

ARE WINE PRODUCERS WITH SUBSIDIES MORE TECHNICALLY EFFICIENT?

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Abstract

The article analyses the technical efficiency of enterprises producing wine in the Czech Republic in the context of provided subsidies. In this paper only the effect of Rural Development Programme subsidies (measure 1.1.3 in 2007–2013 and 4.2.1 in following RDP 2014–2020) are analyzed, where wine producers belong to the main recipients. We used unbalanced data set for the time period from 1998 to 2016. The main aim of this paper is to evaluate the technical efficiency of wine producers and to figure out whether there are differences between supported and non-supported firms – according to the size of enterprise and region. The true fixed effect model was used to do the analysis. Supported producers in general were more technically efficient, but this result was not statistically significant. By region distribution, supported firms were also more efficient, but not significantly. The same result was true for the distribution according to the size. To summarize, the effect of support in this sector is not significant.

Keywords: subsidies, technical efficiency, wine producers, food industry, true fixed effect

JEL Classification: C10, M21

Introduction

The food and beverage industry in the EU is a major contributor to Europe's economy ahead of other manufacturing sectors. The industry maintains the characteristics of a stable, resilient and robust sector. In 2016, the volume of food and drink production was the highest since 2008 and it is the largest manufacturing sector in terms of turnover, value added and employment. The EU food and beverage industry generated a turnover of 1,109 billion EUR (2015) and a value added of 230 billion EUR (2015). Food and drink industry contributed by 2.1 % to EU gross value added, 15.2 % to turnover, 12.1 % to value added and 15 % to employment in manufacturing. The food and drink industry is a significant job provider, but on average, labour productivity in these sectors is lower than in the manufacturing sector as a whole. The EU food and beverage industry is diverse, with a variety of sectors ranging from fruit and vegetable processing to dairy production and many beverages. The top sectors (bakery products, meat products, dairy products, drinks and the "other food products") represent 75% of the total turnover and more than 80 % of the total number of employees and companies. The food and beverage industry is a highly

diversified sector with many companies of different sizes. SMEs generate almost 50 % of the food and beverage industry turnover and value added and provide two-thirds of the employment of this sector (Food Drink Europe, 2018).

The EU also offers specialised funds and grants for different activities that support EU policies. Given the importance of the food and beverage industry, the findings could indicate the need for giving more attention to struggling areas of financial and operational performance of small, medium (SME) and large companies (Gardijan & Lukač, 2018). Some studies predict that subsidies may influence firms' behavior (Ciaian & Swinnen, 2009). Public aids may also improve profit efficiency. Charoenrat et al. (2013). Hussain et al. (2009) found that access to financing sources allows SMEs to get more advanced technological resources and more qualified human resources, which correlates with a positive effect on efficiency.

Wine producers in the Czech Republic have an opportunity to draw subsidies from different sources. From national finance, it means national subsidies according to the agricultural law and support from Wine Found and from Support and Guarantee Funds for Farms and Forestry. From European Union it is the support of Common market organisation (CMO) with wine and Single Area Payment Scheme (SAPS). The last source is a combination of national and EU funds, the Rural Development Programme (RDP). From RDP the producers can be supported from agro-environmental measures and processors can also use the measure of support for investments in processing/marketing and/or development of agricultural products. In this measure, wine producers belong to important applicants. According to Ministry of Agriculture (2016) these enterprises participate on total applications by 14.7 %, which means it's third place behind meat processors (34.0 %) and milk processors (15.9 %).

