How efficient is winemaking in Eastern Europe

ANATOLIY G. GONCHARUK*, ALEKSANDRA FIGUREK**

Jel classification, L66, C14, O47

Abstract

This paper is devoted to estimating the efficiency of winemaking in two Eastern European countries – Ukraine and Bosnia&Herzegovina. Empirical research is based on a sample including 33 wineries. Using the models of Data Envelopment Analysis, the authors found that having the same average efficiency and number of leaders, medium and large wineries are developing more efficiently than small wineries in Ukraine, whereas in Bosnia&Herzegovina small wine businesses are more efficient. The high potential growth of efficiency is discovered and the ways for its realization suggested. Cross-country efficiency analysis enabled authors to find inter-country leaders in the wine industry. They grouped inefficient wineries, calculated the potential to reduce inputs and found the main directions to improve efficiency for each group.

Keywords: *efficiency, winemaking, winery, Ukraine, Bosnia&Herzegovina*

Résumé

Cet article offre une estimation de l'efficacité de la vinification dans deux pays de l'Europe orientale – l'Ukraine et la Bosnie-Herzégovine. La recherche empirique est basée sur un échantillon de 33 exploitations vinicoles. En utilisant l'analyse d'enveloppement des données, les auteurs ont constaté que, malgré la même efficacité moyenne et le même nombre de leaders, en Ukraine les caves moyennes à grandes se développent plus efficacement que les petits établissements vinicoles, alors qu'en Bosnie-Herzégovine les petites entreprises vinicoles sont plus efficaces. La croissance potentielle d'efficacité est mise en évidence et les moyens pour sa réalisation sont suggérés. Une analyse de l'efficacité transnationale a permis aux auteurs de trouver des industries leaders entre les pays. Ils ont regroupé les caves inefficaces, calculé le potentiel pour réduire les intrants et trouvé les principales orientations pour améliorer l'efficacité pour chaque groupe.

Mots-clés: efficacité, vinification, cave, Ukraine, Bosnie-Herzégovine.

1. Introduction

Wine is made traditionally in the southern regions of Europe (Italy, Spain, France etc.), but today wine is produced on all the continents and even in cold countries such as Canada.

The world production and consumption of wine are increasing: the growth rate of wine production in 2011-2014 was 6.4% and for wine consumption – 0.1% (Wine Institute, 2016). Italy, France and Spain remain the leaders of wine production: their total share in the world production in 2014 was 45.9% (Wine Institute, 2016).

Focus in our research will be on the countries that have not yet reached a high level of development in the global wine market. These Eastern European countries are trying to integrate into the EU and attempting to gain a foothold in new markets. For the study we have considered one country from the middle of the list of world's wine producers in 2014 (Wine Institute, 2016) – Ukraine (20th place), and one country from the bottom of this list – Bosnia&Herzegovina (54th place of 57 countries).

Ukraine

In the period 2006-2013, the volume of grape processing was quite high (Figure 1) and ranged from 300 to 450 thousand tons per year (2014), and after the annexation of Crimea (229 thousand tons). The dynamics of wine production in Ukraine for the past nine years is presented in Figure 1.

Odessa, Mykolaiv, Kherson regions and Crimea are the largest wine-producing regions in Ukraine. The shares of these regions in total grape processing (during the period 2010-2013) have been relatively stable and changed between 3-7% per year. However, in 2014 the structure of grape processing has changed significantly: over 61% of grapes are now processed in the Odessa region, about 20% – in Mykolaiv, about 16% – in Kherson, and only 3.7% in other regions of the country.

Changes were also in the structure of wine production, more than 97% of wine industry is concentrated in three regions: the Odessa area – more than 60%, Nikolayev – 21.4% and Kherson – 15.6%.

The biggest share in the total volume of grape processing in Ukraine is held by seven varieties: Aligote, Rkatsiteli, Cabernet Sauvignon, Muscat, Chardonnay, Sauvignon and Riesling. Their total share in the total volume of grape processing in 2011-2014 was 59-62%. Among the leading seven varieties for the whole period (2010-2014) the share of Chardonnay (from 5% to 11%), Cabernet Sauvignon (from 6% to more than 9%), Riesling (from 3.6% to nearly 6 %) and Sauvignon (from 4.2% to 7%) significantly increased due to reduction of Rkatsiteli share (from 11% to 5.5%) and other varieties. The traditional leader – Aligote remains the highest share (12-13%).

Despite some difficulties of doing business and the impact of other negative factors that take place in the country,

* International Humanitarian University, Odessa, Ukraine. agg@ua.fm
** University of Banja Luka, Banja Luka, Bosnia and Herzegovina. aleksandrafigurek@yahoo.com

Figure 1. *Grape processing and wine production in Ukraine in 2006-2014, thousand tons*, Source: Goncharuk and Lazareva, 2015.

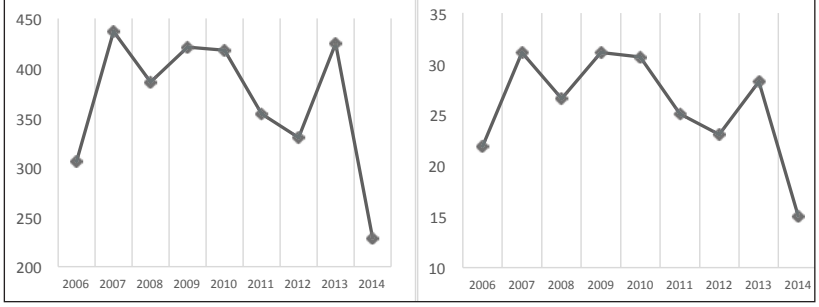
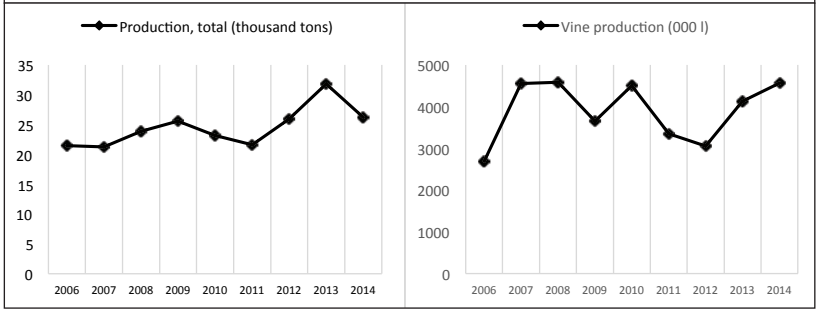


Figure 2. *Grape and wine production in BiH for the period 2006-2014*, Source: ASBH (2015a)



the winemaking in Ukraine is relatively stable. It grows primarily in a part of the production of wine materials for champagne and sparkling wines.

