TECHNICAL EFFICIENCY OF STARTING VERSUS ESTABLISHED AGRICULTURAL HOLDINGS

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Abstract

Setting up of young farmers' businesses is supported by agricultural policy, but it is suggested supporting starting farmers regardless the age because all of them face similar problems. The aim of the paper is to examine whether there are differences in technical efficiency between "new" and well-established farms. It is supposed that starting farmers are at the beginning less technically efficient and their support is justified.innovation

We considered farms established in 2013–2017 (82 observations) as starting, others were founded in 1995–2012 (2 099 observations). Stochastic frontier analysis was chosen to model the Cobb-Douglas production function. Production (sales) was explained by the consumption of material and energy, long-term assets and land. True fixed-effects model with half normal distribution of inefficiency term was used to calculate the technical efficiency. Differences between groups of farms were tested by Wilcoxon rank-sum test.

Average technical efficiency was 85.27%, while established farms were efficient from 85.63% and starting farms from 76.14%. Test revealed that despite that starting farms seem less efficient, there were no statistically significant differences found. Support for starting farmers cannot be clearly justified by lower efficiency of new farmers, but by other issues that are targeted by agricultural policy.

Key words: agriculture, start-up, stochastic frontier analysis, technical efficiency

JEL Code: C23, C12

Introduction

Current discussions about preparation of new Common Agricultural Policy (CAP) after year 2020 are also concerned with generation renewal in agriculture to ensure viability and competitiveness of the sector. "Through its programs, the EU seeks to mitigate the situation by allocations especially for small and medium farms, those with conditions disfavoring, constraints and even the cessation of certain allowances for holding very large, stimulating young farmers setting up new farms medium sized organization of small farmers in the marketing structures of production, etc." (Gradinaru and Mocuta, 2017)

Number of employees and number of agricultural managers in agriculture has decreased during last decades (partly thanks to technical advance and higher productivity, partly due to lack of interest of people to work there). Efficiency of employment in agriculture was examined for example by Cyrek (2017). For successful functioning of the sector, especially the entrance of new managers of agricultural holdings is needed. "There is a decline in farmers, forcing European Union to establish different policy measures and motives for new entrants in agriculture" (Kontogeorgos, Tsampra and Chatzitheodoris, 2015) However, start-ups in agricultural sector faces many difficulties, such as lack of land and finances. According to the survey of Šimpachová Pechrová et al. (2018) based on answers of 510 young farmers, the hardest was to purchase the agricultural land, administrative burden and ensuring the finances for the development and for start-up. Hence, there are policy incentives to attract young people, but it is suggested to support also all newcomers. "Newcomers are characterized by their profiles (female and higher education), the barriers they face (access to land, capital and markets) and by the business models that they adopt (pluriactive and multifunctional)." (Rico and Fuller, 2016)

Research about the impacts of the CAP on young farmers is wide. In Latvia, the research of Krisane and Pilvere (2016) found that support measures for young farmers from Rural Development Program played a crucial role in founding or inheriting farms. Kontogeorgos, Tsampra and Chatzitheodoris (2015) assessed perception of Greek young farmers about their role as environmental protectors. Incentives provided from CAP to farmers in Lithuania to observe agricultural practices beneficial for the climate and the environment beyond their mandatory requirements were examined by Balezentis et al. (2019).

The paper of Rumanovska (2016) analyses impact of the implementation of CAP 2014–2020 on development of agriculture in Slovak Republic. According to her findings "For young farmers in Slovakia (0,02% share on total EU young farmers) is supposed to be such a measure crucial for reaching competitiveness for their farms and even to increase the number of young farmers." According to Burny and Gavira (2015) 42% of the farmers in Wallonia will lose between 2014 and 2019 due to the implementation of the CAP, while 44% will gain and for 14% the situation will not change. They consider the situation politically acceptable as there is given more support to small farms, young farmers and cattle breeders, despite that the finances for direct payments will decline.

The young farmers and newcomers are often considered as a benefit for the sector because they can bring new view and innovations. It is due that firms' innovation activities are linked to intellectual assets (Zygmunt, 2019). Newcomers are forming a new and dynamic group in European rural society and are contributing to strong social motivations and practices to farming. (Rico and Fuller, 2016) Therefore, the paper focuses on the technical efficiency of newcomers to agriculture. The aim is to find out whether there are differences in technical efficiency between farms that are "new" and those which are well established. It is supposed that farmers that are setting up their business are at the beginning less technically efficient then the well-established farms. Hence, the support from grants can be justified by this deficiency in technical efficiency.