1 Theoretical background

Our paper deals with the technical efficiency of the sector. Only a few papers dealing with efficiency of food industry in Europe can be found (Čechura et al., 2011; Dios-Palomers & Martinez-Paz, 2011). Research by Gardijan and Lukač (2018) recognized that Germany, Finland, Estonia and Bulgaria have the largest proportion of efficient food manufacturers. Slovenia, Slovakia, Luxembourg and Romania rank at the bottom. In the beverage industry, the leading counties are Sweden, Germany, Estonia and Portugal, on the other hand Slovenia, Luxembourg and Hungary are at the bottom of drink manufacturing. In both food and beverage industry, we can say that the proportion of efficient companies, regarding to their size, is similar (Gardijan & Lukač, 2018). Vlašicová and Náglová (2015) analysed the economic situation of organic and conventional wine producers in Czech Republic. The researchers confirmed better economic situation of organic producers. Without differentiation they have good financial management and therefore can be able to generate profit without aids. Pechrová (2013) found out that average efficiency of biodynamic farms was irregular with high differences between farms (it varied from 48.67 % to 74.79 % in case of SFA, DEA estimated the efficiency in the interval of 46.85 % to 84.01 %).

Technical efficiency was divided also according to the size of firms to examine the differences. The role of SME in the economy is important (Doern, 2009; Harvie, 2007;

Hussain et al., 2009). They represent the business structure and contribute to the economic growth at most. They play an important role in economic development (Hallberg, 1999).

There are two most used methods for estimating technical efficiency – Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) approaches (Charoenrat & Harvie, 2014; Coelli et al., 2005). Each has its advantages and disadvantages. One of the drawbacks of SFA is that it is parametric model that requires certain functional form that must be assumed before the estimation. To estimate the stochastic frontier model, we need to assume a functional form (Fiorentino et al., 2006). On the other hand, it is stochastic (has error term) that enables to take into account unobserved variables. SFA also enables to include the explanatory variables into the function of the mean of inefficiency or the function of the variance of inefficiency, so the determinants of the technical efficiency can be assessed in one step (Major, 2008). The advantage DEA is non-parametric model which means no functional form is required as same as there is no assumption about the data. It is suitable especially in case when there is a need to include into the model multiple inputs and outputs (Kontodimopoulos et al., 2011). However, it is deterministic and does not take into account the effect of unobserved variables that are not included among explanatory variables. DEA is more sensitive for measurement errors or outliers (Lee, 2011). When analysing the determinant of technical efficiency calculated by DEA, another model must be created (Tobit model with efficiency as explained variable and determinants as explanatory variables).

Vershelde et al. (2016) used the semi-parametric stochastic meta-frontier approach to investigate the firm-level competitiveness across 10 manufacturing sectors in seven EU countries (Germany, Belgium, Spain, Finland, France, the UK and Italy), including the food industry on a general level. They found significant and consistent differences in performance, a wide technology gap (especially for smaller firms). Lukač & Gardijan (2017) investigated the DEA efficiency of very large food producers in 13 European countries. Their study identified Bulgaria, Poland, the Czech Republic and Hungary as leading countries when it comes to very large companies in the food sector. Bosnia and Herzegovina, Montenegro and Slovakia are found to be relatively inefficient in this dataset, whereas Croatia and Romania showed to be somewhere in the top middle. Rodmanee and Huang (2013) have used a relational two-stage DEA to evaluate the efficiency of 23 food and beverage companies. Mad Nasir et al. (2011) also used the DEA approach to evaluate the market competitiveness of small and medium enterprises in the food industry. They found that the industry is not efficient and identified manufactures with low and high technical efficiency. They concluded that the government should establish policies to encourage improvements and technological change.

As we consider only one output (sales), we chose rather parametric SFA analysis.

Our assumptions are, that small wine processors are less efficient than medium and large enterprises and supported processors are more efficient than non supported. Hypothesis are set in section Methods.

