IMPACT OF THE INVESTMENT SUBSIDIES ON THE EFFICIENCY OF SLOVAK FARMS

Vplyv investičnej podpory na efektívnosť slovenských poľnohospodárskych subjektov

Bohuš Kollár[1], **Zlata Sojková**[2]

[1] *Slovak University of Agriculture in Nitra, Faculty of Economics and Management*
Trieda Andreja Hlinku 2, 94976 Nitra
Email:xkollarb@is.uniag.sk

[2] *Slovak University of Agriculture in Nitra, Faculty of Economics and Management*
Trieda Andreja Hlinku 2, 94976 Nitra
Email:zlata.sojkova@is.uniag.sk

Abstract: In this paper the stochastic frontier analysis is applied for the investigation of the farm level efficiency**,** it`s determinants and dynamics. This method enables simultaneous estimation of the production function model and the efficiency model. The efficiency of Slovak farms is studied for the period of 2007 to 2013. The Cobb-Douglas production frontier is estimated with the emphasis on the Common Agricultural Policy subsidies and time development. Hypotheses are that the investment subsidies have significant impact on the farm`s efficiency and that the efficiency improves with time. The equality of the efficiency scores` distribution across the farms` legal forms and prevailing activity are tested. Results show significant impact of investment subsidies and prevailing production activity on the efficiency.

Abstrakt: V príspevku je za použitia analýzy stochastických frontov skúmaná efektívnosť poľnohospodárskych subjektov, jej determinanty a dynamika. Uvedená metóda umožňuje simultánny odhad modelu produkčnej funkcie a modelu popisujúceho efektívnosť. Efektívnosť poľnohospodárskych subjektov je skúmaná za časové obdobie rokov 2007 – 2013 pomocou Cobb – Douglasovej produkčnej funkcie s dôrazom na podpory Spoločnej poľnohospodárskej politiky a časový vývoj. Predpokladom je pozitívny vplyv podpory a zlepšovanie efektívnosti v čase. V príspevku je porovnaná efektívnosť subjektov podľa prevažujúcej produkčnej aktivity. Výsledky naznačujú štatisticky významný vplyv investičnej podpory a prevažujúcej činnosti na efektívnosť.

Keywords: Common Agricultural Policy, efficiency, investment, Stochastic Frontier Analysis, subsidies

Kľúčové slová: Analýza stochastických frontov, efektívnosť, investície, podpora, Spoločná poľnohospodárska politika

JEL classification: C12, C20, H21

Introduction

The expansion of the European Union's (EU) economic and geographical size has led its budget to a steady increase characterized by phases of both reduction and accelerated growth, mainly due to the implementation of new policy actions.

The Common Aricultural Policy (CAP) underwent reforms on many occasions reflecting the changes in its goals. Initial objectives of CAP focused on the productivity, standard of living, agricultural markets, availability and price of food. The Rural Development Program of Slovak Republic 2007-2013 (2007) states that in order to improve competitiveness of Slovak farms the emphasis has to be put on the modernization and innovation of employed machines and buildings. Furthermore, special attention should be paid to environment to ensure that less favored areas will remain farmed and that the degradation of the soil is prevented.

The most important instrument of the CAP is Single Area Payment Scheme (SAPS), which is decoupled from the quantity of production of a farm. In order for a farm to receive SAPS, certain conditions have to be met. These conditions are referred as cross-compliance. However, the SAPS does not follow the flat rate of support for the whole EU. Differences in support levels cannot be justified on a long term. On the other hand, a flat rate of direct payments is not a feasible solution in the environment consisting of states with different wage levels and input costs (Kosior, 2014). The main advantage of decoupled payment is that farmers` output decisions are guided by consumer demand and not distorted by output subsidies, therefore, should be less damaging to the market mechanism (Pokrivčák and Ciaian, 2004). Such statement is supported by Fragoso (2011), according to whom the decoupling of the CAP payments leads the production decisions and the resources allocation to be more dependent on market prices and competitive advantages. Despite this fact, SAPS may also have disadvantages, namely:

- limited potential for supporting farmers' incomes as the payments tend to be concentrated to a few large farms (Happe, Kallermann and Balmann, 2006),
- the SAPS' contribution to food security is not as large as imagined because of the payments for the regions where market prices are sufficient to guarantee food production (Brady et al., 2009).
- SAPS has the tendency to be distributed to richer regions and farmers, which may be harmful to social cohesion (Baldwin, 2005),
- in practice, there is inadequate feedback between levels of public goods provided by agriculture and payments received by individual farms. Farmers are usually remunerated for carrying out particular management tasks rather than being rewarded directly for measured environmental performance, and payment levels are not related to actual costs. (Cong and Brady, 2012)

Programming period 2007-2013

One of the global objectives of the programming period for Slovakia was to increase the competitiveness of agriculture. This should be accomplished by improvement of efficiency and quality of production process. The Rural Development Program of Slovak Republic 2007-2013 (2007) suggests two priorities in order to improve efficiency. These are the support of the modernization and improvement of knowledge and agricultural expertise of management of farms.