Bosnia&Herzegovina

During the war in Bosnia&Herzegovina (1992-1995), wine production suffered multiple damages that are estimated at about 2 million grapevines wine and 1.5 million vines of table varieties of vines. Before war, B&H had 5781 hectares of vineyards with 24,5 million vine plants of European grapevine inoculated on American rootstock: 5691 hectares or 98,4% of vineyards belonged to the Herzegovina winegrowing region, while the north Bosnia region had 90 hectares or 1.6% (Beverage Industry, Bosnia and Herzegovina, Foreign investment promotion Agency, Sarajevo 2011). According to the Institute of Statistics of the Republic of Srpska (RS) and Federal Agro-Mediterranean Institute (MFTERBH, 2015), areas under vines in the RS amounted to about 413 ha and in the Federation, approximately 3,250 ha (2014). The total grape production in B&H amounted to 26,221 tonnes in 2014.

The bearer of wine-growing production was Herzegovina – Neretva Canton, and the largest grapevine areas adorning the municipalities of Mostar, Čitluk, Čapljina, and Stolac. Out of the total area, the private sector occupied 3770 hectares. The most often produced varieties were Žilavka, Blatina, and the accompanying varieties Bena, Krkošija, Smederevka, Vranac, Plavka, Merlot and Cabernet. The wine sector in B&H is relatively small, but the wine sector is significant in several municipalities in western and southern part of the country - in Herzegovina and areas around Trebinje.

The division between registered and unregistered grape production and wine reflects the dual structure of the sector in B&H; on the one hand, 40% of the sector is under a professional organization and management, while 60% of the sector is organized in the form of permanent or semi-permanent production for personal use and sell in the local market. The total vineyard area of Herzegovina is divided into more than 14.200 parcels with an average area of 0.25 ha.

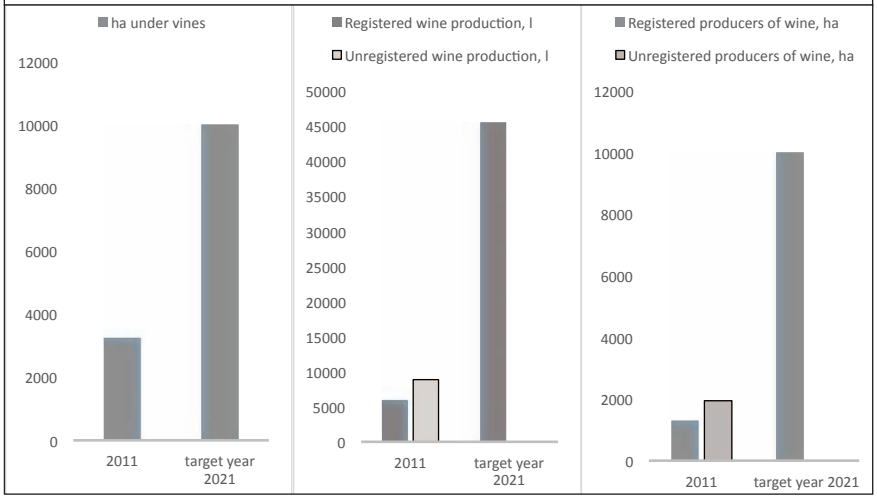
Wine production in B&H has increased slightly last years. Analysing the period 2006-2014, the volume of wine production has increased from 2.6 mil. lit. in 2006 to 4.5 mil.lit. in 2014 (Agency for Statistics of Bosnia& Herzegovina, ASBH, 2015b). Based on the FAO (2012), it can be estimated that the value of wine production in B&H amounts to 66 million KM (33.8 mil.€) in 2011, while the value in 2005 amounted to 48.5 million (24.7 mil.€) on the basis of constant prices on the market, and confirms the progress in this sector.

A value of 66 mln KM from 2011 represented 3.7% of GDP of agriculture and related services in B&H, and 0.27% of total GDP of B&H.

2. Literature Review

Many studies are devoted to different aspects of winemaking: consumption properties of wine, e.g. tastes and aromas (Rinaldo *et al*., 2014; Hanf, 2014), quantitative and qualitative changes in consumption and production of wine in different countries, e.g. Italy (Barisan *et al*., 2015), Germany (Hanf *et al*., 2013), Spain (Gil *et al*., 2015) or Australia (Orr, 1997).

Figure 3. *Defined target values for the production of grapes and wine in B&H.*



Some studies are devoted to the efficiency of wine production. Conradie *et al*. (2006) estimated the relationship between technical efficiency and vineyard size and have shown that efficiency is affected by labour quality, age and education of the farmer, location, the percentage of non-bearing vines and expenditure on electricity for irrigation.

Sellers-Rubio *et al.* (2016) estimated productivity and efficiency at a winery level through a dynamic approachfrom two of the main wine-producing countries in the world (Italy and Spain). According to their results, in order to improve efficiency, firms should be able to identify the sources of poor performance and the alternatives available to make better use of their resources.