2 Data and Methods

2.1 Data

Accounting data were taken from Albertina database of Bisnode company. Data about subsidies from RDP were obtained from the Ministry of agriculture, measure 1. 1. 3. Adding value to agricultural and food products for years 2007–2013 and 4. 2. 1. Support for investments in processing/marketing and/or development of agricultural products for period 2014–2020. This individual data were performed on authors' request and are not ordinarily published, as individual data from Albertina. It ensure the originality of paper. Such analysis in wine industry has not yet been performed. The data were selected according to the sectors CZ-NACE: CZ-NACE 11 Manufacturers of beverages, precisely CZ-NACE 11.02 – Manufacturrse of wine from grape. The businesses were divided according to drawing subsidies (supported and non-supported), according to the region and to its size (small, medium, large¹). We created an unbalanced panel data set for time period from 1998–2016. The production was approximated using sales of each company's own products and goods. Explanatory variables were x_1 – amount of fixed assets, x_2 – current assets, x_3 – equity, x_4 – liabilities, x_5 – personal costs (that approximated the number of employees). There were 1392 observations in the whole sample for 130 firms. This dataset was cleansed, so for the model used only 1217 observations, from which were 1142 non-supported and 75 supported. The majority of observations were from year 2013, 2014, 2015 and 2012. Minimum observations per one firm was 2 in order to preserve panel nature of the data. Maximum was 20 and average 10.

Description of the sample is displayed at Table 1. We tested whether there were differences between supported and non-supported firms by Wilcoxon rank-sum test. Based on the p-value there were found statistically significant differences in sales, fixed assets, current assets, equity, liabilities and personal costs with a 0.05 level of significance.

In the Czech Republic there are according to the assumption data from Czech Statistical Office and Ministry of Industry and trade 280 wine processors. Our sample consist of 130 firms. It means that we analyzed more than 45 % companies in the country. The results can be generalized to whole branch.

¹ Small enterprises have 0–49 employees, medium companies have 50–249 employees and large enterprises have more than 250 employees.

Table 1 | Statistical description of the sample of wine processing companies

Variable	Mean			p-value
	Sample	Non-supported	Supported	
No. of observations	1,217	1,142	75	
RDP subsidies 2007–14 (thous. CZK)	164.47	0	2,861.85	
RDP subsidies 2014–20 (thous. CZK)	13.56	0	238.75	
y – sales (thous. CZK)	85,720.12	85,692	86,180.53	0.0044
x ₁ – fixed assets (thous. CZK)	47,066.49	46,755	52,169.08	0.0014
x ₂ – current assets (thous. CZK)	64,143.46	63,708	71,289.04	0.0029
x ₃ – equity (thous. CZK)	58,173.57	57,559.37	68,246.32	0.0031
X ₄ – liabilities (thous. CZK)	55,776.73	55,648.05	57,887.03	0.0012
X ₅ – personal costs (thous. CZK)	10,540.21	10,460.85	11,841.75	0.0089

Source: authors based on data from Albertina, Ministry of Agriculture (MoA).

2.2 Methods

Cobb-Douglas power production function was estimated in a following linearized form (1).

$$y_{it} = \sum_{k=1}^K \beta_k \ln x_{k,it} + u_{it} - v_{it} \quad (1)$$

where β_k are coefficients of explanatory variables x , subscript k ($k = 1, 2, \dots, K$) is number of explanatory variables, subscript i ($i = 1, 2, \dots, N$), where N is total number of firms, represents particular firm and t ($t = 1, 2, \dots, T$) stays for a time period for which are available company's observations. Total number of observations per one firm varied from 2 to 20.

We estimated True Fixed effects model as proposed by Greene (2002) by method of maximum likelihood. The distribution of stochastic term was assumed to be normal and of $v_{it} \sim N(0, \sigma_v^2)$ inefficiency term was chosen to be truncated normal $u_{it} \sim N^+(\mu, \sigma_u^2)$

The mean of the technical inefficiency μ expresses the heterogeneity among firms and the variance of inefficiency σ_u^2 it the heteroscedasticity. The amount of subsidies was included into the mean inefficiency function.

$$\mu \sim N^+(\delta_0 + \delta_1 z_{1,it}, \sigma_u^2) \quad (2)$$

where δ_0 is a constant and δ_1 is a parameter of variable z_1 , this represents the subsidies. Where there were no subsidies obtained by a firm a small number was replaced with zero (10^{-6}). The technical efficiency of each firm was estimated using JLMS estimate of technical efficiency (Jondrow et al., 1982) where the efficiency is estimated as $\exp[-E(u|e)]$.