Priority of the modernization is justified by the fact that production of farms is characteristic by the outdated and worn buildings and machinery. Therefore, the financial support aims for co-financing of the investment projects which should result in the farms` capability to fulfill the consumers` requirement.

It should be noted that the investment subsidies serve as co-financing instrument maximally to the 60% of the amount of investment project. The rest needs to be financed by the farm`s

means. However, new machinery prevents wasting of the resources and enhances their efficient usage, which should lead to the increased efficiency as a result of the investment subsidies (Pechrova, 2015). Bojnec and Latruffe (2013) on the other hand argue, that negative influence of operational subsidies is expected, as subsidization brings a certain return to farmers who may thus lower their effort in the input waste. Zhu, Demeter and Lansink (2012) conclude that subsidies can either improve efficiency if they provide incentive to innovation or decrease it if they reduce the motivation of farms. How much the subsidies affect the performance of producers is a question for empirical research.

Empirical background

Given the aims of the programming period 2007-2013, the most financial means were allocated for the Modernization of farms. The impact of such investment support was investigated for the Czech Republic farms by Medonos (2012). The contrafactual analysis showed positive impact of investment support on the added value and on the productivity measured as the gross added value to labor cost ratio. Furthermore, the increase in the amount of loans in supported farms was identified. Sample of the Czech farms documents that the bigger farms which had easier access to loans had also easier access to investment subsidies and smaller farms were disadvantaged (Medonos et al., 2012).

Direct payments were further studied in the Czech Republic. The main conclusions are that without the subsidies, the variability of crops would decrease and animal breeding could cease completely (Jelínek et al., 2010). However, in relative terms, the unsupported farms are able to produce greater output and added value. Such output is produced with economic loss. (Trnková, Malá and Vasilenko, 2012). Čechura (2014) researched the farms in less favored areas and concludes that the bigger farms are more efficient and therefore more competitive than the smaller ones. Negative impact of subsidies in the organic agriculture is pinpointed by Malá (2011). Subsidies motivated inefficient subjects to transpose to organic agriculture only to receive the payment. More suitable tool for organic agriculture could be support of the product sales and increase of the awareness among consumers. (Jánsky and Živělová, 2008).

Estimation of the efficiency is usually conducted with the application of the Data Envelopment Analysis (DEA) or Stochastic Frontier Analysis (SFA). Applying the SFA, the efficiency of Slovak and Czech milk producers was compared. Metafrontier multiple output distance function revealed regional differences, where only West Slovak regions could keep up with competitors from Czech Republic (Čechura et al., 2014). Using the same approach (i.e. SFA) the impact of subsidies from the Rural Development Programme 2007-2013 was studied for the Czech Republic by Pechrová (2015). Results for the panel data on 454 farms show statistically significant differences of efficiency between supported and unsupported farms.

Number of works focused on the research of the efficiency of farms in Slovakia applying both DEA (Bielik and Hupková, 2011, Fandel, 2003) and SFA (Covaci and Sojková, 2006). Research documents similar results like in Czech Republic, i.e. bigger farms (Fandel, 2003) and crop production (Bielik and Hupková, 2011) tend to be more efficient. Furthermore, time is statistically significant factor of the efficiency (Covaci and Sojková, 2006).

For this paper the SFA method is chosen as it enables to focus on the determinants of the efficiency. In addition to modeling the production frontier, chosen variables can be used to model the inefficiency term and therefore prove statistically significant impact on the efficiency (Pechrová, 2015, Sinani, Jones and Mygind, 2008, Battese and Coelli, 1995)

The article is structured as follows. Section two sets the aim of the paper and discusses the data and method for estimation of efficiency. In section three the results are presented. Section four concludes.

1 Data and Methodology

The aim of this paper is the research of the impact of investment and non-investment subsidies on the technical efficiency of Slovak farms.

