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The effect of subsidies on the efficiency of farms in the Liberecký region

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Abstract

The aim of the paper is to assess the impact of subsidies on the technical efficiency of agricultural holdings in the Liberecký region. A parametric method – stochastic frontier analysis – was used. A *true* fixed effects model was estimated, assuming a Cobb-Douglas production function with variance of inefficiency explained by explanatory variables. The results reveal that direct payments and agri-environmental payments tend to increase inefficiency, whereas subsidies for Least Favourable Areas have a positive effect on the efficiency of agricultural holdings. The effect of Rural Development Programme subsidies is not statistically significant. Based on our results, we suggest lowering the entitlements (direct payments and agro-environmental measures) as they seem to lower farmers' motivation to engage in efficient production.

Keywords

Agricultural subsidies, stochastic frontier analysis, technical efficiency, true fixed effects model.

JEL Classification: H71, Q18

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The effect of subsidies on the efficiency of farms in the Liberecký region

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1. Introduction

After the entrance of the Czech Republic (CR) to the European Union (EU), the country's agricultural holdings gained the opportunity to obtain subsidies from the Common Agricultural Policy (CAP). According to Malá et al. (2011), this source of financial means *has been fundamentally reflected in the economic development of the agricultural sector in the CR and in the business management of individual agricultural businesses.* For example, Doucha and Foltýn (2008) found that the EU support has a positive impact on the profitability of particular commodities – it has already increased positive profitability or at least helped to minimize losses. Also, Čechura (2012) demonstrated that the factors which most determine both technical efficiency and total factor productivity of Czech agriculture are *the factors connected with institutional and economic changes, in particular a dramatic increase in the imports of meat and increasing subsidies.* However, the role of subsidies can be ambiguous. They can improve farms' viability, but may mitigate farmers' motivation to engage in efficient resource usage.

The OECD has called for more targeted policies for governance or public administration reasons. It wants them to be more accountable and transparent. It also stresses the need to minimize costs, in particular budgetary costs, in a context of budget constraints (OECD, 2007). Because farms are subsidized from the public budget, *it is necessary to continuously analyse the efficiency of spent finances in relation to the gained added value* (Kroupová and Malý, 2010).

The article reflects the need for evaluation of spent public finances. Its aim is to assess the impact of subsidies (direct payments, agro-environmental measures (AEM), subsidies for Less Favourable Areas (LFA) and from Rural Development Programmes (RDP)) on the technical efficiency of farms in the Liberecký region. The structure of the paper is as follows. First, there is a literature review of the research done in the area of technical efficiency using the stochastic frontier analysis (SFA) method. The dataset and model employed are then described. In the next section, the effect of subsidies on technical efficiency is analysed. Then, the impact on policy making is discussed. The last section presents the conclusions.

2. Literature Review

One of the methods most commonly used for the calculation of technical efficiency is the SFA. The area of the efficiency of agricultural holdings has been researched widely using this method. For example, Čechura and Malá (2014) assessed technical efficiency in the Czech and Slovak dairy industry. They discovered that it is higher in the Czech Republic than in Slovakia. Trnková et al. (2012) analysed the influence of the subsidy policy on production, costs and the technical efficiency of agricultural enterprises. They found that the farms which gained the subsidies achieved only 44.6% of potential production, whereas farms without subsidies demonstrated greater efficiency at 60.4%. They concluded that such financial support lowers technical efficiency. Similarly, Kroupová and Malý (2010), on the basis of their analysis, stated that *policy-economical instruments of subsidy policy in the form of direct production aid do not have an unambiguously positive influence on the increase in performance of organic agricultural holdings.* Kroupová (2010) assessed the effect of AEM subsidies and other subsidies per hectare on the technical efficiency of organic farms. Her model shows that both types of subsidies increase inefficiency, although the effect of *organic* subsidies is not statistically significant. This is in line with Pechrová and Vlašicová's (2013) study. They examined the effect of the Single Area Payment Scheme (SAPS) and national subsidies, AEM and LFA payments, RDP aid and other direct payments on the technical efficiency of organic and biodynamic farms. Their model revealed that all types of subsidies mildly decrease inefficiency. Only the effect of other direct payments was not statistically significant. Pechrová (2013) assessed the technical efficiency of Czech biodynamic farms, comparing parametric and non-parametric methods, and determined that their efficiency, calculated using SFA, varied from 46.85% to 84.01%.

3. Data and Methodology

In this section, the data sources and software are described. Subsequently, we present a summary of the SFA method used, the variables included in the model and the model itself. The estimation and verification methods are then described.

Accounting data for farms in the Liberecký region were gathered for the years 2005–2012 from the Albertina database of Bisnode CR a.s. Data on subsidies for the same period were obtained from the State Agricultural Interventional Fund. The calculations were done in Stata 11.2 and IBM SPSS.