1 Data and Methods

Data about 593 farms (2181 observations) were obtained from database of accounting data Albertina and from Land parcel information system (LPIS) for years 2013–2017. We divided our sample on "new" and "other" farms. New starting farms were established in last five years between period 2013 to 2017 (82 observations), while other farms were founded between 1995 and 2012. The panel was unbalanced; on average, there was 3.7 observation per one firm. Only farms with more than 2 years data were considered in calculation.

Production is represented by sales of own products and services (y_{it}) of particular farm i in time t. It is adjusted by agricultural producers' price index (2010 = 100) as the inflation changes the real value of the production in time. Material ($x_{1,it}$) is the amount of consumed material and energy by i^{th} farm in time t. Capital ($x_{2,it}$) consists of tangible long-term assets of i^{th} farm in time t. Both variables were deflated by the industrial producers' price index (2010 = 100) to remove the influence of price changes. All above stated variables are in thous. CZK. Labour ($x_{3,it}$) is represented by number of employees from Albertina database. The acreage of farmland in hectares (input land – $x_{4,it}$) was obtained from LPIS database.

Stochastic frontier analysis was chosen to model the production function. It has the advantage that is parametric and stochastic and disadvantage that it requires certain functional form. We chose linearized form of Cobb-Douglas power function (1).

$$\begin{aligned} &\ln y_{it} = \beta_0 + \beta_1 \ln x_{1,it} + \beta_2 \ln x_{2,it} + \beta_3 \ln x_{3,it} + \beta_4 \ln x_{4,it} + v_{it} + u_{it}, \\ &i = 1,\dots,N; t = 1,\dots,T \end{aligned} \tag{1}$$

where t stands for time period, i marks the farm, β_0 is constants and β_1, ..., β_4 are coefficients of explanatory variables x_1, ..., x_4.

An error (composite error term) consists of two terms: v_{it} is firm specific stochastic idiosyncratic term that locates the firm on the frontier and is normally distributed ($v_{it} \approx N\left[0,\sigma_v^2\right]$ and u_{it} that is an inefficiency term which has half-normal, truncated-normal, exponential or gamma distribution). We choose half normal distribution $u_{it} \approx N\left[0,\sigma_u^2\right]$, because there is a possibility to add the explanatory variable in variance of inefficiency function to explain the heteroscedasticity. In our case, it is explained only by a constant. Technical efficiency was estimated by Jondrow et al. (1982) via $\exp^{[-E(u|e)]}$. Technical efficiency can reach values between 0 and 1 (or 0% to 100%) when the farms with 100% efficiency lie on the efficiency frontier. Farms with lower value than 1 are less efficient in the transformation of inputs to outputs. Calculations were done in statistic software Stata/IC version15.1.

2 Results

Majority of companies in an original sample was founded between 1995 and 2000. There were 1594 observations (70.28%) for them. 438 observations were for farms established in 1996.

Only farms with more than 1-time occasion were considered in a calculation, so from originally 2 268 observations, only 2 181 was included in the calculation. It represented 593 farms. As the panel is unbalanced, the number of firms changed every year. There was 548 of them in 2013 and only 159 in 2017, despite that there were new farms established between 2013 to 2017. Naturally, the least observations were for year 2016 and 2017.

The results of True fixed-effects model are displayed at Tab. 1. Initially, all variables were included into the production function. However, labour was statistically insignificant. The result was also not according to the expectation, as the sign was negative suggesting that increase of those two variables by 1% cause decrease of production by 0.001%.

Therefore, labour was omitted from the model. In a second model with three explanatory variables all parameters were statistically significant and also the model as a whole was statistically significant (Wald χ^2 = 672.10 and its p-value is 0.00). Increase of material consumption by 1% brings increase of production by 0.32%, increase of capital by 1% is less intensive, increase of production will be only by 0.31%. If the land increases by 1%, production increases by 0.14%. 95% confidence intervals show where the value of the coefficients will be with the 95% probability.

Constant in the function of mean of the inefficiency term was negative as same as the constant in the function of variance of the inefficiency term. Estimated parameter lambda is the estimate of the ratio of the standard deviation of the inefficiency component to standard deviation of the idiosyncratic component $\lambda = \sigma_u / \sigma_v$. It is statistically significant suggesting evidence of technical inefficiency in the data (i.e. null hypothesis of no technical inefficiency effects is rejected). It can be concluded that a significant amount of the variation in the composite error term is due to the inefficiency component.