Data

Data on the farms is drawn from the Information Sheets of the Ministry of Agriculture and Rural Development of the Slovak Republic for years 2007-2013. Time comparability of the financial entries is secured by the price indices drawn from the EuroStat, adjusting for the 2014 price level. Furthermore, consistency check had to be performed as not all of the farms existed throughout the whole studied period. Such farms had to be excluded in order to obtain the balanced panel data.

The variables used for the estimation of efficiency measures are total output, capital, labor cost, noninvestment subsidies, investment subsidies in previous period and acquisition of the long-term assets in previous period. Using the one period time lag causes the panel to be one period shorter. On the other hand, time lag is supported by the idea that investment subsidies and long-term assets do not have immediate impact on the level of production.

Methodology

Producers are efficient if they produce as much output as possible with the employed set of inputs and if the given output is produced at the minimum cost (Kumbhakar and Lovell, 2000). The measure of efficiency can be decomposed into technical and allocative efficiencies. Technical efficiency is an ability of a decision making unit to produce maximum output with a given set of inputs.

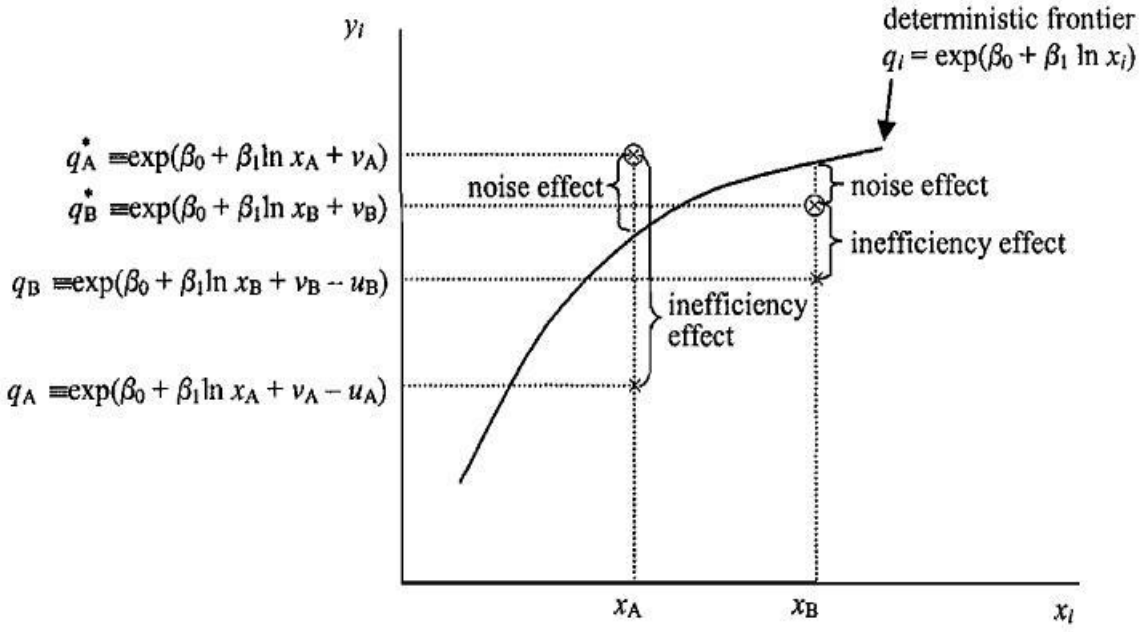
Stochastic frontier analysis

Statistical method applied in this paper for the estimation of efficiency measures is the SFA. Initially proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) the SFA allows for the estimation of the production function model given by the Equation 1:

$$ln(y) = \alpha + \beta * ln(x_i) + v_i - u_i \qquad (1)$$

The SFA accounts for the fact that the quantity of *i*'s firm output is influenced not only by the efficiency of a subject but also by the noise effect (v_i). Deviation from the frontier is known as the compound error term, where the noise effect (v_i) represents impact of random external factors and can be positive or negative. (Greene, 2008) Therefore, SFA model (Eq. 1) consists of three parts, namely deterministic frontier, noise effect and inefficiency (Fig. 1)

Figure 1: Parts of the stochastic frontier



Source: Coelli et al, 2005

Measure of *i*'s farm technical efficiency (TE) is computed as:

$$TE_i = \exp(-u_i) \qquad (2)$$

This measure (Eq. 2) takes values 0 - 1 and represents quantity of *i*'s farm output relative to the output achievable if the inputs had been used efficiently. The SFA assumptions are:
- v_i is symmetrically distributed,
- v_i and ui are independent and identically distributed variables,
- v_i is distributed independently of u_i and both error terms are uncorrelated with the explanatory variables,
- v_i and u_i are homoskedastic. (Coelli et al., 2005)

When the SFA is applied, the presence of systematic inefficiency (u_i) is tested. In the case it is not present, the error term is symmetrical, u_i equals to zero and the error terms equals only to v_i. In cases where u_i is more than zero, compound error is asymmetrical, negatively skewed, indicating inefficiency of studied subjects. Schmidt and Lin (1984), and Coelli (1995) proposed a test for the presence of systematic technical inefficiency (for details see Kubhakar and Lovell, 2000).

