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Technical Efficiency of Organic and Biodynamic Farms in the Czech Republic

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Anotace

Cílem článku je vypočítat na panelových datech za roky 2005–2012 technickou neefektivnost resp. efektivnost biodynamických farem a porovnat ji s ekologickými. S využitím stochastické hraniční analýzy a t-testu jsme ověřovaly, jestli biodynamické farmy jsou při užívání svých vstupů méně efektivní než ekologické farmy. Byl také zjišťován vliv dotací na produkční schopnost a technickou neefektivnost farem.

Průměrná neefektivnost biodynamických farem byla vymezena ve výši 58.09 % a ekologických ve výši 28.60 %, přičemž byly zjištěny statisticky významné rozdíly mezi oběma skupinami. Zatímco přímé platby a podpory z fondu EAFRD produkci obou skupin zvyšovaly a ostatní dotace ji snižovaly, všechny typy dotací snižovaly technickou neefektivnost.

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Klíčová slova

Biodynamické a ekologické zemědělství, technická efektivnost, stochastická hraniční analýza.

Abstract

The aim of this paper is to estimate based on panel data from 2005–2012 the inefficiency and efficiency of biodynamic farms and compare it to the organic. Using stochastic frontier analysis and t-test we tested whether the biodynamic farms are less efficient in using their inputs than organic farms. Another concern was the impact of subsidies on the production and technical inefficiency of the farms.

The estimated average inefficiency of biodynamic was 58.09 % and of organic farms 28.60 % and we found statistically significant differences between both groups. While the direct payments' and support from EAFRD fund increased the production of both types of farms, and other subsidies' decreased it, all type of subsidies decrease the technical inefficiency.

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Key words

Biodynamic agriculture, organic agriculture, technical efficiency, stochastic frontier analysis.

Introduction

Biodynamic agriculture was developed based on a series of eight lectures by Rudolf Steiner in 1924 as one of the first responses to the proliferation of chemical usage in agriculture (Paull, 2011). Current biodynamic agriculture is a form of organic farming that, in addition to the common tools of organic agriculture, as soil building, composting, and crop rotations (Matteo et al., 2013), uses specific biodynamic preparations (Steiner, 2004) as compost additives and field sprays. These preparations are included in the list of materials and techniques permitted in organic farming by an EC Regulation (834/2007). Biodynamic agriculture became the subject of surveys during the past decades. The existing researches in this area are more focused on the effects of biodynamic preparations and their impact on soil and crop quality and profitability, as well as impacts on the physical, chemical and biological properties of soil (e.g. Turinek, 2011; Matteo et al., 2013), whereas an economic efficiency of biodynamic farms was never (as far as we are concerned) examined.

In this paper, the frontier production function models are proposed and estimated with a panel data on Czech organic and biodynamic farms. The structure of the article is as follows. After the introduction to the problematic of the technical efficiency measurement, the methodology is presented. In the results section the alternative models are estimated and the inefficiency is calculated. Last section summarizes the results and brings conclusions.

1. Technical efficiency of organic farms

Organic agriculture is a form of land management where the use of chemical inputs is limited; hence it is more environmental friendly. It contributes to animals' welfare, human health, environment protection and biodiversity. Biodynamic agriculture goes beyond and relates the land management with philosophy. Like organic agriculture, biodynamic agriculture has a certification process. The need to comply with set rules has the impact on farms' performance. "Competitiveness is influenced by the duties and restrictions resulted from the observance of the rules of law and as well by the prices that do not often relate to the quality of production." (Jánský et al., 2006)

Despite having higher market prices of organic products, the profitability of organic farms might be lower if the productive differential between conventional and organic is not compensated. The lower productivity is an argument for justification of financial support. Organic farms can benefit not only from direct payment – Single Area Payment Scheme (SAPS) per hectare of agricultural land, but moreover they obtain support from agri-environmental measures (AEO). Until 2013 also national subsidies (Top-up) were available. However, their effect on the farm economic results is not only positive. Subsidies might support the survival of inefficient farms and further lowers their competitiveness. Such an ambivalent effect of public support has already been observed in many studies. For example Bakucs et al. (2008) analysed the impact of the entrance to the EU on the Hungarian farmers and concluded that the subsidies together with technological progress had negative impact on the otherwise positive development of the technical efficiency of the farmers. Kumbhakar et al. (2009) proclaimed that only technically efficient organic farmers should be compensated. In other words, the finances might be provided only to the farms, where the productivity differential is due to technological difference and not due to technical inefficiency. "Subsidies should be designed in a way that they do not promote inefficiency." (Kumbhakar et al. 2009)