Tab. 1: True fixed effects model with half normal distribution of inefficiency term

ln *y*	**Coefficient**	**Std. error**	**z**	**P > z**	**[95% confidence interval]**	
Frontier						
β_1 [ln x_1]	0.3248	0.0195	16.6400	0.0000	0.2865	0.3630
β_2 [ln x_2]	0.3057	0.0239	12.8100	0.0000	0.2590	0.3525
β_4 [ln x_4]	0.1361	0.0292	4.6700	0.0000	0.0790	0.1933
Mean of inefficiency term function						
constant	-1.7659	0.0344	-51.3100	0.0000	-1.8334	-1.6984
Variance of inefficiency term function						
constant	-27.2591	2.1470	-12.7000	0.0000	-31.4672	-23.0510
σ_u	0.4136	0.0071	58.1100	0.0000	0.3998	0.4277
σ_v	1.2045×10^{-6}	0.0000	0.9300	0.3520	0.0000	0.0000
λ	343389	0.0071	4.8000×10^{7}	0.0000	343388	343389

Source: own elaboration

Technical efficiency was calculated by Jondrow et al. (1982) estimator. The results are displayed at Tab. 2. Average technical efficiency of the whole sample was 85.27%, half of farms was more efficient than 90.80%. 25% of farms was less efficient than 79.01% and 25% more efficient than 99.99%. Longer time established farms were efficient from 85.63% and starting farms only from 76.14%. Medians of both types of farms were, however, more similar – 90,80% in case of other farms versus 88,33% in case of new farms. It was tested by non-parametric two-sample Wilcoxon rank-sum test whether there are differences in technical efficiency between new and other farmers. H_0: $\mu_0 = \mu_1$ was not rejected. Probability that those technical efficiencies are equal was 0.52 (z value 0.65). Probability that technical efficiency of other farms is higher than of new farms was 0.52. Hence, we cannot conclude that other farms are more technically efficient than new farms as it seems that they are equal.

Tab. 2: Technical efficiency

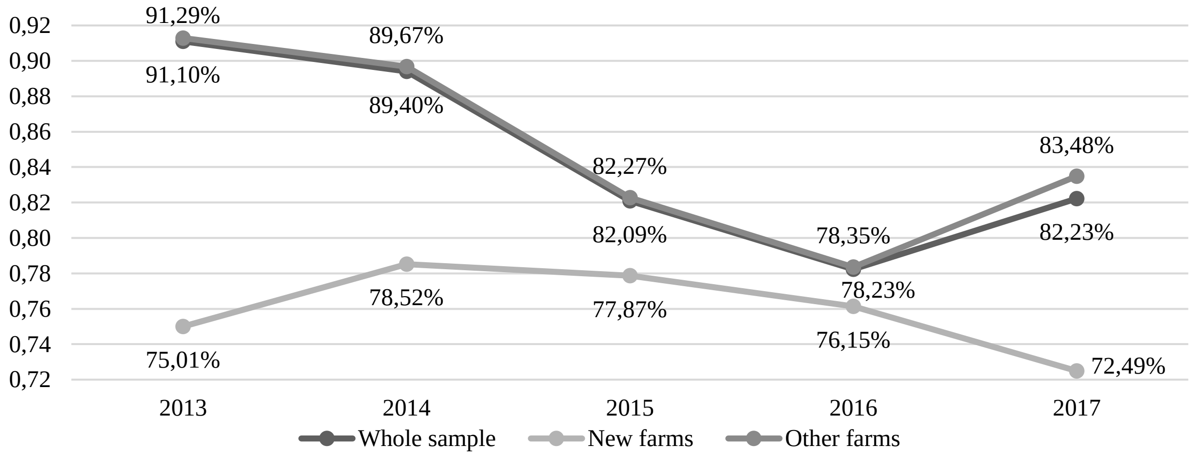
	Observations	**Mean**	**Median**	**Std. dev.**	**Minimum**	**Maximum**
Whole sample	2 181	0.8527	0.9079	0.1837	0.0310	1.0000
New farms (1)	82	0.7614	0.8833	0.2822	0.0310	1.0000

Other farms (0)	2 099	0.8563	0.9080	0.1779	0.0979	1.0000

Source: own elaboration

We examined further the development of technical efficiency among farms in time. From Fig. 1 can be seen that technical efficiency of new farms was lower during the whole period. However, there was not enough observation in each year that would allowed statistical testing of the differences. For example, there were only 6 new farms in 2013 that were efficient from 75.00% only. We cannot clearly prove on our sample that the differences are significant.