3.1 Stochastic frontier analysis

Technical efficiency was defined by Pitt and Lee (1981) as *the maximum quantity of output attainable by given input*. Originally, the methods of efficiency calculation were based on linear or quadratic programming. Econometric methods, with SFA in a prominent position, were developed later.

The bases of the SFA were introduced independently by Meeusen and van den Broeck (1977) and Aigner et al. (1977). In both articles, a compound error term was proposed. This consists of statistical noise (v_i) and an inefficiency term (u_i). The inefficiency term u_i measures technical inefficiency in the sense that it measures the shortfall of output (y_i) from its maximal possible value given by the stochastic frontier (Jondrow et al., 1982). It is non-negative and the value $u_i = 0$ suggests that the firm is not at all inefficient. Values higher than zero ($|u_{it}| > 0$) measure the degree of inefficiency. In contrast, the efficiency is normalized between 0 and 1 where the value of 1 means that the farm is 100% efficient. The distribution of the inefficiency term must be set prior to the estimation of the production function. For example, Battese and Coelli (1988) assumed u_{it} to have either half normal or truncated normal distribution. The production function itself might be specified, for example, in Cobb-Douglas, Translog, Constant elasticity of substitution or Leontief form.

The inefficiency (efficiency) could vary in time, as reflected, for example, in the *true* fixed and *true* random effects models developed by Greene (2002, 2005). Another concern was to model heterogeneity (often present as firms are different in many respects) and heteroscedasticity. Battese and Coelli (1995) proposed the inclusion of heterogeneity (expressed by firm-specific variables) in the mean of the u_i. Heteroscedasticity can be explained in the function of the variance of the inefficiency term σ_{ui}.

One of the possible means of assessing the effect of subsidies is to include them in the frontier function as one of the production factors. However, according to Kumbhakar et al. (2012), this approach *suffers from certain problems: (1) while traditional inputs are necessary for production, subsidies are not; and (2) subsidies alone cannot produce any output, while traditional inputs can.* Besides, there should be no positive correlation between production and subsidies (Malá et al., 2011) as McSharry and Fishler's reform of the CAP decoupled the subsidies from production.[1] Another approach (used for example by Kroupová, 2010) is to construct a recursive model of technical inefficiency where one equation expresses the production frontier function and the second explains the technical inefficiency. An alternative is first to estimate the efficiencies of particular farms and then explain them in a separate equation with various factors (see e.g. Speelman et al., 2008).

The essence of the SFA is illustrated in Figure 1. We suppose that companies use one unit of input x to produce one unit of output y. First, there is the stochastic frontier of the production function estimated on the real firm data. Then, the distance of the firm from the frontier is measured. Those companies which lie on the production frontier are 100% efficient – e.g. firm F_1. Those which are under the frontier are technically inefficient. For example, firm F_2 with available resources x_2 could have produced output at the level of y_2', but produced only the level of y_2.

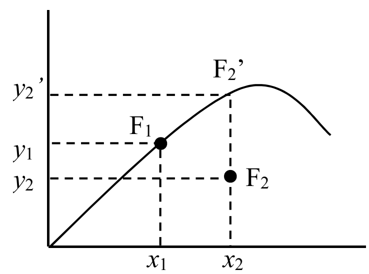

Figure 1 Stochastic frontier of production function

3.2 Variables

The explained variable (y_{it} – production of i^{th} subject at time t) was represented by sales in thousand CZK. To mitigate the influence of inflation, production was deflated by the agricultural producers' prices (2005 = 100). The explanatory variables were materials, capital, labour and land. These were calculated from accounting data of the farms according to the methodology used, for example, by Čechura (2012). Usage of material and services in thousand CZK ($x_{1,it}$) and capital consumption in thousand CZK ($x_{2,it}$) were deflated by industry producers' prices (2005 = 100). The number of employees ($x_{3,it}$ – labour) was calculated as the division

[1] Despite this, Pechrová (2014) found out that SAPS and other subsidies mildly decreased production levels, while agri-environmental payments from RDP and HRDP, LFA payments and RDP subsidies tended to increase production.

of labour costs by average wage in agriculture in the Liberecký region in a particular year. Land ($x_{4,it}$) was represented by the division of SAPS subsidies gained by a farm and the level of SAPS payment in the respective year.

Subsidies – direct payments ($z_{1,it}$), AEM ($z_{2,it}$), LFA ($z_{3,it}$), and RDP payments ($z_{4,it}$) – explained the variance of inefficiency. A dummy variable ($z_{5,it}$) was used to distinguish between conventional (value of 0) and organic (value of 1) farms in the sample because they use different technology.