Technically efficient production is defined as "the maximum quantity of output attainable by given input" (Pitt and Lee, 1981). Regarding the technical efficiency of organic farms in the Czech context a study of Kroupová (2010) can be mentioned. She concluded that organic farmers are by 13.5 % less efficient in comparison with conventional farms. „In average, the organic farms are moving on 55.1 % of the potential production, although 50 % of surveyed organic subjects achieve less than 50.1 % of the technical efficiency" (Kroupová, 2010). Čechura (2012) used the Fixed Management model for the estimation of technical efficiency and the construction of TFP for the total agriculture and its individual branches. He came to the conclusion that "technical inefficiency is an important phenomenon in Czech agriculture and its individual branches" Čechura (2012).

The influence of EU's subsidies on the technical efficiency of the Czech agriculture was examined by Čechura and Matulová (2011). They used model with random parameters to estimate stochastic frontier (SF) of different sectors and examined the technical efficiency and the impact of the subsidies on it. They found out that the differences in technical change between livestock and plant production were not statistically significant. Hence, the direct payments meant to support this change did not motivate the farmers to invest into new technologies. Antoušková et al. (2011) assessed the impact of subsidies on the production ability, cost efficiency, and profit of the conventional and organic farms. They found that cancellation of the payment on permanent grasslands and lowering of the payment on arable land would contribute to the profit and production increase. Malá et al. (2011) examined the subsidies effect on the farms in plant sector. They concluded that direct payments lower the amount of production. In livestock production, the effect of payments tied to hectares is only indirect via own feed production and consumption while hog and poultry producers do not receive subsidies at all. Trnková et al. (2012)

examined the effect of subsidy policy on technical efficiency of livestock production. They estimated frontier function using Battese and Coelli (1992) model with heterogeneity and found that subsidized farms produce only 44.6 % of the potential product, while those without subsidies achieve 60.4 %.

Materials and methods

The aim of this paper is to estimate based on panel data from 2005–2012 the inefficiency and efficiency of biodynamic farms and compare it to the organic. The analytical part utilizes the data from the organic farmers register administrated by the Ministry of Agriculture of the Czech Republic. It contains the information about the total farms' acreage. This database was combined with Albertina (managed by Bisnode Česká republika, a.s.) which includes bookkeeping information from balanced sheets and profit and loss statements of the legal persons. Prices indexes were obtained from Czech Statistical Office. The amount of subsidies received by each farm was acquired from database of State Agricultural Interventional Fund. Official prices of farmland came from a study of Pírková (2013).

In order to assess the technical efficiency of the organic and biodynamic farms, SFA was used. We considered alternative specifications of "true" fixed effect (TFE) model as suggested by Green (2002) and estimated Cobb-Douglas production function. Subscript i $(i = 1, 2, \ldots, N)$, where N is total number of farms, represents particular farm and t $(t = 1, 2, \ldots, T)$ stays for a time period for which are available farm's observations. Company's production (y_{it} – output) is represented by the sales of own products and services and change of the stock of own activity in particular year (in thousands of CZK). In order to remove the impact of price changes, the production was deflated by the price index of agricultural producers for particular year (2005 = 100).

Material ($x_{1,it}$) is represented by the amount of consumed material and energy by $i^{(th)}$ farm in time t. To remove the influence of price changes from data it was deflated by the industrial producers' price index (2005 = 100). Similarly capital ($x_{2,it}$), consisting of long-term assets of $i^{(th)}$ farm in time t was deflated.

Labor ($x_{3,it}$) is calculated as the division of personal costs of $i^{(th)}$ agricultural holding in time t by average wages in agriculture in particular region. The data for wages were available for years 2005 to 2010, for others were estimated from linear trend function. For companies with no employees was assumed that there is at least one owner and the labor input was set to 1.

The acreage of farmland (input land – $x_{4,it}$) was corrected to take into account land quality. The actual land price for $i^{(th)}$ farm was multiplied by normalized (official farmland price in a region divided by the maximum price from all regions in particular year). Official prices of farmland in the Czech Republic are on the basis of quality soil-ecological unit (BPEJ) and reflect the climatic region, type of soil, slope, exposure, and depth of the soil profile and stoniness. The data were available for years 2009–2012, but as the prices were not much volatile, they were predicted for other years by linear trend function.