Galluzzo (2014) identified that producers of Protected Designation of Origin (PDO) wine have the poorest level of technical efficiency, because of the level of agrarian capital and labour force compared to conventional ones. In their research, Toth and Gal (2014) used a two stage model on a panel of most of the major wine producing countries over the period 1995-2007 identifying factors of the inefficiency (development of the financial system, the quality of human capital and per capita wine consumption). Output-oriented version of the weighted additive model can be used to properly identify revenue, technical, and allocative inefficiencies in Spanish designation of origin (Aparicio *et al.*, 2013).

The efficiency of wine production is also searched by Henriques *et al*. (2009) using several parametric techniques and Bojnec and Latruffe (2008, 2009) using non-parametric techniques. Lazareva (2015) identified the level of efficiency of 11 wineries in Ukraine using three-criteria approach (relative, dynamic and structural) and detected ineffectiveness of small business in the Ukrainian wine industry.

The system of partial indicators of economic efficiency of grapes and wine in the dynamics of the years 2005-2011 was researched by Timofti (2013). He developed a methodology for calculating the synthetic (integral) indicator of efficiency which can take into consideration the basic indicators of grape production and the results of their processing.

Vázquez-Rowe *et al*. (2012) used LCA (Life Cycle Assessment) and DEA in their research which confirmed that improving the operational performance of inefficient vine-growing farms is not only worthwhile from an environmental perspective, but also regarding economic profits. Strategic evolution towards more specialisation could be more profitable for their growers owners than further integration towards packaged wine sales (Couderc and Marchini, 2011).

Thus, a literature review revealed a weakness of studies of the efficiency of winemaking in the developing countries and the absence of comparative studies for these countries.

The purpose of this study is to evaluate and compare the efficiency of winemaking in two developing countries (Ukraine and Bosnia&Herzegovina) from the perspective of their development.

3. Methods

The following methods are being often applied for winemaking: corrected ordinary least squares (COLS), production functions, stochastic frontier analysis (SFA), data envelopment analysis (DEA) etc. In SFA, inefficiency is assumed to have asymmetrical distribution, usually a half normal distribution and random error is expected to have standard symmetrical distribution. SFA deals with the problem that not all deviations from criteria are due to a lack of efficiency and they may also occur as a result of misfortune (fortune) or measurement errors (Vincová, 2005).

Jozsef and Peter (2014) used SFA and Cobb-Douglas production function to explore macroeconomic factors influencing the technical efficiency of 16 major wine producing countries. Moreira *et al*. (2011) use a Cobb-Douglas model to estimate a stochastic production frontier (SPF) and to obtain efficiency scores both at the individual block and at the farm level for a sample of wine grape producers in Chile.

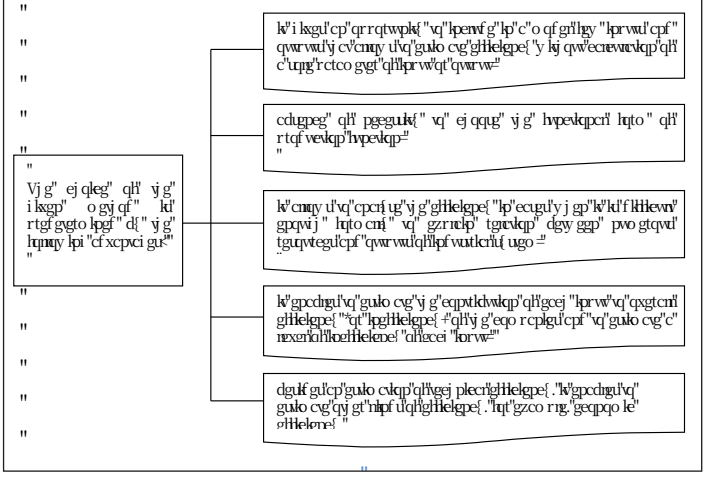
Today researchers constantly seek for new and innovative ways to improve performance and competitive advantage in winemaking and wine grape growing. In the micro-economic aspect among the other methods, DEA must be the most expedient tool for analysis of efficiency of the winemaking industry providing us with answers to the following two basic questions:

what are the most efficient subjects in the group of subjects? and b) how inefficient is each particular subject compared to the rest of the group and how can it improve its performance?

Besides, DEA method supposes simultaneous use both cost and physical units that allows to generalize heterogeneous input and output parameters.

DEA is a non-parametric frontier method, first offered by Charnes *et al.* (1978) that has received wide theoretical development and practical application over the last decade in

Diagram 1 - *Advantages of using DEA*.



a management of various fields of human activity, for example, in water utilities (Lo Storto, 2014), banking and investments, postal service (Çakır *et al*., 2015), healthcare and pharmaceuticals (Goncharuk and Getman, 2014), education (De Witte, 2015), manufacturing (Monat, 2009), energetics (Goncharuk, 2013), etc. Its essence consists in the use of methods of linear programming for construction of a piecewise linear convex surface (frontier) for enterprises sample, and estimation of efficiency concerning this surface.

Bouzdine-Chameeva (2012) made research with a focus on measuring performance through an efficiency value of wine chateaux in Bordeaux region in France and the use of the DEA methodology for estimating potential resources of performance for 58 wine producing companies in Bordeaux regions. The performance was measured against best-practice firms taking into consideration multiple input and output data, complex by their nature.

Sellers and Alampi-Sottini (2016) used several parametric and non-parametric tests to analyse the influence of firm size on these performance indicators. Their results obtained with a sample of 723 Italian wineries (limited companies and cooperatives) in 2013 showed that size has a positive influence on the economic performance of wineries.

Townsenda *et al*. (1998) found that the most of wine grape producers operate under constant returns to scale. Comparing the efficiency of private companies and cooperatives, Barros and Santos (2007) found that Portuguese wine cooperatives are more efficient than their private counterparts. Using DEA, Aparicio *et al.* (2013) estimated revenue inefficiency decomposed to technical and allocative inefficiencies. They showed that revenue efficiency was higher in the case of PDOs with specific wine products serving niche markets and without clear competition.