Normality of distribution of efficiency was tested using Shapiro-Wilk test. Null hypothesis assuming normality was rejected (p-value 0). Hence, the differences between two sub-samples (subsidized vs. non-subsidized firms) were tested by non-parametric Wilcoxon

rank-sum test ($H_0: \mu_0 = \mu_1$) and between more samples by non-parametric Kruskal-Wallis test ($H_0: \mu_1 = \mu_2 = \dots = \mu_r$). The calculations were done in econometric software StataIC version 15.

3 Results

Wald X^2 test revealed that the model with this dataset is statistically significant. All coefficients were statistically significant at 0.05 level, but only equity was on 0.1 level.

Subsidies were included in the function of a mean of inefficiency. The subsidies positively influence the mean of technical inefficiency. If the subsidies increase, average of inefficiency decreases. The coefficient is statistically significant. The distribution of inefficiency term was chosen to be a truncated normal, so the mean of the inefficiency could have been explained by explanatory variables in a separate function.

Results are displayed in Table 2. Increase of fixed assets by 1 % means increase of sales by 0.05 %. Increase of current assets by 1 % brings increase of sales by 0.69 %, which is the highest intensity of all production factors. This is very positive and also a logical finding. The current assets are mainly composed of products (in this case products from wine) that bring the firm the highest value in increasing their sales. Increase of equity by 1 % causes increase of sales by 0.01 %, which is the lowest intensity. Also, in case of liabilities, its increase by 1 % means increase of sales by 0.01 %. Increase of personal costs by 1 % brings increase of sales by 0.04 %.

Table 2 | Results of True fixed-effect model

	Coef.	Std. dev.	p-value
$\ln x_1$	0.0459	0.0004	0.0000
$\ln x_2$	0.6913	0.0061	0.0000
$\ln x_3$	0.0057	0.0030	0.0600
$\ln x_4$	0.0083	0.0033	0.0120
$\ln x_5$	0.0392	0.0003	0.0000
Mean inefficiency function			
constant	-126.2814	12.4934	0.0000
Subsidies total	-0.0284	0.0089	0.0020
Variance inefficiency function			
constant	-13.5166	0.7786	0.0000
σ_u	14.4967	0.6966	0.0000
σ_v	0.0012	0.0004	0.0100
λ	12469.49	0.6966	0.0000

Source: authors.

Average efficiency was 64.02 % which shows that there is still possibility for improvement. The median was higher than the average efficiency at 70.02 %, i.e. half of firms are more

efficient than this threshold, but the other half less. There are few ineffective firms that reduce the efficiency of the whole sample. The average efficiency is lower than in the oil sector (85.5 %) and milling sector (85.3 %), but higher in the dairy sector (67.8 %), according to study done by Čechura & Malá (2014).

Sum of coefficients is below one (0.7905), which points the attention to that the firms are exhibiting a decreasing returns to scale. The sample mostly consists of small enterprises, that do not reach any saving thresholds. Returns on scale relate to large businesses and can be considered as a driving force, which was confirmed also by Bourlakis et al. (2014). Most food products are processed in large companies and they can benefit from returns to scale. But can involve lengthy supply chain and higher transport costs and Environmental impacts. In comparison, mall scale production can provide flexibility to the food supply chain (Almena et al., 2019). Wijnands et al. (2008) recommended to improve economies of scale and economies of scope, because they found weak food industry's competitiveness.

3.1 Technical efficiency in subsidized vs. non-subsidized firms

As can be seen from Table 3 firms with subsidies were on average slightly more technically efficient (from 68.07 %). Firms without subsidies achieved efficiency of 63.75 %. The probability that the distribution of technical efficiency is normal is equal to zero based on Shapiro-Wilk test. Hence, we used a non-parametric two sample Wilcoxon rank-sum test to test the differences in technical efficiency between supported and non-supported firms. The test did not reveal any statistically significant differences between the efficiency of supported and non-supported companies as p-value was equal to 0.33. There were very few observations of supported firms in comparison with not supported. Primary recipients of investment support in wine industry are natural persons and there is no possibility to include them to this sample because they do not report financial statements. It might be because a number of non-supported firms range much higher than supported. In total, there were 256 supported firms and more than half of them were individuals, so the research of the paper was a little limited. In comparison, Pechrová (2015) showed different results in agricultural holdings. There are statistically significant differences depending on whether the farm received the RDP subsidies or not. They concluded that this subsidy has a positive impact on technical efficiency, and it seems that the policy has contributed to competitiveness of agricultural holdings. We can conclude that in wine sector is still room for improving competitiveness by investments.