Sum of SAPS and Top-up subsidies was included in variable x_5. Subsidies related to the AEO were summarized with support for Less Favored Areas (LFA) and Rural Development Program (RDP) in variable x_6. Variable x_7 contained all other direct payments.

We used dummy variable (*Dummy*) taking value of 1 when the farm was biodynamic. Dummy variables were utilized also to distinguish the region where the farm was situated. The composite error term consisted of the noise and inefficiency $(\varepsilon_{it} = v_{it} - u_{it})$.

First approach towards the assessment of the subsidies' effect is to estimate the SF function, quantify the inefficiency and then in second step construct separate inefficiency function, where the u_{it} is explained by various factors. Despite being widely used, this procedure violent the basic assumption about the inefficiency term (i.e. that it is independently distributed). Therefore, better approach, which we also used, is to include the subsidies directly in the SF function. As suggested by Kroupová (2010) we considered subsidies and localization of the farm as explanatory variable in linear function of the variance of the inefficiency term. We only changed the localization in LFA for the region.

Model A

We considered the inefficiency term to be homoscedastic, i.e. with constant variance. The SF function (1a) linearized as (1b) consisted of production factors (inputs) and a dummy variable for biodynamic agriculture (added in non-logarithmic form).

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

$$\ln y_{it} = \beta_1 \ln x_{1,it} + \beta_2 \ln x_{2,it} + \beta_3 \ln x_{3,it} \quad (1b)$$

The inefficiency term was half normally (2a) and stochastic noise normally distributed (3). These assumptions were similar for all models.

$$u_{it} \sim N^+(0,\sigma^2) \quad (2a)$$

$$v_{it} \sim N(0;\sigma_v^2) \quad (3)$$

Model B

Second model was extended to take into account heterogeneity among farms and the heteroscedasticity in inefficiency term (2b). Inefficiency variance function included as explanatory variables constant and subsidies (x_5 – direct payments, x_6 – support from EAFRD including those for organic farming and x_7 – others). The specification of frontier function is the same as stated above (1a, 1b).

$$u_{it} \sim N^+(0,\sigma_{it}^2) = N^+(0,\omega_1 + \omega_2 x_{5,it} + \omega_3 x_{6,it} + \omega_4 x_{7,it}) \quad (2b)$$

Model C

The specification of the third model enlarged the frontier function of subsidies (1c) and explained the variance in the inefficiency term by dummies for NUTS II regions, where the farm was situated (2c).

$$\ln y_{it} = \beta_1 \ln x_{1,it} + \beta_2 \ln x_{2,it} + \beta_3 \ln x_{3,it} + \beta_4 \ln x_{4,it} + \beta_0 Dummy + \beta_5 \ln x_{5,it} + \beta_6 \ln x_{6,it} + \beta_7 \ln x_{7,it} + v_{it} - u_{it} \quad (1c)$$

$$u_{it} \sim N^+(0,\sigma_{it}^2) = N^+(0,\ \omega_1 + \omega_5 MS + \omega_6 NE + \omega_7 NW + \omega_8 SC + \omega_9 SM + \omega_{10} CM) \quad (2c)$$

where *MS* represents Moravian-Silesian region, *NE* North East, *NW* North West, *SC* South Bohemia, *SM* South Moravia and *CM* Central Moravia. All regions are compared to Central Bohemia. There was no farm from Prague, therefore the region was omitted.

Farms with incomplete data and those with only one observation (1 farm) were excluded from a sample. Final unbalanced panel of 48 farms (including 4 biodynamic) and time period from 2005 to 2012 contained 293 observations (24 for biodynamic farms).

We compared the estimated models according to Akaike (AIC) and Bayes (BIC) information criteria. To test the specification of the model we used likelihood-ratio (LR). To calculate the inefficiency of particular farm the Jondrow et al. (1982) estimator was used. The efficiency was estimated via $e^{-E(u|e)}$.

The statistical significance of the differences in mean and standard deviation in technical inefficiency (or efficiency) between biodynamic and organic farms was tested by t-test and F-test. We assumed that biodynamic farms would be less efficient in resources usage than classical organic farms because of technology's specifics.

The calculations were done in econometric software Stata version 11.2. Descriptive statistics and tests were elaborated in software Statistica version 10.