Among existing DEA models in the context of given research, it is expedient to use the following:

(a) to estimate an efficiency score for each wine company, the common input-oriented model with a constant return of scale (CRS) (see Charnes *et al*., 1978) and input-oriented model with a variable return of scale (VRS) (see Banker *et al*., 1984) will be used;

(b) to estimate an influence of production scale on the winery efficiency and to define returns to scale (RTS) for each winery, the parameter of scale efficiency will be defined on the following ratio:

$$UG = \frac{VG_{ETU}}{VG_{XTU}}. \qquad (1)$$

where TE_{CRS} is technical efficiency score for CRS model and TE_{VRS} is technical efficiency score for variable return of scale (VRS) model (Goncharuk, 2009);

(c) to make full ranking for wine companies, the DEA model of super-efficiency, offered by Anderson and Petersen (1993), will be used. Mathematically the input-oriented DEA model of super-efficiency for *m* inputs, *r* outputs and *n* DMUs can be formalized in the following way:

$$\begin{aligned} &\text{o lp } l' = \theta^{uwr}. \\ &uvdlgevaVq< \\ &\sum_{l=3.\neq s}^{p} z_{lk}\lambda_l + u_k^- = \theta^{uwr} z_{ls}. k=3.4.000o \\ &\sum_{l=3.\neq s}^{p} \{_{lk}\lambda_l - u_k^+ = \{_{ls}. k=3.4.000t \\ &\lambda_l . u^-. u^+ \geq 2 \end{aligned} \qquad (2)$$

where θ^{sup} is a scalar; λ_j is a weight of DMUj; x_{ij}, y_{ij} are inputs and outputs of DMUj; s_i^-, s_i^+ are input and output slacks (Goncharuk, 2011);

(d) to estimate the reserves of inputs reduction for companies and industry the slack-based model (SBM) advanced by Tone (2001) will be used. SBM has the following mathematical form:

$$\begin{aligned} &\text{o cz} \sum_{k=3}^{o} y_k^- u_k^- + \sum_{t=3}^{u} y_t^+ u_t^+. \\ &uvdlgevaVq< \\ &\sum_{l=3}^{p} \lambda_l z_{lk} + u_k^- = z_{lo}. k=3.4.000o \\ &\sum_{l=3}^{p} \lambda_l \{_{tl} - u_t^+ = \{_{tq}. t=3.4.000u \\ &\lambda_l . u_k^- . u_t^+ \geq 2. \sum_{l=3}^{p} \lambda_l = 3 \end{aligned} \qquad (3)$$

where s_{ij} and y_{ri} are inputs and outputs for company *j*; s_i^- and s_r^+ are the slacks variables that reflect input excess and output shortage correspondingly; λ_j are the weights of companies; w_i^- and w_r^+ are user-specified weights obtained through value judgement.

4. The Data

The sample in this research includes 33 wine companies (17 - Ukrainian and 16 - Bosnian). We used material costs, number of employees and fixed assets as inputs and net sales as output. Input variables reflect the basic factors of production (materials, labour and fixed capital) and net sale represent companies' output – volumes of product sold. Small number of variables and significant volume of sample provide rigorous results of the analysis and narrows number of the companies that lie on industry frontier of efficiency.

Considering that results of DEA are sensitive to errors in initial data, the annual reports of wine companies for 2013, reliability of which is confirmed by the auditor conclusions, were used as a source of information. The descriptive statistics of a sample of the companies is framed in Table 1.

Total annual net sales of 33 wineries included in a sample in 2013 were 251.6 mln EUR. Total number of employees was above 3.2 thousand people.

5. The Results

DEA CRS model allowed us finding the efficient and inefficient wineries in each country. The relative efficiency for Ukrainian and Bosnian wineries was evaluated separately: 35% Ukrainian wineries are effective and the other have efficiency score less than 1; 37% Bosnian wineries are

Table 1 - *Descriptive statistics for wineries' sample*.

Descriptive stat.	*No. of Employees*	*Fixed Assets 000 EUR*	*Mat. cost, 000 EUR*	*Net sales, 000 EUR*	*No. of Employees*	*Fixed Assets 000 EUR*	*Mat. cost, 000 EUR*	*Net sales, 000 EUR*
	Ukraine				Bosnia&Herzegovina			
Mean	175	11336	6139	14323	16	2087	460	506
Median	141	3995	2905	7433	4	198	59	84
Stand. dev.	136	17965	7906	17982	30	5124	935	1002

Source: Annual reports of wineries and authors' calculations.

effective and the other have efficiency score less than 1. The average efficiency score in both samples are very similar: it is 0.71 for Ukraine and 0.72 for Bosnia& Herzegovina. Ukrainian and Bosnian wineries have similar distribution of efficiency scores and average relative efficiency.

In order to find country leaders on efficiency we used DEA-super-efficiency model that allowed ranking the relative efficiency of the wine companies within an international sample. In table 2, there are results of super-efficiency estimation with return to scale (RTS) for the wine companies.

Wine industry leaders on efficiency are *Shabo* – in Ukraine and *AG Međugorje* – Bosnia&Herzegovina. Shabo has relatively a big scale with above 200 employees and over 60 mln EUR net sales per year, and AG Međugorje is a small winery with 7 employees and only 66 ths EUR net sales per year.

Analysing data, we found that all Ukrainian leading wineries are medium or big businesses with multi-million EUR annual net sales. Among inefficient Ukrainian wineries 10 have increasing RTS. Those wineries are not large enough to achieve a high efficiency. We can conclude that small businesses in Ukrainian wine industry are characterized by inefficiency.

The largest wineries in Ukraine (Artemivsk Winery and Koblevo) have decreasing RTS and they have a medium efficiency. The reason of that can be overproduction and there is a need to reduce the scale of wine production to improve an efficiency of their business.

