Analysis of costs and their effectiveness in the EU agrarian sector

Reception of originals: 09/27/2019
Release for publication: 03/04/2020

Jaroslav Svoboda
Assoc. Prof. PhD in Department of Accounting and Finances
Institution: University of South Bohemia, Faculty of Economics
Address: Studentská 13, 370 05 České Budějovice, Czech Republic
E-mail: **svoboda@ef.jcu.cz**

Jana Lososová
Master in Agricultural Engineering
Institution: University of South Bohemia, Faculty of Economics
Address: Studentská 13, 370 05 České Budějovice, Czech Republic
E-mail: **lososova@ef.jcu.cz**

Radek Zdeněk
Assoc. Prof. PhD in Department of Accounting and Finances
Institution: University of South Bohemia, Faculty of Economics
Address: Studentská 13, 370 05 České Budějovice, Czech Republic
E-mail: **zdenek@ef.jcu.cz**

Abstract

This paper deals with the assessment of costs in the EU in the agricultural sector. Cost monitoring and analysis are one of the basic prerequisites for good financial management of every company. An international comparison for the EU was made in 2004-2017 and it was based on the Farm Accountancy Data Network (FADN). The absolute amount of costs reached 67 thousand EUR in 2017 while the total average cost per hectare in the EU was EUR 1,748 at a cost growth rate of 1.8 % per year. In terms of cost structure, specific costs amount to about 42 %; overheads amount to 26 %; depreciation amounts to 15 %; wages amount to 10 %; rent amounts to 5 % and interest amounts to 2 %. A cluster analysis has also made it possible to classify countries that are characterized by common features. In terms of the total cost ratio, where costs are measured in relation to production, only 17 out of the 28 EU countries (EU28) achieve a value that is lower than 1 (i.e. firms are profitable). In this case, it is gross profitability (excluding the balance of operating subsidies and taxes). In assessing the total cost ratio, a relation is necessary in terms of specifics of the countries concerned – in particular in terms of their climatic conditions and production structure. In the next phase of this paper, it was assessed whether increasing production volume is economically effective. In all the states without exception, production volume increased in the period under review. Increasing cost-effectiveness was achieved in 15 EU countries. An average farm in the EU achieved increasing cost-effectiveness with profit gains. During the period under review, there was a relative cost saving of EUR 48 due to a decrease in the total cost ratio and an increase in profit by EUR 1,919 due to an increase in production.

Keywords: Costs. Effectiveness. Agriculture.

1. Introduction

Cost monitoring and analysis are one of the basic prerequisites for good financial management of each company. Firstly, they are based on the determination of an appropriate cost structure (either by a generic or purpose-defined classification), as well as the determination of an optimum cost amount and, last but not least, the monitoring of their effectiveness.

Costs are a monetary representation of the consumption of assets, including the wear and tear of fixed assets, live labour (wages) and outsourced services purchased from other firms. Costs must be distinguished from cash expenses, which represent a decrease in cash funds of a firm (cash, money in bank accounts), regardless of the purpose for which they are used, e.g. purchase of machinery is a money expenditure but not a cost (Synek et al., 2011).

Agriculture is one of the sectors of material production whose final results are based on the direct impact of a company on nature. A specific feature of agriculture is its production and non-production function as well as lower productivity with limited possibilities for its improvement. Low productivity is affected by technical and technological options when compared to other sectors. Production costs are reflected in consumer prices and these are manifested as socio-economic impacts (Vošta, 2010). The objective of this paper is to analyze the structure, amount and development tendencies of the costs of farms in individual member states of the European Union.

2. Literature Review

The agricultural sector is considered sustainable if it is able to withstand crisis periods and align its productivity with stability and fairness. The development of productivity in intermediate consumption shows that agriculture is less efficient than other economic sectors and it is also experiencing significant instability in countries with a well-developed agricultural sector (Ciutacu et al., 2015).