Results and discussion

There were 2 689 organic farms in the Czech Republic in 2009. (Darmovzalová et al., 2010) Since 1990, where there were only 3 farms farming on 480 ha, but since 1992 the number increased every year by average 18.49 %. However, the developments varied from 0.84 % to 64.93 % inter year change. There was mild decrease between 1994 and 1995 due to the problems with certification and in 2004 after the entrance of the CR in EU. Over 10 % of the agricultural land in the Czech Republic is farmed organically, which is above average of the EU. On the other hand, there are only three certified biodynamic farms with average size of 445 hectares (Demeter certificate holders) and few others farming the land in biodynamic way. In spite of limited sample of biodynamic farms; the analysis provides useful view to the problematic. Despite that biodynamic farms use less material, capital and labor, they produce higher average output. On the other hand, they utilize more land, which points out on more extensive way of production.

As expected, the standard deviation of production, labor and land is much higher in biodynamic holdings than in organic farms. In total, standard deviation of production is over two times higher than mean production, standard deviation of consumed material is almost twice higher than an average of it, standard deviation of used capital is also higher than mean (1.5 times) as same as it is the case of labor (1.3 times). Only standard deviation of land is lower than its mean. This points out on huge differences and high heterogeneity among farms. The summary statistics of the panel for years 2005 to 2010 are presented in Table 1.

Type	Var	Mean	Min.	Max.	Std. Dev.
Biodynamic farms	y_{it}	223 406	239	1 187 023	388 059
	$x_{1,it}$	4 402	4	16 691	5 660
	$x_{2,it}$	23 005	368	98 185	33 348
	$x_{3,it}$	20	1	117	36
	$x_{4,it}$	352	7	919	318
Organic farms	y_{it}	56 942	27	720 867	102 074
	$x_{1,it}$	32 045	65	543 283	58 842
	$x_{2,it}$	68 131	655	696 963	102 384
	$x_{3,it}$	101	1	933	130
	$x_{4,it}$	277	.4	847	256
All farms	y_{it}	70 624	27	1 187 023	153 492
	$x_{1,it}$	29 773	4	543 283	56 897
	$x_{2,it}$	64 422	368.1	696 963	99 298
	$x_{3,it}$	94	1	933	126
	$x_{4,it}$	283	.4	919	262

Source: own processing

Table 1: Summary statistics for biodynamic, organic and all farms in a panel.

T-test was used to assess whether there are statistically significant differences in the amount of production between organic and biodynamic farms. It proved that means of both groups are statistically significantly different from each other with the exception of land input. Therefore we included explanatory variables for farms heterogeneity in models B and C. The results of various specification of TFE are discussed below and displayed in Table 2.

1. Model A

Firstly, only explanatory variables of the production frontier were inputs and dummy variable taking value of 1 for biodynamic farm. We supposed that these alternative farms will have lower production than conventional organic farms. All coefficients, with exception of land were statistically significant at least at 0.05 level. As expected, an increase of each production factor (i. e. material, capital, labor and land) causes an increase of the production.

If the farm is biodynamic, the value of production is by 1 959 CZK higher. This might be due to the majority of organic farms in the Czech Republic maintain permanent grasslands and are not realizing this production on a market. According to Darmovzalová et al. (2010), there were 330 thousand ha of permanent grasslands in 2009 which accounts to 82 % of total land in organic agriculture. Hence, the most of the production of farms (grass) is not reflected in sales or stocks (i.e. in production). On the other hand, biodynamic farms work on self-sustain principle and probably produce more market products.

The coefficient λ implies that the SF function differs significantly from the regular production function. Hence, the technical inefficiency is significant and must be taken into account.

2. Model B

Second model took heteroscedasticity in account. The variance in inefficiency among farms can be caused by various factors which are farm-specific. Firstly, the subsidies were considered because they condition the rational behavior of the farms which consequently reflects in their technical efficiency. Coefficients in frontier function were statistically significant for material, capital and labor. The interpretation of all inputs is similar to this in Model A. Again the highest influence on production had labor.

The results showed that subsidies had positive influence on the inefficiency of the farms. As it can be seen from variance of the inefficiency term function, if the SAPS and Top-up subsidies increase, the inefficiency decreases. The increase of EAFRD finances caused the decrease in the inefficiency as same as the other subsidies. The influence is statistically insignificant for other subsidies and for the constant. However, the influence is very mild. The information criteria (AIC, BIC) and likelihood-ratio test favor this model to Model A.

3. Model C

Another possibility how to assess the differences among agricultural holdings is to include the regions where they farm in a form of dummy variables in the equation explaining variation of the inefficiency term. The model included 6 NUTS II regions (without Prague) which were compared to Central Bohemia. The subsidies were included in SF as one of the inputs in order to assess their impact on production.