Table 3 | Differences in technical efficiency of non-supported and supported firms

	Obs.	Mean	Std. dev.	Min	Max	p-value
Whole sample	1217	0.6402	0.2852	3.27e ⁻¹³	0.9979	-
Non-supported	1142	0.6375	0.2873	3.27e ⁻¹³	0.9977	0.3304
Supported	75	0.6808	0.2487	2.75e ⁻¹²	0.9979	

Source: authors.

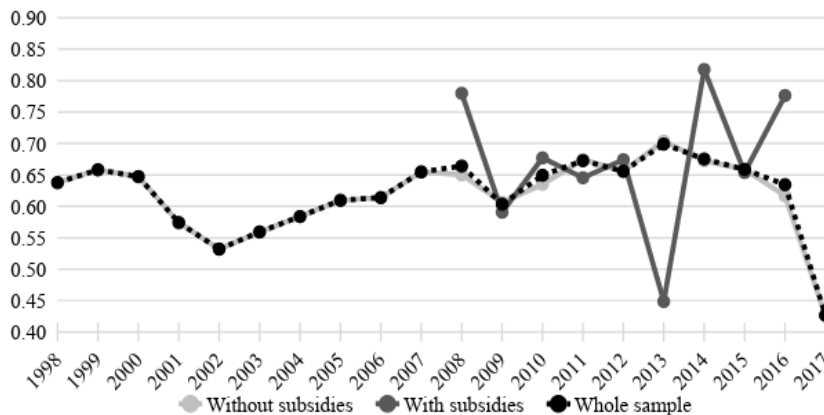
3.2 Technical efficiency in time

The development of technical efficiency in time is displayed at Fig 1. It can be seen that the highest efficiency was in year 2013 (69.90 %) and 2014 (67.53 %) and the lowest was at the beginning of the period in 2002 (53.20 %) and 2003 (55.93 %) – year 2017 is also

marked with low technical efficiency, but it might be due to low number of observations (17 only), where all companies in the sample might be less effective than the others not included this year, but relatively efficient to those in previous years. The technical efficiency did not decrease in 2008 during the crisis, but only a year after. There was a steep reduction from 66.41 % in 2008 to 60.35 % in 2009.

Since 2008 till 2016 we can divide the firms in each year on subsidized and unsubsidized. Firms with subsidies were more efficient than without subsidies in years 2008, 2010, 2012, 2014 and 2016. However, the number of observations for subsidized firms was exceedingly low in each year, so the influence of subsidies cannot be assessed. It was not possible to test the differences among different years between supported and non-supported firms due to the lack of observations in each year (the minimum should be at least 30).