The main task in the preparation of each kind of production is to achieve such a relationship between sales, production volume and costs so as to achieve a reasonable profit. Economic performance may vary considerably between farms, even if they operate under more or less similar conditions. Differences in economic results are usually attributed to differences in management, with management being considered as a fourth factor of

production alongside land, labour and capital (Rougoor et al., 1998). The effectiveness of agricultural production is increased mainly by the growth of production through the growth of income in kind and yield. Machado et al (2018), for example, focus in their study on the costs in milk production. They claim that farmers focus primarily on the growth of production, but insufficient attention is paid to the costs per unit of production, which may affect their competitiveness.

Reduction of agricultural production costs is achieved by focusing primarily on reducing labour costs through mechanization and modernization of production processes. This process brings several benefits, including increased labour productivity, reduced dependency on labour costs and labour availability, increased production process flexibility (easier adoption of new production processes), reduced material inputs (i.e. agrochemicals and fertilizers) and improved product quality (better process control). However, production systems are becoming more and more complex, requiring higher investment and service costs (Bochtis et al., 2018).

If profit margins are low, even a small increase in production costs often eliminates the expected profit and makes production unprofitable. Cost management should therefore be continuous so that costs remain low (Bochtis et al., 2018). According to a study by Ren et al. (2019) the size of farms has a significant impact on the economic effectiveness of agriculture. Given the indivisibility of capital, such as investment in machinery, it is difficult to reduce the average input costs per area of small farms (Manjunatha et al., 2013). In the case of large farms, on the other hand, the fixed cost for farmed land is low (Carter, 1984), resulting in higher production effectiveness (Rios and Shively, 2005). Lu et al., (2018) state that an increase by one unit in farm size leads to about an 8% decline in the average production cost.

Many studies deal with the costs of environment use, the so-called externalities, which are side effects of economic activities and their costs are not part of the prices paid by producers or consumers (Waibel et al., 1999; Tegtmeier and Duffy, 2004; Pretty, et al. 2005; Knowler and Bradshaw, 2007). A study by Pretty et al. (2000) assesses the total external cost of the environment and health of modern agriculture in the United Kingdom. It argues that the total external costs of agriculture in the United Kingdom are substantial, including 89 % of the average net agricultural income for 1996. If externalities are not included in prices, they distort the market by encouraging activities that are costly to companies, even if private benefits are substantial (Lewis, 1996, Brouwer, 1999, Pretty et al., 1999). Other studies deal with comparing the production costs of organic and conventional agriculture (Kroupová and

Malý 2010; Seufert, et al. 2012; Krause and Machek, 2018), the energy balances of agricultural production processes (Špička and Jelínek, 2008), the costs of reducing ammonia emissions (Wagner et al., 2017) and greenhouse gas emissions (Pellerin et al., 2017).

The objective of this paper is to analyze the structure, amount and development tendencies of the costs of farms in individual member states of the European Union. It is a comparative analysis of costs, the resulting indicators of production effectiveness and their structure. The Farm Accountancy Data Network (FADN) database was used for this purpose. The structure of this article is as follows: after an introduction and a brief overview of the current state of knowledge in the area under review follows a description of the database used and methodological procedures for solving the issue. This is followed by a description of the main results of the paper, i.e. a comparative analysis of the cost structure in the individual Member States, then by a cluster analysis used for identifying clusters of EU states according to total costs and their structure, followed by the assessment of total cost ratio and cost-effectiveness.

3. Methodology

International comparison for the EU25, or the EU28 to be more precise, relies on Standard Output (SO), which is information compulsorily submitted on an annual basis by the individual Member States to the Directorate-General for Agriculture and Rural Development (DG AGRI). SO is an average monetary value of agricultural production at agricultural producer prices for each commodity in each region. The SO coefficients are expressed in the Euros and the economic size of individual companies is measured as the total standard production of a company expressed in Euros. The basic comparative unit of this sample survey is the so-called average company, which is represented in each individual member state in general and is also differentiated, e.g. by the focus of production, economic size, etc. A so-called weighting system is used to determine average size parameters for all operated company size groups. This system is used to express weighted averages of all the FADN database values. The results presented by the European Commission are converted into a representation of an average company using a relatively complex weighting procedure. Final comparable data for all Member States is published with a two-year delay as compared to the current situation. The submitted analysis is based on the final data for the years of 2004 – 2017 (FADN 2019).