Two largest wineries in Bosnian sample (Hepok and Vinarija Čitluk) are inefficient and they are characterized by the decreasing RTS. Inefficiency of big wine business in Bosnia&Herzegovina causes the need to reduce the scale of wine production in order to improve an efficiency of their business. Feature of Bosnian leading wineries is their small size with less than one-million EUR annual net sales. These results give a picture about Bosnian wine industry with the conclusion that small business is efficient.

Summarizing the above mentioned results, there is the same average efficiency and number of leaders in both country. Medium and large wineries in Ukraine are developing more efficiently than small wineries; in Bosnia& Herzegovina, on the contrary, a small wine business is more efficient. Positive correlation coefficient between the efficiency scores and the number of employees (at the Ukrainian wineries (0.39) and negative one for the Bosnian wineries (-0.28)) also supported mentioned conclusion.

In our research, we have applied the slack-based DEA model (SBM) on two samples of wine companies in order to identify the reserves for cost reduction and increase of an efficiency potential. With the purpose of revealing potential growth of efficiency of Ukrainian and Bosnian wine industry, we applied Computer program DEAFrontier^{TM}. Reserves of inputs reduction for each company have been estimated, and total results are presented in Table 3.

Our calculations showed the existence of significant reserves of input reduction and potential growth of output. The highest reserve on fixed assets reduction specifies a presence of excessive fixed capital or a share of their unproductive part (39.3% in Ukrainian and 79.1% in Bosnian wine industry), of which the wineries can escape on reaching a benchmark level of capital productivity.

There is a significant gap in a labour productivity level of benchmark wineries in Ukraine (efficient) and other wineries because of the high reserve of reduction in number of employees in (13% – 388 workers).

Table 2. *Super-efficiency scores and RTS for wine companies.*

Ukraine			Bosnia&Herzegovina		
Company name	Super-efficiency score	Returns to Scale (RTS)	Company name	Super-efficiency score	Returns to Scale (RTS)
Shabo	**1.9198**	→	**AG Međugorje**	**4.4432**	→
Bakhchisaray	**1.4500**	→	**Vino Produkt**	**1.6462**	→
Tsjurupinske	**1.4044**	→	**Vinarija Jelic - Bortoluzzi**	**1.5336**	→
Odesa Factory of Sparkling Wines	**1.3057**	→	**Proto**	**1.4577**	→
Feodosiya	**1.2636**	→	**Podrumi Vukoje 1982**	**1.2266**	→
Kyiv Factory of Sparkling Wines	**1.1287**	→	**Pod. Manast.Tvrdoš**	**1.1092**	→
Harchovyk	0.9568	↑	Vinarija Jungic	0.8798	↑
Artemivsk Winery	0.8690	↓	Vinarija Čitluk	0.7933	↓
Odesavinprom	0.7996	↑	Podrum Pavicevic	0.7887	↑
Vynogradar	0.7710	↑	P.M.V.	0.6722	↑
Koblevo	0.6790	↓	Premium Vinogradi	0.6160	↑
Prince Trubetskoy	0.6189	↑	Podrum Tarana	0.5523	↑
Victoria	0.5288	↑	Podrumi Banj. Biskupije	0.5505	↑
Limanskiy	0.5282	↑	Hepok	0.4803	↓
Bolgrad Winery	0.5255	↑	Komrad	0.4418	↑
Dnistrovske	0.3437	↑	Popovo Polje	0.3284	↑
Beregovo-Tisa	0.2778	↑			

Source: Authors' calculations.

Table 3. *Potential growth of efficiency and reserves of inputs reduction of Ukrainian and Bosnian wine industry.*

Country	Reserves of inputs reduction, %			Potential growth, %	
	Material cost	Fixed Assets	Employees	Output	Efficiency
Ukraine	0.0	39.1	13.0	8.8	28.9
Bosnia &Herzegovina	26.4	79.1	0.5	1.2	28.3

Source: Authors' calculations.

Table 4. T*he results of cross-country efficiency analysis of wineries.*

Country Code	Company name	Number in a total rating	Super-efficiency score	Returns to Scale (RTS)	Scale efficiency score
B&H	**AG Medugorje**	**1**	**2.7064**	→	**1**
UA	**Shabo**	**2**	**1.9198**	→	**1**
UA	**Bakhchisaray**	**3**	**1.4500**	→	**1**
UA	**Tsjurupinske**	**4**	**1.3770**	→	**1**
UA	**Odesa Factory of Sparkling Wines**	**5**	**1.2736**	→	**1**
UA	**Feodosiya**	**6**	**1.2636**	→	**1**
UA	**Kyiv Factory of Sparkling Wines**	**7**	**1.1261**	→	**1**
B&H	**Proto**	**8**	**1.0690**	→	**1**
UA	Harchovyk	9	0.9568	↑	0,9998
UA	Artemivsk Winery	10	0.8690	↓	0,8690
B&H	Vinarija Jelic - Bortoluzzi	11	0.8267	↑	0,8267
UA	Odesavinprom	12	0.7996	↑	0,9999
B&H	Vino Produkt	13	0.7871	↑	0,9045
UA	Vynogradar	14	0.7710	↑	0,9979
B&H	Podrumi Vukoje 1982	15	0.7506	↑	0,9955
UA	Koblevo	16	0.6790	↓	0,9982
B&H	Pod. Manast.Tvrdoš	17	0.6720	↑	0,9508
UA	Prince Trubetskoy	18	0.6122	↑	0,9983
B&H	Vinarija Jungic	19	0.6063	↑	0,8841
B&H	Vinarija Čitluk	20	0.5960	↑	0,9964
UA	Victoria	21	0.5288	↑	0,9991
UA	Limanskiy	22	0.5282	↑	0,9969
UA	Bolgrad Winery	23	0.5255	↑	0,9992
B&H	P.M.V.	24	0.4837	↑	0,4837
B&H	Podrum Pavicevic	25	0.4607	↑	0,4607
B&H	Premium Vinogradi	26	0.4366	↑	0,4366
B&H	Podrum Tarana	27	0.4176	↑	0,4176
B&H	Podrumi Banj. Biskupije	28	0.3728	↑	0,9501
B&H	Hepok	29	0.3428	↑	0,9985
UA	Dnistrovske	30	0.3367	↑	0,9711
B&H	Komrad	31	0.3032	↑	0,8036
B&H	Popovo Polje	32	0.2553	↑	0,9759
UA	Beregovo-Tisa	33	0.2171	↑	0,9899
Average on a total sample			*0.6978*	↑	*0,8815*

Source: Authors' calculations.