3.3 Model

The production frontier of agricultural holdings is estimated using the *true* fixed effects (TFE) model specified by Greene (2002) (1). This enables inefficiency and firms' heterogeneity to vary in time. The model substitutes the constant in Schmidt and Sickles' (1984) stochastic frontier model using a firm dummy. Thus:

$$y_{it} = \alpha_i + \mathbf{x}_{\mathbf{it}}^{'}\boldsymbol{\beta} + v_{it} - u_i, \quad (1)$$

where u_i is the inefficiency term with half-normal distribution, $\mathbf{x}$ is the matrix of explanatory variables and $\boldsymbol{\beta}$ is a vector of corresponding coefficients. Unobserved heterogeneity is included in the constant α_i.

Regarding the functional form, we chose the Cobb-Douglas production function:

$$y_{it} = x_{1,it}^{\beta_1} x_{2,it}^{\beta_2} x_{3,it}^{\beta_3} x_{4,it}^{\beta_4} e^{\varepsilon_{it}}, \quad (2)$$

where β_k, k =1...4 are the coefficients of explanatory variables x_k, k =1...4 for each farm i (i = 1... 40) at time t and ε_{it} is an idiosyncratic term consisting of:

$$\varepsilon_{it} = v_{it} - u_i, \quad (3)$$

where $v_{it} \sim N(0, \sigma_{v_{it}}^2)$ is a two-sided error term (statistical noise) and $u_i \geq 0$ is a one-sided error term (technical inefficiency). We chose exponential distribution of the inefficiency term:

$$u_{it} \sim \mathrm{Exp}(\lambda), \quad (4)$$

where λ is the parameter of exponential distribution.

For the inclusion of subsidies in the analysis, we used the one step approach suggested by Kumbhakar et al. (2012). The subsidies are explanatory variables in inefficiency variance function:

$$\sigma_{u_i}^2 = \delta_0 z_{1,it}^{\delta_1} z_{2,it}^{\delta_2} z_{3,it}^{\delta_3} z_{4,it}^{\delta_4} z_{5,it}^{\delta_5} e^{w_i}, \quad (5)$$

where δ_0 represents the constant, $\delta_{k,it}$ (k = 1...5) are coefficients of $z_{k,it}$ variables (k = 1...4 different types of subsidies and $z_{5,it}$ dummy for organic farms) and w_i is the stochastic term.

Heteroscedasticity was modelled only by the exponential function of the stochastic term variance ($\sigma_{v_{it}}^2$) with constant (ω_0) as the explanatory variable:

$$\sigma_{v_{it}}^2 = e^{\omega_0} \quad (6)$$

Inefficiency and efficiency were calculated using the method suggested by Jondrow et al. (1982).

3.4 Estimation method

The model was estimated using the maximum likelihood method, which seeks values that maximize the likelihood function ($L(\beta)$) or (more often) the logarithm of likelihood ($\ell(\beta)$) – see equation (7). Parameters are set in such a way that there is the maximal likelihood that true value is measured.

$$\ell(\beta) = \ln\left(L(\beta)\right), \text{ where } L(\beta) = \phi(y;\beta). \quad (7)$$

3.5 Parameters and model verification

The statistical significance of parameters was tested using the t-test (H_0: $\beta_k = 0$). The level of significance was set at $\alpha = 0.05$. The goodness of fit was assessed by the likelihood-ratio (LR). This compares the specification of the null model to the alternative model. The H_0 states that the parameter vector of a statistical model satisfies some smooth constraint. The LR test statistic (8) is approximately χ^2 distributed with degrees of freedom equal to the difference of the numbers of unrestricted and restricted parameters.

$$\Lambda = -2\ln\left(\frac{L_R}{L_U}\right), \quad (8)$$

where L_R is the value of the restricted model (null model) likelihood and L_U is the likelihood for the unrestricted model (alternative model). The Wald χ^2 test was used as the alternative goodness of fit test (H_0: $\beta_1 = \beta_2 = ... = \beta_k = 0$).

3.6 Comparison of farms

First, the Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test whether inefficiency and efficiency originate from normal distribution. Then, we tested the statistical significance of the differences in means and standard deviations of technical inefficiency (or efficiency) between organic and conventional farms and between farms receiving and not receiving subsidies using non-parametric tests. Specifically, we chose the Wald-Wolowitz runs test for the difference in means (H_0: $\mu_{\text{organic}} = \mu_{\text{conventional}}$ or H_0: $\mu_{\text{subsidized}} = \mu_{\text{non-subsidized}}$) and Median tests ($H_0$: $\tilde{x}_{\text{organic}} = \tilde{x}_{\text{conventional}}$ or H_0: $\tilde{x}_{\text{subsidized}} = \tilde{x}_{\text{non-subsidized}}$).