As the results show, if material, capital, labor or land input increase by 1 %, the production increase by less than 1 %. Coefficient of dummy variable implies that if the farm is biodynamic, the production is about 9692 CZK higher. SAPS and Top-up subsidies surprisingly contribute to the production increase. Despite that the effect is only mild, it is contrary to the expectations. SAPS were designed by McSharry reform in 1992 to decouple the provided financial support from the production. This was to mitigate former overproduction. Our results are also not in line with those of Malá et al. (2011). They came to the conclusion that "direct payments have a negative effect on the production of [conventional]

	Model A	Model B	Model C
Frontier			
β_1 (ln $x_{1,it}$)	.231366 (.082008)***	.278999 (.969192)***	.5888342 (.036666)***
β_2 (ln $x_{2,it}$)	.23053 (.102507)**	.218020 (.070309) ***	.135924 (.102999)
β_3 (ln $x_{3,it}$)	.431208 (.117102)***	.351256 (.068899)***	.458056 (.122556)***
β_4 (ln $x_{4,it}$)	.316692 (.255802)	.320977 (5.28185)	.118381 (9.141763)
β_0 (*Dummy*)	1.958705 (.442143)***	2.40183 (22.47924)	9.691662 (62.072170)
β_5 (ln $x_{5,it}$)			.0186726 (.006884)***
β_6 (ln $x_{6,it}$)			.000789 (.002250)
β_7 (ln $x_{7,it}$)			-.000461 (.002391)
Inefficiency variance function			
ω_1 Constant		.285698 (244600)	-1.95460 (.817384)
ω_2 ($x_{5,it}$)		-4.03e-07 (1.38e-07) ***	
ω_3 ($x_{6,it}$)		-2.42e-07 (5.52e-08) ***	
ω_4 ($x_{7,it}$)		-6.29e-08 (4.35e-08)	
ω_5 (Moravian-Silesian)			1.180455 (.861589)
ω_6 (North East)			-.034465 (.837477)
ω_7 (North West)			1.613818 (.888546)*
ω_8 (South Czechia)			.959242 (.950446)
ω_9 (South Moravia)			.370090 (.811116)
ω_{10} (Central Moravia)			.651117 (.861244)
Information criteria			
Prob > χ^2	.0000	.0000	.0000
Log likelihood	-52.7185	-9.7445	-11.1084
AIC	205.4369	135.4890	122.2167
BIC	389.1031	348.5418	305.8829
λ	.986848 (.049129)***	.580024	.420721
σ_u	.580024 (.049129)***	.420721 (N/A)	.523008 (N/A)
σ_v	5.88e-08 (5.18e-06)	.127466 (.011326)***	6.49e-07 (6.81e-06)
Returns to scale			
RTS	1.209796	1.169252	1.301195

Note: Estimated standard errors in parentheses; Statistical significance: -) coefficient is not significant, *) α = 0.1; **) α = 0.05; ***) α = 0.01; N/A = not available
Source: own processing

Table 2: Estimated SF – TFE model.

agricultural businesses." Increase in direct payments by 1 % caused decrease in production by 0.19 % in their case. Kroupová and Malý (2010) focused only on organic farms and identified the same impact of the direct payment, but the effect was milder). Increase in direct payments by 1 % caused decrease in production by 0.10 % in the second case. In our case, the increase of SAPS and Top-up causes increase in production by 0.02 % and subsidies from EAFRD (AEO, LFA and investments RDP) increase of 0.0008 %. On the other hand, other subsidies cause mild and not statistically significant decrease of production by 0.0005 %. The impact of the region on inefficiency is statistically significantly only in case of North West. Assessment by the information criteria preferred this model to the previous one.

4. Returns to scale

The sum of variables' coefficients was higher than 1 in all models, hence there are increasing returns to scale. Model A, B and C estimated that 1% increase of inputs causes 1.21%, 1.17% or 1.30% increase of outputs, respectively. This might be explained by the fact that organic farms are large. Despite that the average size of organic farm is steadily decreasing since 2001, when it was the highest, it is still true, that the acreage of average organic farm is higher than conventional. (Darmovzalová et al. 2010).