In Bosnia&Herzegovina, low reserve of reduction of a number of employees (0.1% – only 2 workers) indicates the small difference in the level of labour productivity.

Zero reserve of material inputs reduction testifies the insignificant gap in a level of material capacity of production between the efficient and inefficient wineries in Ukraine. High reserve of material costs reduction are characterized by the Bosnian wineries (total reserve is about 2 mln EUR or 26.4%).

Identifying reserves in wine industry, we found that the high potential growth of efficiency in Ukrainian wineries (till 28.9%) can be realized due to staff reduction and reduction of excessive fixed assets (improving and optimizing the facilities and equipment). These problems can be decided by implementing new technologies that would increase labour productivity in inefficient Ukrainian wineries. In Bosnian wineries, reduction of specific consumption of raw materials and excessive fixed assets would affect the potential growth of efficiency (till 28.3%).

Reserve of material inputs reduction equal to zero prevented us from seeing how much effectively raw materials are used in the Ukrainian wineries. That is why our next research assignment was to conduct cross-country efficiency analysis.

Cross-country efficiency analysis

In the next steps, we have tried to reveal the features of individual wine businesses and to find opportunities for their effective development. The following tools are used:

– CRS and VRS DEA models to estimate scale efficiency and RTS for each winery;

– DEA model of super-efficiency to make a full ranking for wineries and finding cross-country leaders in wine industry;

– SBM to define the reserves of inputs reduction for inefficient wineries.

On the cross-country efficiency frontier are 8 out of 33 wineries. Six medium and big Ukrainian wine companies are in a leaders' group. All of them have constant RTS, but only four have positive net profit (*Shabo, Tsjurupinske, Feodosiya* and *Kyiv Factory of Sparkling Wines).* Two Bosnian wineries are in the leaders' group: (*AG Međugorje* and *Proto)*. *AG Međugorje* has the highest super-efficiency and also high profitability (above 30%).

Other wineries are inefficient and can be divided into three groups.

The most numerous group presents the middle-efficient wineries with increasing RTS and the prospects for efficient development. This group includes 13 wineries (7 Ukrainian and 6 Bosnian). All they need to improve operational technologies and increase sales and output to reach efficiency frontier.

The second numerous group includes low-efficient wineries. This group includes 10 wineries (2 Ukrainian and 8 Bosnian), small and medium wineries and have no chance in the near future to achieve efficiency frontier. Each of them has own problems, but all have an increasing RTS, hence if their business grows then efficiency will increase.

The third group is relatively small and includes two wineries - the big Ukrainian wine companies that have accelerated growth in inputs when increasing output. To improve their efficiency companies' management should decrease output or implement a significant change in operational technologies.

The scale inefficiency for observed sample is about 12% and total potential growth of efficiency

Diagram 2 - *Classification of Ukrainian and Bosnian wineries in three groups according to the cross-country efficiency analysis*.

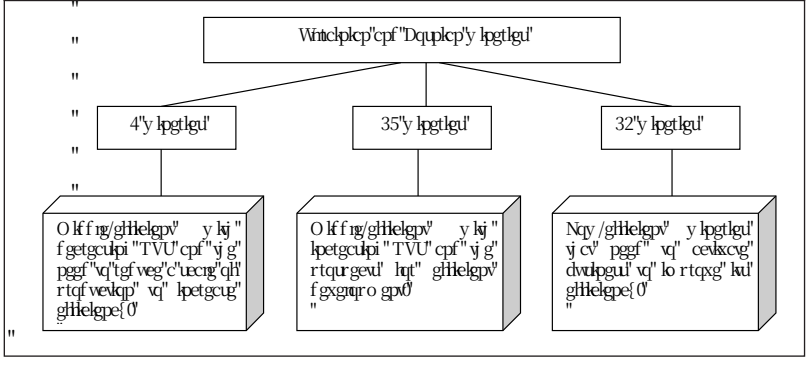
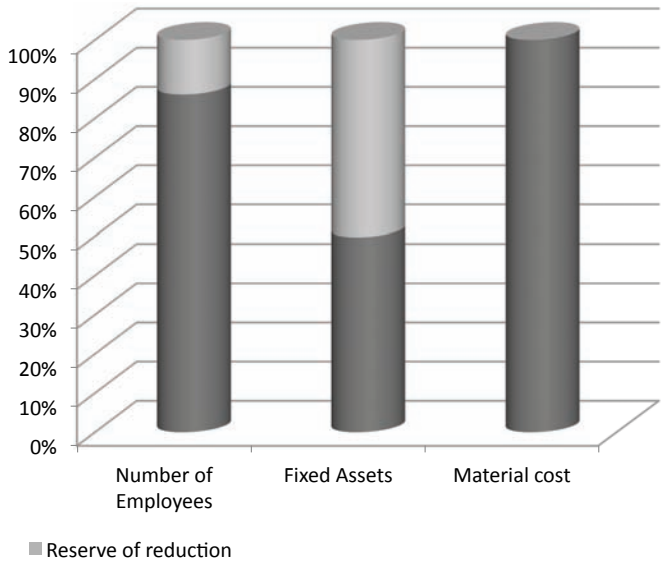


Figure 4 - *Potential to reduce inputs in wine industries of Ukraine and Bosnia&Herzegovina*.