We assumed that conventional farms would be more efficient in resource usage than organic farms because of their technological differences. We also supposed that the efficiency of farms which received subsidies would be statistically significantly higher.

3.7 Basic data on the Liberecký region

The Liberecký region is (according to the EU's population grid classification) an intermediate NUTS 3 region. Due to its climate and geographic conditions, agriculture does not have the optimal environment for development. In 2011, the share of agricultural land in the total area was 44.2% and of arable land only 20.6%, which is below the CR's average. In contrast, forests occupy 44.5% of the total land, which is above the CR's average (CZSO, 2011). Another specificity of this region is the presence of nature conservation areas that require specialized management. Almost 70% of the area can also be categorized according to the EU's classification as LFA. Hence, this region cannot be considered optimal for intensive agricultural production (CZSO, 2009). This implies that the role of subsidies in ensuring farms' viability is crucial, especially for those holdings located in LFA.

4. Results

The panel data for 40 farms in the Liberecký region contained 209 observations for the years 2005 to 2012. It was an unbalanced panel with 5.2 observations for one farm on average (minimum observation 1, maximum 8). The average deflated production was CZK 26 thousand. Companies used more capital per year (on average CZK 26 thousand) than material and services (on average CZK 19 thousand per year). Farms had around 24 employees on average and the average area of land was 530 hectares.

Production was explained by production factors in the stochastic frontier production function. The variance of the inefficiency term was explained by subsidies. The estimated parameters are given in Table 1.

According to the Wald χ^2 test, the model as a whole is statistically significant, i.e. at least one parameter is statistically significantly different from zero. Similarly, all coefficients of the production factors are statistically significantly different from zero. Their signs correspond to the expectations given by economic theory. An increase in production factors implies an increase in the production level. Production is higher when the farm uses more materials, capital, labour and land. An increase in each of these production factors of 1% causes an increase in production of 0.41%, 0.23%, 0.09% and 0.08% respectively.

The effect of subsidies on inefficiency is clear from the variance of the inefficiency function. When the sign is positive, subsidies result in increased inefficiency (and lower efficiency) and vice versa. When the amount of direct payments increases by 1%, inefficiency also increases – by 0.01%. However, the effect is not statistically significant. In contrast, the effect of AEM is statistically significant. A 1% increase causes an increase in inefficiency of 0.02%.

On the other hand, subsidies for LFA and from RDP have a positive effect on the efficiency of agricultural holdings as they lower inefficiency by 0.02% and 0.01% respectively. However, the effect of the latter is not statistically significant.

Table 1 Estimation of the parameters of the TFE model

	Coeff.	*Std. Err.*	*p-value*
Frontier			
β_1 ($\ln x_{1,it}$)	0.405	0.001	0.000
β_2 ($\ln x_{2,it}$)	0.226	0.000	0.000
β_3 ($\ln x_{3,it}$)	0.092	0.003	0.000
β_4 ($\ln x_{4,it}$)	0.079	0.003	0.000
Variance of inefficiency term			
δ_1 ($\ln z_{1,it}$)	0.009	0.356	0.797
δ_2 ($\ln z_{2,it}$)	0.019	0.009	0.039
δ_3 ($\ln z_{3,it}$)	–0.022	0.010	0.022
δ_4 ($\ln z_{4,it}$)	–0.013	0.015	0.373
δ_5 ($z_{5,it}$ dummy)	1.333	0.477	0.005
δ_0 (const.)	–2.165	0.521	0.000
Variance of stochastic term			
ω_0 (const.)	–18.494	8.141	0.023
Information criterion			
Wald $\chi^{2\,[4\,d.f.]}$	3.18e+07	–	0.000
Log likelihood	–21.247		

Source: Own elaboration based on accounting data from the Bisnode database and from SAIF (2012)

The results of the Kolmogorov-Smirnov and Shapiro-Wilk tests revealed that the distributions of inefficiency and efficiency are not normal. This implies that non-parametric tests of hypothesis have to be used.

The average inefficiency of a farm was estimated at 43% with a standard deviation of 66%. It ranged from 0.03% to 574%, but the majority of farms had an inefficiency level lower than 100% (median 29%). Only 18 farms had an inefficiency level higher than 100%. The inefficiency distribution is displayed in Figure 2.