Estimation of stochastic frontier and inefficiency measures is based on the assumption of distribution of u_i. The most widely used distributions applied are half-normal, gamma, exponential, and truncated normal distribution. In practical application it has to be tested whether the deviations from the frontier could be assigned solely to the statistical noise (v_i) or if the inefficiency is present (u_i). The stochastic frontier is estimated by the maximization of the likelihood function (Coelli et al., 2005).

Greene (2008) states that it is up to a researcher to involve variables into the frontier model or as variables explaining the technical efficiency. For the purpose of this paper it is assumed that subsidies are statistically significant explanatory variables of the technical efficiency.

For the purpose of this paper the statistical software STATA 13 is used.

2 Results

Applying the SFA, Cobb-Douglas production frontier is estimated on the 705 farms using variables capital, wage, agricultural land of a farm, acquisition of long term assets and investment subsidies with one period time lag, non-investment subsidies and time variable defining the year (Tab. 1). Furthermore, for the modeling of the variability of efficiency, we use acquisition of assets, both types of subsidies, time variable and dummy variable for the prevailing production activity of a farm. Dummy variable takes values of 0 if the farm has more revenues from crop production and 1 for the prevailing of the revenues from animal breeding. (Tab. 1)

Table 1: Efficiency model

	Coef.	**Std. Err.**	**z**	**P>|z|**	**95% Interval**	
Capital	0.744	0.008	83.690	0.000	0.727	0.763
Wage	0.390	0.021	18.460	0.000	0.348	0.432
Land	0.193	0.014	13.000	0.000	0.164	0.222
Time	0.016	0.013	1.190	0.233	-0.011	0.043
Assets Acq.	-0.011	0.003	-2.990	0.003	-0.019	-0.004
Inv. Subs	-0.006	0.001	-3.440	0.001	-0.011	-0.003
Noninv. Subs.	-0.082	0.013	-5.980	0.000	-0.109	-0.055
Const	-0.054	0.207	-0.260	0.793	-0.462	0.353
lnsig2v						
Const	-2.034	0.035	-58.040	0.000	-2.102	-1.965
lnsig2u						
Assets Acq.	-0.058	0.023	-2.540	0.011	-0.103	-0.013
Inv. Subs.	-0.057	0.019	-2.940	0.003	-0.095	-0.019
Noninv. Subs.	-0.365	0.038	-9.670	0.000	-0.439	-0.291
Time	-0.160	0.111	-1.440	0.149	-0.378	0.057
Prev. activity	0.883	0.113	7.840	0.000	0.662	1.103
Const	2.156	0.486	4.430	0.000	1.203	3.108
sigma_v	0.362	0.006	0.346	0.374		

Source: Own computation, STATA 13

Using the chosen variables, the efficiency model is obtained (Tab. 1). The results document that the time variable did not have statistically significant impact neither on the production possibilities, nor the variability of efficiency scores. Despite this fact the insignificant variable is kept in the model because it shows the best log-likelihood ratio among other tested models. All the other variables included in the model have statistically significant impact. (Tab. 1)

Capital, wage and farmed land show positive elasticity, which, as expected, means that these factors increase the production of a farm. On the other hand, subsidies and long term assets acquisition show negative elasticity. Such coefficients signify that:

- newly obtained long term assets do not bring increased revenues, similarly as the investment subsidies. This can be viewed in a way that although the production possibility might be increased with the additional assets, these did not reflect in terms of revenues. Alternatively, one period time lag might not be enough to show positive investment effect,
- non-investment subsidies do not serve as the motivation to increase revenues. Despite the fact, that without subsidies the farms would create loss, the amount of payment does not reflect itself in the increased revenues of a farm.

