: participation on conferences, workshops and trainings, participation in an agricultural association or cooperatives, accepting information and consultations from other farmers or experts and having previous experience in other relevant farm.

Formal knowledge is provided by the number of school years attended by farmers: 16 for the university degree, 12 for finished secondary school, 8 for finished primary school etc.

4 Results

The ability of farmers to produce more output while keeping the inputs fixed is calculated by the parametric SF. The average estimated output-oriented technical efficiency is about 70% and together with the OLS estimates of Cobb-Douglas production function is shown in Table 1. Here, both input variables are statistically significant at 1% and the constant is 10% significant. Although the negative values in the Cobb-Douglas production function are not expected, this may happen, and the situation is rather explained as a standard finding (Filipe and Adams, 2005).

Table 1: Parameter, OLS estimates using Stochastic Frontier analysis (n=21)

Variables		Coefficient	St. Error	t-ratio [d]
Constant	β_0	3.458	2.693	**1.294** [c]
Feed	β_1	-1.672	0.334	**-5.001** [a]
Other inputs	β_2	1.913	0.172	**11.129** [a]
Technical efficiency		**0.698**		
log likelihood		555.01		
sigma		0.60		
gamma		0.90		
eta		0.00		

[a] statistically significant at 1%, [b] statistically significant at 5%, [c] statistically significant at 10%
[d] the significance of t-ratio is estimated from the probability (p) value

Given the results obtained for the output orientation farmers' managerial practices are more adjusted for the inputs use. The low value of output-oriented TE is an indicator for difference in the production structure (such as: breeds selection, intensive vs. extensive technology, etc.).

Factors influencing output-oriented efficiency are explained in Table 2. Given the results, only one variable "distance to the closes market or big city" is not significant for the efficient production. All of the other selected variables show high significance. Positive influence on the farmer's ability to increase the output without additional increase in the inputs was found from: formal education, informal education, experience of farming, number of piglets on birth etc. Attending conferences, seminars, workshops and training, participating in agricultural cooperative or association, changing the experience and information are significantly positive for achieving technical efficiency. According to Manevska-Tasevska (2013) educated farmers have the ability to influence on the economic performances on their farms and to obtain higher production efficiency.

Table 2: OLS regression results of the second stage variables

Variables	Coefficient	St. Error	t-ratio [d]
Distance	0.741	0.845	0.877
Birth of piglets	0.001	0.054	1.908 [b]
Mortality	1.019	0.788	1.393 [c]
Technology	3.100	0.675	**4.591** [a]
Formal education	0.231	0.174	1.328 [c]
Informal education	1.227	0.282	**4.359** [a]
Years of farmers' experience	0.233	0.048	**4.816** [a]
Marketing	-2.928	1.423	-2.058 [b]
Bookkeeping	-4.559	1.056	-4.316 [a]
Constant	1.644	1.221	1.346 [c]

[a] statistically significant at 1%, [b] statistically significant at 5%, [c] statistically significant at 10%
[d] the significance of t-ratio is estimated from the probability (p) value

Moreover, proper technology used in the production contributes to increase in the number of piglets at birth, and lowers the mortality rates. However, managerial practices like bookkeeping and marketing were found to have significant influence on decreasing the technical efficiency. One possible explanation is the farmers' competence and costs for such activities, but their influence should be subject to further and more detailed analysis. Galev and Lazarov (1968) and Bamiro (2008) explain that the most efficient approach is farms to be located no more than 1 km away from the closest city or big market. However, "distance to the closest market or big city" was found to have no significant influence on the TE. These results are likely to appear due to the fact that there are no bigger distances than 5 km.

5 Conclusion

Relative technical efficiency in output ordination is estimated using the parametric SF approach. Taking into consideration that the noise is included in the SF econometric model, this model is expected to provide accurate efficiency results by including the influencing variables in the analysis. Proper production structure could increase the output production by 30%. However, it should be emphasized that this approach estimates the relative technical efficiency of the farms, i.e. all of the surveyed farms may increase the efficiency score. The increase of productivity and efficiency of production by appropriate use of inputs is confirmed in similar studies of other regions. Hence, Sharma et al (1996) explain that Hawaii's swine producers are operating at about 55-60% efficiency levels, while Adetunji and Adeyemo (2012) found that stocking, feed and labour costs are significant factors that influence pig production.

Managerial factors contributing to more efficient output-oriented efficiency are: formal education, informal education and farmers' experience. In less developed economies, like the Republic of Macedonia, improvement in farmers' knowledge is crucial for increasing the technical efficiency of production. The importance of formal and informal education of farmers is also confirmed in Manevska-Tasevska (2013) and Adetunji and Adeyemo (2012) research.

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