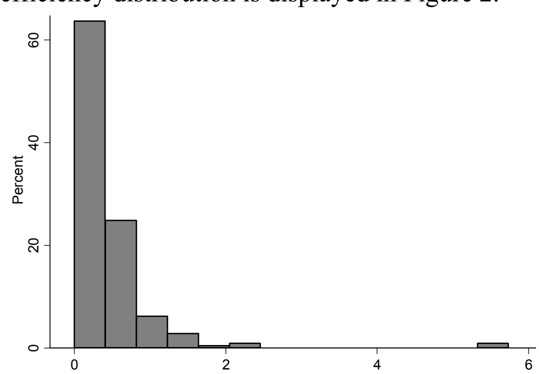

Figure 2 The inefficiency distribution of farms

The average efficiency was estimated at the level of 0.73. In other words, this means that the average farm produced 72.74% of its potential production. The standard deviation of efficiency was 23.60% and efficiency ranged from 0.32% to 99.97%. The majority of farms had greater than 50% efficiency as the median was higher than average (74.48%). In total, 64 farms were more than 90% efficient. The efficiency distribution is presented in Figure 3.

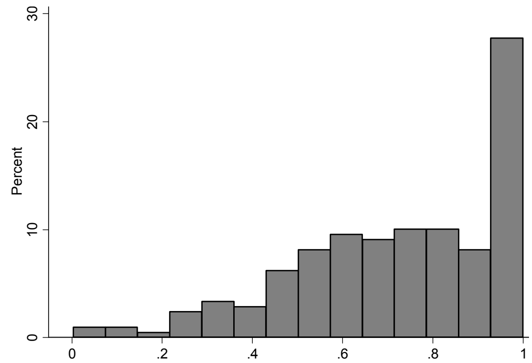

Figure 3 The efficiency distribution of farms

There were 23 observations for organic farms and 186 for conventional farms in a sample distinguished by the dummy variable. The coefficient of this dummy ($z_{5,\,it}$) had a positive sign. This suggests that the variance of inefficiency is higher when the farm is organic. Clearly, the technology in the two systems is different. The average annual production of a conventional farm is CZK 28,764 thousand, whereas that of organic farms is only CZK 5,669 thousand. Organic farms also have (on average) fewer resources (production factors) available.

There is also a difference in the average inefficiency (the average organic farm is almost two times more inefficient than a conventional farm). Also, the efficiency of conventional farms is higher than that of organic farms. Considering the median, which is not burdened by extreme values, organic farms are less inefficient and more efficient than conventional farms. This contradictory situation might be caused by the fact that there are few very inefficient farms. Such extremes cause bias of the statistical mean.

The differences in average and median inefficiency and efficiency were tested using non-parametric tests. The Wald-Wolowitz runs and median tests for the differences between means and medians of the inefficiency and efficiency between organic and conventional farms showed no statistically significant differences (see Table 2).

We supposed that subsidies would help to increase the efficiency of agricultural holdings. Therefore, we tested whether there were statistically significant differences in the means and medians of technical inefficiency and efficiency between companies which receive a given type of subsidies and those which do not. This test was not performed for direct payments as almost all farms in the sample receive this type of subsidy (only one farm does not). Therefore, the first test was done for AEM payments (see Table 3).

Table 2 Tests for the differences between organic and conventional farms

Category		*Organic*	*Conven-tional*	*Tests' p-values*
No. of observations		23	186	–
Inefficiency	Mean	0.758	0.385	0.245*
	Median	0.289	0.295	0.981
Efficiency	Mean	0.660	0.736	0.245*
	Median	0.749	0.744	0.981

*Computed using the maximum number of runs when breaking inter-group ties among the records; α = 0.05

Table 3 Tests for the differences between farms receiving or not receiving AEM payments

AEM payments		*yes*	*no*	*Tests' p-values*
No. of observations		105	104	–
Inefficiency	Mean	0.453	0.399	0.184
	Median	0.343	0.199	0.045
Efficiency	Mean	0.705	0.750	0.184
	Median	0.710	0.820	0.062

In line with the TFE model results (and contrary to the desirable situation), the average inefficiency was higher when the company received subsidies (45.3%). An average farm with subsidies was efficient at a level of 70.5% while the level for an average farm without subsidies was 75.0%. The situation was analogous for medians, i.e. farms with subsidies are on average more inefficient and less efficient than those without. The statistically significant differences are only in the medians of inefficiency between farms with and without AEM payments.

The differences in technical inefficiency are also notable in the case of farms receiving LFA payments (38.4%) and not receiving LFA payments (51.2%). Similarly, the efficiency of a subsidized farm (74.4% on average) was higher than that of non-subsidized farms (69.2%). This implies that this type of subsidy plays its role and lowers inefficiency. However, as can be seen from Table 4, the differences in neither the means nor the medians are statistically significant.