In the first part of the paper, the data will be used to analyze the total costs and their structure (production consumption, depreciation and external costs – wages, ground rent and interest). A clear overview of the structure of the costs recorded in the FADN database is presented in the Figure 1 which follows. Total inputs are the costs linked to the agricultural activity of a holder and are related to the output of an accounting year. Included are amounts relating to inputs produced on a holding (farm use) = seeds and seedlings and feed for grazing stock and granivores, but not manure. When calculating the FADN standard results, farm taxes and other dues are not included in the total for costs. They are taken into account in the balance of subsidies and taxes /subsidies – taxes/ on current and non-current operations. The personal taxes of a holder are not to be recorded in the FADN accounts.

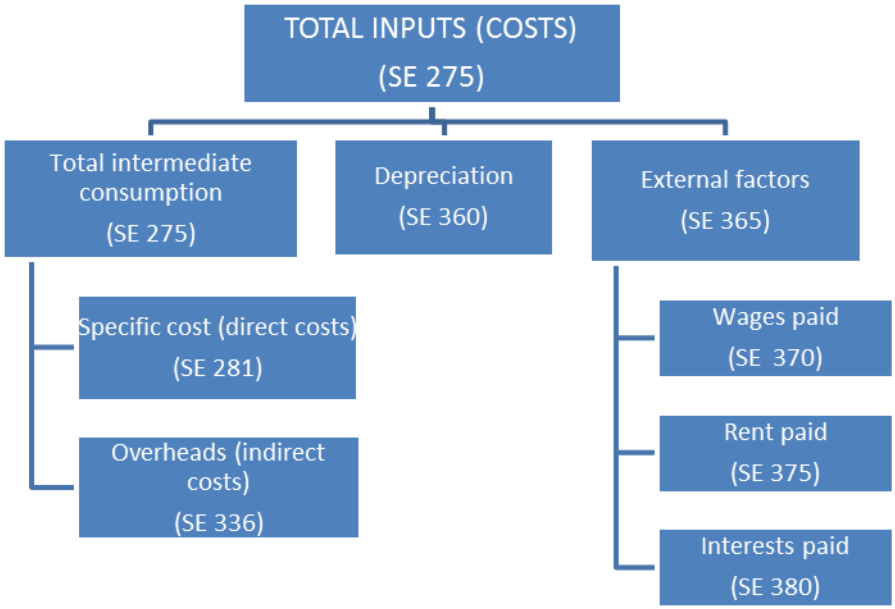

Figure 1: Cost structure according to FADN
Source: FADN, authors' own processing

Standard descriptive statistical characteristics and a cluster analysis will be used for this analysis. It will allow us to set clusters (groups) of states within the EU characterized by common features.

Based on the data processed by the cluster analysis, a multi-variable statistical method dividing the large groups under review into smaller and more homogeneous groups could be carried out. The clustering process can be roughly divided into three categories – hierarchical, non-hierarchical and a two-stage category. Ward's method was used in this article. Ward's method joins two clusters, *A* and *B*, which minimize an increase in the sum of squares of error within a cluster, I_{AB} (Rencher (2002), Řezanková, Húsek and Snášel, (2009),

where n_A, n_B are the numbers of points in *A*, *B*; and $\bar{\mathbf{y}}_A$, $\bar{\mathbf{y}}_B$ are centroids of A and B, respectively. As a distance function, Euclidean distance is used between two vectors $\mathbf{x} = (x_1, x_2, ..., x_p)^T$ and $\mathbf{y} = (y_1, y_2, ..., y_p)^T$, defined as (Rencher, 2002)

In the following part of the paper, the cost analysis will be extended to other indicators (production – SE 131, profit – profit/loss), which will allow us to assess the total cost ratio (total cost ratio; cost/revenue ratio) and subsequently to determine cost effectiveness.