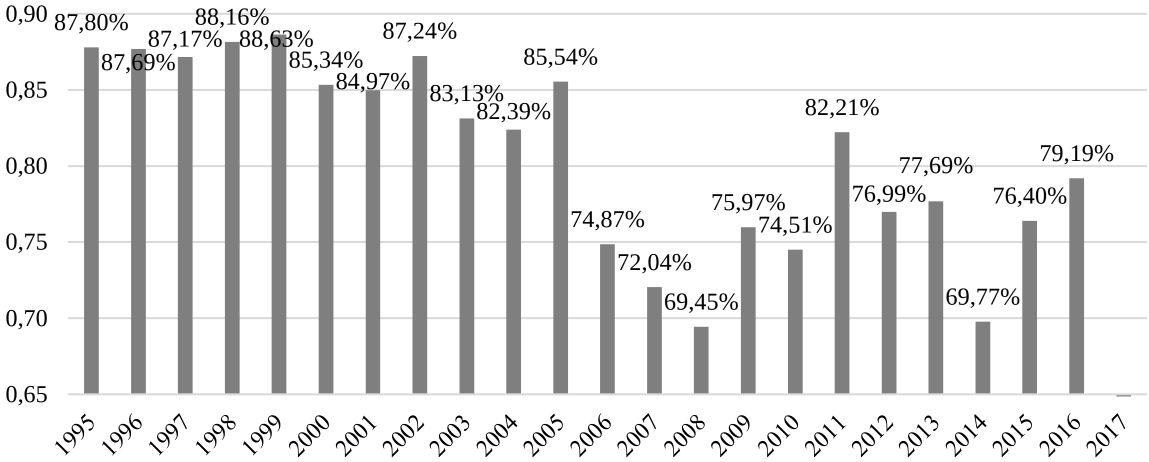
Fig. 1: Development of technical efficiency among farms from 2013 to 2017



Source: own elaboration

Fig. 2 displays the development of technical efficiency according to the year of establishment of the farms. The highest average technical efficiency has farms established in years 1999, 1998, 1995 and 1996. Also, whose established in 2005 are relatively highly efficient in transformation of their inputs into outputs. Economic crisis year 2008 is clearly visible as the efficiency of farms established at that year is the lowest. Also, farms that were founded two and one year before the economic crisis, did not have good results in observed years. Farms established in year 2014 were less efficient, but it might be due to few observation (only 13) that the mean is not representative.

Fig. 2: Average technical efficiency of farms established in different years



Source: own elaboration

As there are no significant differences in technical efficiency between farms that are "new" and those which are well established, we cannot justify the support for starting farmers by the lower technical efficiency. Besides, provided grants on arable land and investment subsidies for start-up have ambiguous effects on technical efficiency. For example, Pechrová (2015a) found out that direct payments and agri-environmental payments even tend to increase inefficiency (and decrease efficiency). Only subsidies for Least Favoured Areas had a positive effect on the efficiency of agricultural holdings. However, Lambarraa and Kallas (2009) found the significant negative impact of LFA subsidies on the technical efficiency of Spanish olive farms. Regarding the start-up grant, according to Pechrová (2015a), the effect of Rural Development Program subsidies (start-up grant) was not statistically significant. Also, Lattrufe et al. (2017) found no significant effect of subsidies per ha on the technical efficiency of mixed crops-livestock farms. In general, the effect of a particular type of subsidy depend on the sample's production orientation and on the performance of a farm as found out by Latruffe and Desjeux (2016).

Regarding the young farmers, Pechrová (2015b) found out "that young and other farmers do not statistically significantly differ in terms of the technical efficiency". But the more experienced farmers and farmers who seek information can have higher levels of technical efficiency as was found out by Wilson, Hadley and Asby (2001) for wheat farms in eastern England. We can conclude that there are other arguments for support of starting farmers then their technical inefficiency.

Conclusion

For successful functioning of the agricultural sector the entrance of new managers of agricultural holdings is needed. However, start-ups in agricultural sector faces many difficulties and therefore are supported by agricultural policy. So far, the subsidies are received only by young starting farmers, but it is suggested supporting all farmers regardless the age all of them face similar problems. The aim of the paper was to find out whether there are differences in technical efficiency between farms that are “new” and those which are well established and hence to justify the support by this argument. It was supposed that farmers that are setting up their business are at the beginning less technically efficient.

Based on data about 593 farms (2181 observations) a stochastic frontier analysis was done to model the Cobb-Douglas production function. Average technical efficiency was 85.33%, while established farms were efficient from 85.63% and others from 76.14%. In a second stage it found out by Wilcoxon rank-sum test that there were no statistically significant differences between new farms and well-established farms in terms of technical efficiency. We cannot justify the support for starting farmers by the lower technical efficiency. Besides, provided grants on arable land and investment subsidies for start-up have ambiguous effects on technical efficiency. There are other arguments for support of starting farmers then their technical inefficiency, such as lack of finances for initial investments, lack of access to the land, difficulty to obtain credits and loans etc.

Acknowledgment

The paper was supported by the Ministry of Agriculture of the Czech Republic, institutional support MZE-RO0918, Internal Research Project no. 1113/2019.

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