Table 4 Tests for the differences between farms receiving or not receiving LFA payments

LFA payments		*yes*	*no*	*Tests' p-values*
No. of observations		141	68	–
Inefficiency	Mean	0.384	0.512	0.639
	Median	0.271	0.351	0.279
Efficiency	Mean	0.744	0.692	0.639
	Median	0.271	0.351	0.324

RDP subsidies, which are in the nature of investment, should help to enhance efficiency and decrease inefficiency. However, the farms receiving subsidies from RDP are on average slightly less efficient. Also, the median of inefficiency of non-subsidized farms is lower than that of subsidized. Only when we consider the mean are farms receiving subsidies less inefficient. This might again be due to the nature of the mean, which considers extreme values. There are 16 non-subsidized farms with an inefficiency value higher than 1, but only two subsidized farms. Therefore, it is only this comparison that does not support the other results.

The differences in means and in medians are displayed in Table 5. There are no statistically significant differences in average inefficiency and efficiency between subsidized and non-subsidized farms.

Table 5 Tests for the differences between farms receiving or not receiving RDP payments

RDP payments		*yes*	*no*	*Tests' p-values*
No. of observations		23	186	–
Inefficiency	Mean	0.390	0.430	0.648*
	Median	0.318	0.291	0.641
Efficiency	Mean	0.723	0.728	0.648*
	Median	0.728	0.747	0.676

* Computed using the maximum number of runs when breaking inter-group ties among the records; $\alpha = 0.05$

5. Discussion

We agree with Kumbhakar et al. (2009) that *subsidies should be designed in such a way that they do not promote inefficiency.* Whether they compensate more financially demanding farm management (e.g. organic production) or less favourable conditions, or whether they support farms' investments, they should not lower the motivation of the farmers or the efficiency of the farms.

Regarding organic farming, the variance of inefficiency is higher when the farm is organic. This finding would support the argument that the organic type of management is more financially demanding and therefore the conversion of the production factors to outputs is less efficient.

However, the results of the tests imply that although organic farms seem at first sight more inefficient, the differences are not that important. What is more, organic farms in the Liberecký region had even higher average technical efficiency than the conventional farms. This might be due to the climatic conditions. As for the region, a high share of LFA is typical and organic land management seems more appropriate for these unfavourable agricultural conditions. However, the tests showed that the differences were not statistically significant. This has implications for subsidy policy. It shows that the provision of financial support for organic farms is not justified by the argument of differences in technologies. Although organic farms are bound by legal requirements regarding production, they are able to achieve the same level of technical efficiency (or inefficiency) as conventional farms.

Furthermore, subsidies for organic farms (which are part of the AEM payments) may lower the motivation of the farmers to produce efficiently. This is underpinned by the results of the TFE model. It is clear that increasing AEM payments (which consist of subsidies for organic and integrated agricultural production, land care, grasslands, etc.) statistically significantly increases the variance of the inefficiency of the farms. This is not a desirable state of affairs.

We supposed that after receiving the payments, agricultural holdings would be at least as efficient as non-subsidized farms (if not more so). However, the average inefficiency was higher when the farms were subsidized. This conclusion is contrary to expectations, but was demonstrated in Kroupová's (2010) study. She found that (although the effect was not statistically significant) increasing subsidies for organic production increases inefficiency by 0.08%. The differences in the medians of technical inefficiency of subsidized and non-subsidized farms related to AEM payments were statistically significant. Farms are more inefficient when they obtain these subsidies. Hence, inefficiency is higher when the holding is not subsidized. Again, this finding shows that subsidies for organic farms in the Liberecký region are not optimally set. It can be recommended that organic farms do not rely on AEM payments, as they could increase their inefficiency, but rather that they invest in innovations to make their production more efficient.

A high share of LFA is typical of the Liberecký region. Hence, it is not surprising that two thirds of the farms in our sample received payments on grassland in LFA. The TFE model demonstrates that those payments statistically significantly decrease the variance of technical inefficiency. Comparing the averages and the medians of technical inefficiency and efficiency confirms that the effect of LFA is positive and according to expectations: 20.38% of farms located in LFA are more than 90% efficient. However, we must maintain some caution before arguing for higher subsidization of the farms in LFA. First, the effect on inefficiency is low (a 1% increase in LFA payment decreases inefficiency by 0.02%). Second, our sample contains only a few farms without LFA support and therefore the results are not statistically significant. Research on a larger sample of farms is needed.

The subsidies examined so far are in the nature of entitlements. If the agricultural holding fulfils certain conditions (certified as organic, located in an LFA, etc.), financial support is granted. In contrast, subsidies from RDP are allocated only to investment projects and it is not guaranteed that the farmer will receive them. The main aim of this support (stated in the National Strategic Plan for Rural Development of the CR for the years 2007–2013) is to improve the competitiveness of agriculture and forestry. Hence, we supposed that *the support is targeted at investments which increase the total economic performance of the agricultural enterprise in order to increase its competitiveness* (Ministry of Agriculture, 2013). The modernization of technology and equipment should decrease the wasting of resources and enhance the competitiveness of the farms receiving such subsidies. Hence, the subsidized farms should be less technically inefficient and more technically efficient than those which do not obtain subsidies. This assumption is not supported by our results.