In addition to frontier model, the factors affecting the variability of inefficiency are studied. All, but one explanatory variables mentioned earlier in this chapter once again show statistical significance. Among the variables, the only one with positive coefficient is dummy variable for the prevailing production activity. This variable takes value one for the prevailing animal breeding. Therefore, farms with this type of dominant production have greater variability of the efficiency scores. (Tab. 1)

Despite the fact, that increase in long term assets and subsidies have negative impact on the production frontier these variables tend to lower the variability of inefficiency. This can be viewed as a positive signal suggesting that in terms of efficiency, mentioned variables influence overall efficiency and competitiveness in a positive manner. Furthermore, the model (Tab. 1) signifies that investment subsidies help to achieve the CAP goals.

Summary statistics for the efficiency scores estimated by the model (Tab. 1) is provided in Table 2.

Table 2: Summary statistics of efficiency

Year	Mean	St. Dev.	Median	IQR
2008	0.757	0.117	0.788	0.119
2009	0.655	0.142	0.681	0.177
2010	0.710	0.129	0.738	0.151
2011	0.746	0.122	0.778	0.139
2012	0.757	0.118	0.788	0.120
2013	0.723	0.128	0.755	0.138
Total	0.725	0.131	0.758	0.153

Note:IQR stands for Inter-Quartil Range
Source: Own calculation, Stata 13

Summary statistics (Tab. 2) further documents that there is no visible improvement in efficiency during the studied period. All the characteristics in the table appear to be rather stable supporting the statistical insignificancy of the time variable in the model (Tab. 1).

Given that the time variable is not statistically significant factor for the production frontier and for the efficiency variability, we test for the hypothesis that:

- efficiency scores come from the same distributions for the legal forms of farms. Legal forms are either agricultural cooperatives or agricultural company,
- efficiency scores come from the same distributions for the prevailing production activity.

Results are summarized in the Table 3.

Table 3: Effiency scores testing

Period	Legal form	Prevailing activity
2008	0.000	0.320
2009	0.000	0.172
2010	0.174	0.520
2011	0.397	0.017
2012	0.022	0.002
2013	0.037	0.017

Source: own computation, STATA 13

Based on the testing (Tab. 3), there are significant differences in efficiency scores among legal forms. Only the years 2010 and 2011 show the same efficiency results. Furthermore, there is no visible trend of efficiency measures getting closer, i.e. continually coming from the same distribution. On the other hand, crop production and animal breeding show same efficiency for the years 2008-2010. Then on the efficiency scores come from the different distributions. This fact further supports the results of the efficiency model (Tab. 1), where the prevailing activity variable is statistically significant.

Conclusion

The CAP subsidies still raise questions for researchers about the efficiency of payments and their quality to help fulfill the CAP goals. One of these goals for the programming period 2007-2013 was to raise efficiency and competitiveness of farms and to modernize the farms` assets. Given the situation in Slovakia with outdated machinery, this paper focuses on the efficiency of farms and discusses the role of CAP subsidies as the factor influencing production possibilities and the efficiency itself.

Applying the SFA, the Cobb-Douglas production frontier model and the model for the variance of efficiency are estimated. Results suggest that capital intensiveness with the highest elasticity of 0.744. Furthermore, even if the investment support is one period lagged, it has still negative impact on the revenues of a farm. Similar applies for the non-investment subsidies and the increase of long term assets.

On the other hand, same variables have positive impact on the variance of the efficiency, as they decrease it. Interestingly, the time variable did not prove to be statistically significant factor in any of the models. This suggests that farms on average did not get more efficient with time. Despite the fact that the standard deviation of efficiency scores increased during the studied period (from 0.117 to 0.131), the amount of subsidies and acquired assets contribute to the decrease of variance and therefore contribute to competitiveness. Such conclusion is supported by the fact that the average efficiency changed from 0.757 in 2008 to 0.725 in 2013and mentioned factors have negative coefficient in the efficiency variance model.

To sum up the results, subsidies appear to have positive effect on the efficiency of farms and are important and useful tool for achieving the CAP goals. Test of equality of efficiency scores documents that there is no significant trend in differences among legal forms of farms and these scores can be considered equal for the most of the studied periods (differences are found only in the years 2010 and 2011 where the p-value is higher than α=0.05). On the other hand, when the types of prevailing activity are tested, there are significant differences in efficiency for the years 2008-2010. In the second half of studied period, i.e. years 2011-2013, there is no statistically significant difference in efficiency scores, supporting the fact that prevailing activity dummy variable proved to be significant in the suggested production frontier model.

Therefore, it can be concluded that efficiency of crop production and animal breeding became equal during the studied period.

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