Total output (production) = output of crops and crop products, livestock and livestock products or other outputs. Sales and use of (crop and livestock) products and livestock

+ change in the stock of products (crop and livestock)

+ change in the value of livestock

– purchases of livestock

+ various non-exceptional products.

Profit/loss = total output (production, SE 131) – total input (cost), SE 270)

Total cost ratio = total input (cost, SE 270)/total output (production, SE 131)

We use total cost ratio, calculated as the total costs from production compared to the total revenue from production (Davidova et al., 2002; Bojnec and Latruffe, 2013). According to this measure, farms with a ratio lower than 1 are profitable, while farms with a ratio higher than 1 are unprofitable. We calculate total revenue from production by excluding subsidies so that the true profitability of production is assessed.

The degrees of cost-effectiveness reflect qualitatively different developmental trends that are based on the relationship between production volume and costs. These trends influence fundamental changes in the dynamics of profitability, profit (loss) volume and production volume (Střeleček et al., 2011). Based on the relationship between production volume and cost dynamics, nine basic levels of effectiveness can be expressed. The assessment of cost-effectiveness is influenced by the dynamics of production volume. For this reason, we divide the degrees of effectiveness for three cases of production volume:

increasing production volume, constant production volume and decreasing production volume. We use the relations shown in Table 1 to assess cost-effectiveness.

Table 1: Relations used to assess cost-effectiveness

Index of output	$I_R = R_1 / R_0$
Index of cost	$I_C = C_1 / C_0$
Cost/revenue ratio	$c = C / R$
Differential cost	$dc = (C_1 - C_0) / (R_1 - R_0)$
Change in cost (ΔC) can be broken down to:	
• Relative change in cost due to total cost ratio	$\Delta C_c = (c_1 - c_0) \cdot R_1$
• Relative change in costs due to output	$\Delta C_R = c_0 \cdot (R_1 - R_0)$ $\Delta C = \Delta C_c + \Delta C_R$
Change in profit/loss (ΔP) can be broken down to:	
• Relative change in profit due to output	$\Delta P_R = (1 - c_0) \cdot (R_1 - R_0)$
• and minus relative change in cost due to total cost ratio (ΔC_c)	$\Delta P = -\Delta C_c + \Delta P_R$

Note: R stands for production (FADN code SE131), *C* is costs (SE270), *P* is Profit/Loss, and Δ is difference operator

4. Results and Discussion

4.1. Total costs

The total amount of costs (in an absolute amount) in EU agriculture increased in an average farm from EUR 53 thousand in 2004 to EUR 67 thousand in 2017, with an average growth rate of 1.8 % per year. Recalculation of the total costs per hectare of utilized agricultural land (UAA) does not affect the growth rate. In 2004, the total costs/ha of UAA amounted to EUR 1,515 and they had increased by 2017 to EUR 1,914/ha of UAA.

The development of the total costs per hectare of agricultural land assessed according to a cluster analysis is shown in Figure 2.