The subsidies from RDP for investments decreased the variance of inefficiency, but not statistically significantly. Although the average inefficiency was lower in the case of subsidized farms, the median inefficiency was higher. However, no statistically significant differences were found between the farms with and without subsidies. This might be due to the fact that whilst investment subsidy might improve efficiency, it is not high enough to cause significant improvement. This would imply that RDP subsidies are not fulfilling their objective. However, we must keep in mind that farms might use other financial sources for investment and therefore the effect of RDP subsidies would not be that visible. The average RDP subsidy per one agricultural holding was only CZK 427 thousand, whereas annually direct payments brought the average farm CZK 3,507 thousand, AEM payments CZK 1,246 thousand and LFA subsidies CZK 1,424 thousand. Furthermore, the sample contained only a small number of farms in receipt of RDP subsidies. A sample with more subsidized farms is needed to obtain statistically significant results. In spite of this, we may still conclude that the effect of investment subsidies in the Liberecký region is negligible.

6. Conclusion

The aim of this article was to assess the impact of subsidies on farms' efficiency in the Liberecký region. The SFA analysis employed the Cobb-Douglas production function and a *true* fixed effects model. An average farm was less than 50% inefficient. On the other hand, the average farm produced only 72.74% of its potential production. As organic and conventional farms have different technology, we also tested for any statistically significant differences in inefficiency and efficiency between those two types of farm. We found none, which undermines the justification for the subsidization of organic farms. As the Liberecký region has a high share of unfavourable agricultural areas, organic land management is more appropriate and enables farms to be more technically efficient.

Regarding the subsidies, direct payments and AEM increased inefficiency and LFA and RDP decreased it. Only the AEM and LFA subsidies had statistically significant effects. Subsequently, we tested whether there were statistically significant differences in the average inefficiency and efficiency between farms receiving or not receiving the subsidies. Although in the majority of cases no differences were found, it was clear that inefficiency is higher when farms are subsidized by AEM and lower in the case of LFA and RDP subsidies.

This implies that subsidy policy is not optimally set. According to our model, had the AEM subsidies been lower, the inefficiency would have decreased and hence the farms could have been more efficient. Therefore, based on our calculations, we may suggest lowering the AEM subsidies. On the other hand, the situation with LFA subsidies is different. The Liberecký region is not optimal for intensive agricultural production and therefore the subsidies for LFA are important to ensure farms' viability. Our study demonstrates a positive and statistically significant effect of the payments on decreasing the variance of technical inefficiency.

We cannot reach definitive conclusions regarding RDP support. The RDP subsidies do not seem to have a desirable effect and do not stimulate agricultural holdings to invest in modernization. In this case, there could be a moral hazard problem. On the other hand, subsidies can lead to positive technological change that can increase productivity. Hence, more detailed research is needed.

In future research, other regions in the Czech Republic should be analysed and compared. More observations will also lead to statistically significant results, which could serve as a basis for decision making with regard to policy. Also, the impact of subsidies on other beneficiaries (municipalities or Local Action Groups) could be assessed.

References

AIGNER, D., LOVELL, C.A.K., SCHMIDT, P. (1977) Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics* 6(1): 21–37.
http://dx.doi.org/10.1016/0304-4076(77)90052-5

BATTESE, G.E., COELLI, T.J. (1988). Prediction of firm-level technical efficiencies with a generalised frontier production function and panel data. *Journal of Econometrics* 38(3): 387–399.

http://dx.doi.org/10.1016/0304-4076(88)90053-X

BATTESE, G.E., COELLI, T.J. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* 20(2): 325–332. http://dx.doi.org/10.1007/BF01205442

ČECHURA, L. (2012). Technical efficiency and total factor productivity in Czech agriculture. *Agricultural Economics* 58: 147–156.

ČECHURA, L., MALÁ, Z. (2014). Technology and efficiency comparison of Czech and Slovak processing companies. *Procedia Economics and Finance* 12: 93–102. http://dx.doi.org/10.1016/S2212-5671(14)00324-4

DOUCHA, T., FOLTYN, I. (2008). Czech agriculture after the accession to the European Union – impacts on the development of its multifunctionality. *Agricultural Economics,* 54: 150–157.