Source: Authors' calculations.

is above 30%. Those results present good prospects for effective development of the wine industry in both countries. In order to realize this potential of the inefficient wineries, there is necessity of learning the best practices from industry leaders and enhance the activity in the field of sales promotion.

In the next phase, we have used SBM in order to define the potential to reduce inputs to achieve the efficiency frontier (Figure 5).

Analyzing the inputs of Ukraine and Bosnia& Herzegovina wineries and their potential to reduce them, we concluded that there is a high reserve of reduction in number of employees (about 14% – 450 workers). This indicates the significant gap in a labour productivity level of benchmarks (efficient) and other wineries. There is insignificant gap in a level of material capacity of production between the efficient and inefficient wineries in Ukraine and Bosnia& Herzegovina, because the reserve of material inputs reduction is close to zero. The highest reserve on fixed assets shows a share of their unproductive part (over 50%), of which the wineries can escape reaching a benchmark level of capital productivity.

6. Discussion and conclusions

Cross-country efficiency analysis enabled us to find inter-country leaders in wine industry – small Bosnian wineries and large Ukrainian wine companies; to group inefficient wineries and find main directions to improve efficiency for each group; to define a potential growth of efficiency (above 30%) and scale inefficiency (about 12%) for a total sample; to calculate the potential to reduce inputs in wine industry and potential growth of output at constant inputs for total sample. The high potential growth of efficiency in Ukrainian wineries (till 28.9%) can be realized due to reduction of excessive fixed assets (improving and optimizing the facilities and equipment) and staff reduction. Together these problems can be decided by implementing new technologies that increase labour productivity in inefficient Ukrainian wineries. In accordance with the results of this study we can recommend for the government of Ukraine to remove the barriers for development of small business in the wine industry. One of the major barriers in this country is the high license fee for the right to sell a wine, which amounts to about 20000 EUR per year. This amount is very difficult for a small business and significantly decreases its effectiveness. As a result, none of the small wineries in Ukraine today is effective or profitable.

The high potential growth of efficiency in Bosnian wineries (till 28.3%) can be realized due to a reduction of specific consumption of the raw materials and excessive fixed assets. The development of the wine sector in B&H will, to a large extent, depend on the measures of market-price policy, structural policy measures and measures of financial support. The research system is also an important actor in this respect. One significant development issue for the B&H wineries is the situation regarding the payment (90 days) terms of the clients and the associated delays. Furthermore, next challenges must be met with the education and training of wine producers and processors in B&H, but also of the sector down the value chain in general, where emphasis is on the processes of a small-scale wine making.

The characteristic of wine production in B&H is the fact that it deals with a large number of small producers who produce the same products in different ways which makes them difficult to harmonize and consolidate the joint bid. Often such production can be described as extensive, and a way of producing traditional and typical for the area. On the other hand, it can be an advantage if such products are supplied in the market as products with protected designation of origin or traditional products.

In support of the objective pertaining to the improvement of efficiency in this sector, generally raising the technological level of production must also be ensured by increasing the volume and sources of investment financing.

Acknowledgements

We would like to thank reviewers for the useful and accurate suggestions that have contributed to improve our paper.

References

Anderson P. and Petersen N. C., 1993. A procedure for ranking efficient units in Data Envelopment Analysis. *Management Science,* 39(10): 1261-1264.

ASBH, 2015a. *Production of fruit and grapes. Bulletins for 2006-2014*. Agency for Statistics of Bosnia&Herzegovina, Agriculture, BHAS. Sarajevo.

ASBH, 2015b. *Industrial production in Bosnia&Herzegovina. Bulletins for 2006-2014*. Agency for Statistics of Bosnia&Herzegovina, Agriculture, BHAS. Sarajevo.

Asif M., 2015. Determining improvement needs in higher education benchmarking. *Benchmarking: An International Journal*, 22(1): 56-74.

Aparicio J., Borras F., Pastor J. and Vidal F., 2013. Accounting for slacks to measure and decompose revenue efficiency in the Spanish Designation of Origin wines with DEA. *European Journal of Operational Research*, 231(2): 443-451.

Banker R.D., Charnes R.F. and Cooper W.W., 1984. Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, 30: 1078-1092.

Barisan L., Boatto V., Rossetto L. and Salmaso L., 2015. The knowledge of Italian wines on export markets: A non-parametric methodology to analyze promotional actions. *British Food Journal*, 117(1): 117-138.

Bojnec S. and Latruffe L., 2008. Measures of farm business efficiency. *Industrial Management & Data Systems,* 108(2): 258-270.

Bojnec S. and Latruffe L., 2009. Determinants of technical efficiency of Slovenian farms. *Post-Communist Economies,* 21(1): 117-124.

Bouzdine-Chameeva T., 2012. An application of the DEA methodology in wine sector: the comparison of traditional versus "bio" wine companies in terms of production and efficiency value. *ROADEF,* Angers, 11-13 april 2012.

Charnes A., Cooper, W. and Rhodes, E., 1978, Measuring the efficiency of decision making units, *European Journal of Operational Research,* 2(2): 429-444.

Conradie B., Cookson G. and Thirtle C., 2006. Efficiency and farm size in Western Cape grape production: pooling small datasets. *South African Journal of Economics,* 74(2): 334-343.

Couderc J.□P. and Marchini A., 2011. Governance, commercial strategies and performances of wine cooperatives: An analysis of Italian and French wine producing regions. *International Journal of Wine Business Research*, 23(3): 235-257.

De Witte K., 2015. *Contemporary Economic Perspectives in Education*. Leuven: Leuven University Press.

FAO, 2012. *The wine sector in Bosnia and Hercegovina*. Preparation of IPARD Sector Analysis in BiH, GCP/BiH/007/EC, Regional Office for Europe and Central Asia, Food and Agriculture Organization of the United Nations, Budapest.