Figure 1 | Development of technical efficiency in time



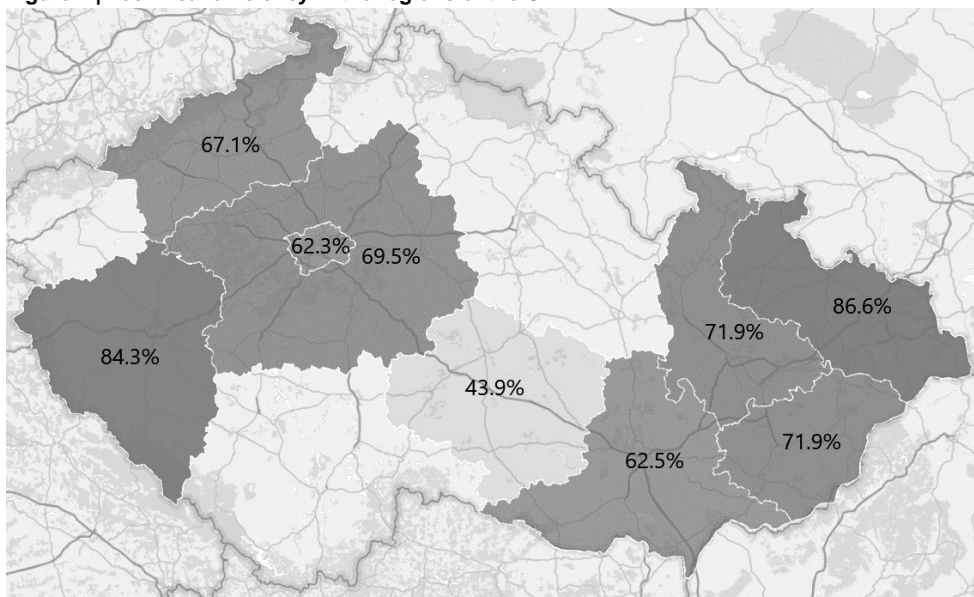
Source: authors.

3.3 Regional differences in technical efficiency

It can also be assumed that there might be regional differences in average technical efficiency as production of wine is dependent on environmental conditions and processing of wine depends on the quality of grapes. There are 14 NUTS 2 level regions in the CR, but the wine is produced in only nine of them. As it is visible from Fig 2, the firms with the highest technically efficiency are firms in the Moravian Silesian region (86.64 % on average), from which subsidized firms were efficient from 86.38 % and non-subsidized from 89.93 %. This result is a little bit unexpected, because another region, South Moravia, has the main grape's production.

As can be seen from Table 4, mostly unsubsidized firms were less efficient than subsidized ones. Only in Olomoucký region, the firms with subsidies were efficient only from 43.71 % and without subsidies from 73.66 %, then in Ústecký region, 51.92 %, resp. 67.35 %. There were no firms with subsidies in Vysočina region probably because of the unfavorable conditions for agriculture. According to Balios et al. (2015); Charoenrat & Harvie (2014) enterprises are strongly influenced by the region in which they operate, and their efficiency will be conditioned by the economic, social, and demographic situation of the region.

Figure 2 | Technical efficiency in the regions of the CR



Source: authors in MS Excel

Note: darker shade means higher efficiency.

Two-sample Wilcoxon rank-sum test was used to test the differences in efficiency between subsidized and unsubsidized firms. There were no statistically significant differences found between supported and non-supported firms in particular regions despite that the supported firms seemed more efficient.

Table 4 | Technical efficiency of non-supported and supported firms in regions

Region	Obs.	Mean	Median	Non-supported		Supported		p-value
Prague	51	0.6229	0.6250	48	0.6181	3	0.6995	0.3055
Middle Bohemia	33	0.6950	0.6588	31	0.6927	2	0.7260	0.9314
Plzeňský region	18	0.8429	0.8314	17	0.8428	1	0.8450	0.9232
Ústecký region	76	0.6711	0.7262	75	0.6735	1	0.5192	0.3374
Vysočina region	23	0.4385	0.4408	23	0.4385	0	-	-
South Moravia region	1,045	0.6253	0.6843	976	0.6219	69	0.6726	0.2500
Olomoucký region	17	0.7190	0.7138	16	0.7366	1	0.4371	0.1025
Zlínský region	96	0.7194	0.8271	94	0.7147	2	0.8931	0.4050
Moravian Silesian region	29	0.8664	0.8627	28	0.8638	1	0.8993	0.7098

Source: authors.

3.4 Technical efficiency and size of the firm

The dataset was also divided into firms according to their size. A majority of firms were small. Then there were middle sized firms and large firms. There were enough observations, hence we tested by non-parametric Kruskal-Wallis to test the differences in technical efficiency among various sizes. The resulting P-value was close to zero, therefore there are statistically significant differences among wine processors of different sizes. The most technically efficient were middle sized firms (73.11 %), then large firms (70.74 %) and finally as expected the less technically efficient were small firms (60.25 %). According to Pérez-Gómez et al. (2018) when compared large companies to SME, they adapt better to changes in the market and new customer needs, and their organizational structure allows for faster decision making. These companies are highly flexible, allowing them to better adapt to technological changes and promote better income distribution than larger companies. With respect to this opinion it is important to deal with low efficiency of small wine processors, because their share on business structure is significant and its support is needed.