5. Efficiency and inefficiency

Estimated models suggested that the inefficiency of organic and biodynamic farms is between 28.93 % (Model B) to 32.40 % (Model A). Model B, where subsidies were included in inefficiency variance function, predicted the lowest inefficiency. However, when the subsidies are added to the production function (Model C), the inefficiency is higher. The farms are using their resources only from 77.73 % (Model A) to 79.30 % (Model B). The comparison of inefficiency and efficiency estimated by each model is presented in Table 3.

6. The differences between biodynamic and organic farms

The hypothesis about lower efficiency of biodynamic farms was tested. Table 4 displays the inefficiency and efficiency estimates for biodynamic and organic farms. It can be observed that biodynamic farms are more inefficient and less efficient than the conventional ones. According to Model C the biodynamic farms produce only 65.94 % of the potential output, while

	Model A	Model B	Model C
Estimated technical inefficiency			
Mean	.324022 (.481949)	.289280 (.431714)	.310360 (.436934)
Min.	2.82e-07	.000010	2.13e-06
Max.	3.900815	3.667509	3.689260
Estimated technical efficiency			
Mean	.777346 (.212949)	.793042 (.190702)	.779671 (.203975)
Min.	.020225	.025540	.024991
Max.	1.000000	.999990	.999998

Source: own processing

Table 3: Estimated technical inefficiency and efficiency.

	Model A	Model B	Model C
Technical inefficiency			
Biodynamic farm	.517502	.517726	.580942
Organic farm	.305587	.268746	.286038
Technical efficiency			
Biodynamic farm	.683780	.680192	.659445
Organic farm	.782825	.803184	.790477

Source: own processing

Table 4: Technical inefficiency and efficiency according to the type of a farm.

	Mean		t-value	p-value	Std. Dev.		F-ratio	p-value
	Organic farms	Biodyn. farms			Organic farms	Biodyn. farms		
Inefficiency	.286038	.580942	-3.217920	.001438	.393756	.728535	3.423316	.000001
Efficiency	.790477	.659445	3.057600	.002440	.271045	.271045	1.954585	.013321

Source: own processing

Table 5: Difference in mean and standard deviation in technical inefficiency and efficiency.

the organic holdings produce 79.05 %. Model B and C give analogical results. Model B predict the highest efficiency of organic farms (80.31 %) and Model B of biodynamic (68.38 %).

Based on the AIC and BIC, we use model C for consequent analysis. The results of the t-test and F-test are displayed in Table 5. We came to the conclusion that there are statistically significant differences between biodynamic and organic agriculture in technical inefficiency and efficiency. These differences are statistically significant both in mean and also in standard deviation (on 0.05 significance level).

As there are no other researches on the biodynamic technical efficiency, it is not possible to compare our results with other findings. However, we can consider the situation to be analogical to the comparison of organic and conventional farmers. It has been proved that conventional technology is more productive and that the organic farms are, on average, less technically efficient than conventional farms. (Kumbhakar et al., 2009; Kroupová, 2010). Therefore our results correspond to the reality. Despite that the biodynamic farms are producing more, their technical inefficiency is higher.

Conclusion

The aim of the paper was to estimate the technical inefficiency and efficiency of the organic and biodynamic farms. Based on SFA and estimation of the TFE model the inefficiency of all farms in the sample was 31.04 % which was according to expectation, but lower than in Kroupová's (2010) study.

Because the organic farming is subsidized, another concern was the impact of subsidies on the production and technical inefficiency of the farms. SAPS and Top-up were decoupled from production in 1992 in order to limit overproduction. Therefore we supposed negative impact on the production. However, our model predicted slight increase. This shows that direct payments still are not clearly fulfilling their purpose and are not fully decoupled from production. The situation might change after introduction of Single Payment Scheme after 2014, where a single payment per farm will be applied. Subsidies under RDP had positive impact on production possibilities of the farms as expected. Our assumption that subsidies will lower the inefficiency of organic farms was proved. The effect, despite being mild, was even statistically significant with exception of other subsidies. Hence, the financial support for agricultural holdings seems to be justified.

We found statistically significant differences in the inefficiency and efficiency of resources usage between biodynamic and organic farms. The first mentioned produce only 65.94 % of the potential output, while the organic 79.05 %. Therefore, some farmers farming biodynamically should reconsider their stay in a business. If they are not able to use their production factors efficiently, they should rather leave this type of land management and maintain only organic type. This does not mean that they would necessary produce more output in organic regime, but they can increase their efficiency by up to 13.09 %. Another possibility is that they remain in business, but will modify their production technology to be more efficient.

The challenge for future research is to use data also from foreign countries and compare the technical inefficiency among them.

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