FMAFWM, 2015. *Mid-term development strategy of agricultural sector in the federation of Bosnia&Herzegovina 2014-2018*. Federal Ministry of Agriculture, Forestry and Water Management. FBIH, Sarajevo.

Galluzzo N., 2014. Analysis of efficiency in organic vinegrowing farms using Italian F.A.D.N. Dataset. *European Journal of Business, Economics and Accountancy*, 2(2): 73-83.

Gil A.J., Garcia-Alcaraz J.L. and Mataveli M., 2015. The training demand in organizational changes processes in the Spanish wine sector. *European Journal of Training and Development*, 39(4): 315-331.

Goncharuk A.G., 2009. Improving of the efficiency through benchmarking: A case of Ukrainian breweries. *Benchmarking: An International Journal*, 16(1): 70-87.

Goncharuk A.G., 2013. What causes increase in gas prices: the case of Ukraine. *International Journal of Energy Sector Management*, 7(4): 448-458.

Goncharuk A.G. and Getman M., 2014. Benchmarking to improve a strategy and marketing in pharmaceuticals. *Benchmarking: an International Journal*, 21(3): 364-385.

Goncharuk A.G. and Lazareva N.O., 2015. About the efficiency of Ukrainian wineries. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 15(4): 95-98.

Goncharuk A.G. and Monat J.P., 2009. A synergistic performance management model conjoining benchmarking and motivation. *Benchmarking: An International Journal*, 16(6): 767-784.

Hanf J.H., 2014. Literature survey on new participative pricing mechanisms for wine tastings. *Journal of Applied Management and Investments*, 3(4): 201-213.

Hanf J.H., Gagalyuk T. and Schweickert E., 2013. Problems of goal alignment for German wine cooperatives. *Journal of Applied Management and Investments*, 2(4): 244-252.

Henriques P.D.d.S., Carvalho M.L.d.S. and Fragoso R.M.d.S., 2009. Technical efficiency of Portuguese wine farms. *New Medit*, 8(1): 4-9.

Jozsef, T. and Peter, G., 2014. Is the New Wine World more efficient? Factors influencing technical efficiency of wine production. *Studies in Agricultural Economics*, 116(2): 95-99.

Liu H.Y. and Lv K., 2010. Productive efficiency and its influencing factors of wine-making firms in China. A research based on DEA-Tobit approach. *Collected Essays on Finance and Economics*, 2: 1-6.

Lo Storto C., 2014. Benchmarking operational efficiency in the integrated water service provision: Does contract type matter?. *Benchmarking: An International Journal*, 21(6): 917-943.

MAFWM, 2015. *Report on the impact assessment regulations on the draft law on spiriti drinks*. Ministry of agriculture, forestry and water management of Republic of Srpska, Banja Luka.

Mencarelli F. and De Propris, L., 2014. Map of sustainable production models: indicators of sustainable winegrowing, pp. 34-61. In: Unione Italiana Vini. *First Report on Sustainable Winegrowing, towards EXPO Milano 2015*. , available at: http://www.vinosostenibile.org/wp-content/uploads/2014/11/First-Report-Wine-Sustainability-Ocotber-2014.pdf

MFTERBH, 2015. *Annual report from the field of agriculture, food and rural development in Bosnia&Herzegovina for 2014*. Ministry of Foreign Trade and Economic Relations of Bosnia&Herzegovina Sarajevo.

Moreira V.H., Troncoso J.L. and Bravo-Ureta B.E., 2011.

Technical efficiency for a sample of Chilean wine grape producers: A stochastic production frontier analysis. *Ciencia e investigación agraria*, 38(3): 321-329.

Lazareva N.O., 2015. Evaluating the efficiency of wineries in Ukraine: A three-criteria approach. *Journal of Applied Management and Investments*, 4(4): 239-242.

Liu H.Y. and Lv K., 2010. Productive efficiency and its influencing factors of wine-making firms in China. A research based on DEA-Tobit approach. *Collected Essays on Finance and Economics*, 2: 1-6.

Orr S.C., 1997. Technology and process management in the Australian wine industry. *Benchmarking for Quality Management and Technology*, 4(1): 18-33.

Rinaldo S.B., Duhan D.F., Trela B., Dodd T. and Velikova N., 2014. Evaluating tastes and aromas of wine: a peek inside the "black box". *International Journal of Wine Business Research*, 26(3): 208-223.

Sellers-Rubio R., Sottini V. and Menghini S., 2016. Productivity growth in the winery sector: evidence from Italy and Spain. *IJWBR,* 28(1): 59-75.

Sellers R. and Alampi-Sottini V., 2016. The influence of size on winery performance: Evidence from Italy. *Wine Economics and Policy,* 5: 33-41.

Timofti E., 2013. Methodology elaboration of integral appreciation of economic efficiency of wine growing sector 's production in the Republic of Moldova. *Economic Engineering in Agriculture and Rural Development*, 13(1): 431-434.

Tone, K. A. (2001), "Slacks-Based Measure of Efficiency in DEA", *European Journal of Operational Research*, Vol. 130 No. 3, pp. 498-509.

Toth J. and Gal P., 2014. Is the New Wine World more efficient? Factors influencing technical eficiency of wine production. *Studies in Agricultural Economics,* 116: 95-99.

Townsenda R.F., Kirstena J. and Vinkb N., 1998. Farm size, productivity and returns to scale in agriculture revisited: a case study of wine producers in South Africa. *Agricultural Economics*, 19(1-2): 175-180.

Vázquez-Rowe I., Villanueva-Rey P., Iribarren D., Moreira M.T. and Feijoo G., 2012. Joint life cycle assessment and data envelopment analysis of grape production for vinification in the *Rías Baixas* appellation (NW Spain). *Journal of Cleaner Production*, 27: 92-102.

Vincová K., 2005. Using DEA models to measure efficiency. *BIATEC,* 8: 24-28.

Wine Institute (2016), *World Statistics*. Wine Institute. http://www. wineinstitute.org/resources/statistics.