We also tested the differences between non-supported and supported firms, but only in groups of small firms, because there were not enough observations in the other groups. We found no statistically significant differences between non-supported and supported firms in group of small firms despite that supported firms appeared to be more technically efficient (70.34 %) than non-supported firms (60 %). The results are displayed in Table 5. Galdeano-Gomez and Cespedes-Lorente (2008) report that increasing firm size had a positive impact on the technical efficiency of agri-food firms. On the opposite hand, Schiefer and Hartmann (2008) find that for German food processing firms, that the size has no influence. Pérez-Gómez et al. (2018) estimated the efficiency in small and medium-sized manufacturing enterprises. Average efficiency of food SME is 49.37%. Company size, export orientation, government assistance and labour productivity are positively related to its efficiency. Although, age is negatively correlated. A positive relationship between the size and efficiency of SMEs was found for example by Balios et al. (2015), Charoenrat et al. (2013), Margono & Sharma (2006), Yang (2006) and Latruffe et al. (2006). This demonstrates that larger SMEs are able to take advantage of economies of scale to a greater extent and have better opportunities to access information and technological resources (Pérez-Gómez et al., 2018).

Table 5 | Technical efficiency of non-supported and supported firms according to the size

Size	Whole sample			Non-supported		Supported		p-value
	No. obs.	Mean	Median	No. obs.	Mean	No. obs.	Mean	
Small	854	0.6025	0.6432	805	0.6000	49	0.7034	0.4478
Medium	328	0.7311	0.7784	303	0.7296	25	0.6424	-
Large	35	0.7074	0.7722	34	0.7034	1	0.8450	-
p-value	1,217	0.0001						

Source: authors.

Conclusions

The main aim was to evaluate the technical efficiency of wine producers with respect to other variables (size, region and drawing of subsidies). One of the main contributions is that the article used original and individual representative data, that are not commonly published. Such Analysis in Czech wine industry has not yet been performed and contributed to scientific knowledge about this branch. According to Wilcoxon rank-sum test, the results suggest that the selected indicators (sales, fixed assets, current assets, equity, liabilities and personal costs) differ between supported and non-supported firms. All values of indicators are higher in supported firms. The highest intensity was found that an increase of current assets by 1 %, brings 0.69 % increase in sales.

Firms with subsidies were on average slightly more technically efficient (from 68.07 %), but it was not statistically significant. By dividing the firms according to their region, subsidized firms are more effective than unsubsidized. Although again the results were not statistically significant. There were statistically significant differences in technical efficiency among wine processors of different sizes, but by dividing them to supported and non-supported, no significant results have been found.

The issue of wine processors support seems to be ambiguous, because the technical efficiency of supported enterprises shows higher, but it is not statistically significant findings. Besides, it is unstable over time. The reason can possibly be ineffective use of the company's technologies or the technologies are not so highly profitable to grant them a competitive advantage over unsupported businesses. Overall, the less effective ones are small enterprises, in this case it can be more beneficial to provide support to them, and also the firms in less effective regions.

This result should be considered in the context of creation of new Common Agricultural Policy 2021+ (Strategic plans) because wine processors are one of the main recipients of investment supports. Findings can be used for subsidies targeting and redistribution of financial sources. It is possible to specify the aid according to size of enterprises or region. Strategic plans should consider smaller wine producers, because their efficiency is very low in comparison to others firm sizes. Other question to policy makers is if the finance were used effectively, because the results between supported and non-supported processors did not differs significantly. The measure should be more focused on investments with higher value added. The applicants requested small modernization of their firms that did not bring any significant economic impacts. It should be also in their interest to implement more effective and useful technologies or to use current technologies in more efficient way (as some companies exhibit decreasing returns to scale).

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