GREENE, W. (2005). Reconsidering heterogeneity in panel data estimators of the stochastic frontier model. *Journal of Econometrics* 126(2): 269–303. http://dx.doi.org/10.1016/j.jeconom.2004.05.003

GREENE, W. (2002). The behavior of the fixed effects estimator in nonlinear models. *Working paper*, No. 02–05: 1–31. New York: New York University.

JONDROW, J. et al. (1982). On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics* 19: 233–238.

KROUPOVÁ, Z. (2010). Technická efektivnost ekologického zemědělství České republiky. *ER-CEREI* 13(2): 63–75. http://dx.doi.org/10.7327/cerei.2010.06.01

KROUPOVÁ, Z., MALÝ, M. (2010). Analýza nástrojů zemědělské dotační politiky – aplikace produkčních funkcí. *Politická ekonomie* 58(6): 774–794.

KUMBHAKAR, S.C., LIEN, G., HARDAKER J.B. (2012). Technical efficiency in competing panel data models: A study of Norwegian grain farming. *Journal of Productivity Analysis* 41(2): 321–337. http://dx.doi.org/10.1007/s11123-012-0303-1

KUMBHAKAR, S.C., TSIONAS E.G, SIPILÄINEN, T. (2009). Joint estimation of technology choice and technical efficiency: An application to organic and conventional dairy farming. *Journal of Productivity Analysis* 31(3): 151–161. http://dx.doi.org/10.1007/s11123-008-0081-y

MALÁ, Z., ČERVENÁ, G., ANTOUŠKOVÁ, M. (2011). Analysis of the impact of common agricultural policy on plant production in the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 59: 237–244. http://dx.doi.org/10.11118/actaun201159070237

MEEUSEN, W., VAN DEN BROECK, J. (1977) Technical efficiency and dimension of the firm: Some results on the use of frontier production functions. *Empirical Economics* 2(2): 109–122. http://dx.doi.org/10.1007/BF01767476

OECD (2007). Policy design characteristics for effective targeting. *Working Party on Agricultural Policies and Marktes*, Paris: OECD.

PECHROVÁ, M. (2014). The impacts of the EU's subsidies on the production of organic farms. In: *Hradecké ekonomické dny 2014/V*. Hradec Králové: Univerzita Hradec Králové, 124–131.

PECHROVÁ, M. (2013). Efficiency of biodynamic farms. In: *22nd International Scientific Conference on Agrarian Perspectives – Development Trends in Agribusiness*. Prague: Czech University of Life Sciences Prague, 55–69.

PECHROVÁ, M., VLAŠICOVÁ, E. (2013). Technical efficiency of organic and biodynamic farms in the Czech Republic. *Agris on-line Papers in Economics and Informatics* 5: 143–152.

PITT, M.M., LEE, L-F. (1981). The measurement and sources of technical inefficiency in the Indonesian weaving industry, *Journal of Development Economics* 9(1): 43–64. http://dx.doi.org/10.1016/0304-3878(81)90004-3

SCHMIDT, P., STICKLES R.C. (1984). Production frontiers and panel data. *Journal of Business and Economic Statistics* 2(4): 367–374. http://dx.doi.org/10.2307/1391278

http://dx.doi.org/10.1080/07350015.1984.10509410

SPEELMAN, S., D'HAESE, M., BUYSSE, J., D'HAESE, L. (2008). A measure for the efficiency of water use and its determinangs: a case study of samll-scale irrigation schemes in North-West Province, South Africa. *Agricultural Systems* 98(1): 31–39. http://dx.doi.org/10.1016/j.agsy.2008.03.006

TRNKOVÁ, G., MALÁ, Z., VASILENKO, A. (2012). Analysis of the effects of subsidies on the economic behavior of agricultural businesses focusing on animal production. *Agris on-line Papers in Economics and Informatics* 4: 115–126.

Other sources

CZSO (Czech Statistical Office) (2011). *Charakteristika Libereckého kraje.* [Online], accessed at 27. 02. 2014. Available at: <http://www.czso.cz/xl/redakce.nsf/i/charakteristika_kraje>.

CZSO (Czech Statistical Office) (2009). *Vývoj zemědělství a lesnictví v Libereckém kraji.* [Online], accessed at 27. 02. 2014. Available at: <http://www.czso.cz/csu/2009edicniplan.nsf/t/3B00404BE0/$File/511361-09k3.pdf>.

Ministry of Agriculture (2013). *Program rozvoje venkova České republiky na období 2007–2013*. [Online], accessed at 25. 02. 2014. Available at: <http://eagri.cz/public/web/file/272493/PRV_schvaleno_08_2013.pdf>.

SAIF (State agricultural and interventional fund) (2012). *Seznam příjemců dotací.* [Online], accessed at 15. 07. 2012. Available at: <http://www.szif.cz/irj/portal/szif/seznam-prijemcu-dotaci>.