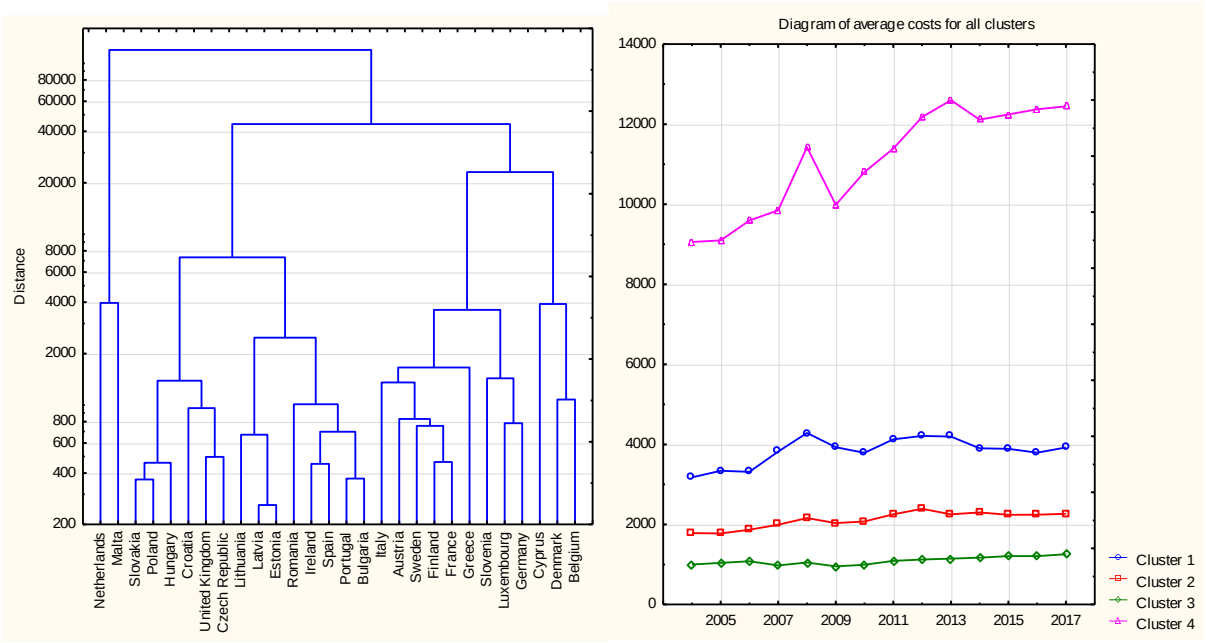

Figure 2: Cluster analysis of the total costs per hectare of the EU
Source: FADN, authors' own calculations

Four clusters were used for the assessment. Each cluster contains member states with approximately the same level of total costs per hectare of utilized agricultural land – see Table 2.

Table 2: The total average costs in EUR/ha of utilized land and the growth rate (index)

CLUSTER 1	Cyprus (3,410.0/1.001); Belgium (4,019.0/1.022); Denmark (4,076.7/1.025) **Average total costs: 3,835.3**
CLUSTER 2	Germany (2,536.3/1.021); Greece (1,854.2/1.003); France (1,973.6/1.020); Croatia (1,344.7/1.008); Italy (2,182.6/1.001); Luxembourg (2,366.2/1.027); Austria (2,036.0/1.040); Finland (2,088.9/1.021); Sweden (1,904.2/1.030); Slovenia (2,228.0/1.049) **Average total costs: 2,116.3**
CLUSTER 3	Lithuania (639.2/1.068); Latvia (760.9/1.051); Estonia (787.6/1.067); Portugal (913.1/1.022); Romania (940.3/0.964); Bulgaria (967.5/1.040); Spain (992.1/1.030); Ireland (1,066.3/1.037); Poland (1,214.5/1.028); Slovakia (1,218.3/1.052); Hungary (1,282.9/1.031); United Kingdom (1,412.1/1.024); Czech Republic (1,494.0/1.041) **Average total costs: 1,092.1**
CLUSTER 4	Netherlands (10,779.8/1.031); Malta (11,382.6/1.019) **Average total costs: 11,081.2**

Source: FADN, our own calculations
Note: Bulgaria, Romania since 2007; Croatia since 2013.

The average total cost per hectare is EUR 1,748 in the whole EU. The average growth rate of costs in the period under review was 1.8 % per year. Decreasing total costs can only be observed in Italy (by 4 %) and Romania (by less than 1 %). However, the costs recalculated per hectare of utilized agricultural land in Malta and the Netherlands are the highest in the

EU, which can be explained by high production intensity. The fastest growth in total costs is apparent in the Baltic states and Slovakia (approx. 5-6 %).

A more detailed development of the total costs recalculated per hectare is shown in Figure 2. As already mentioned, it shows a clear deviation of Cluster 4 – the Netherlands and Malta, whose total costs are more than 6 times higher than the EU average. This group is followed by Cluster 1 – containing Cyprus, Belgium and Denmark, which have total costs per hectare of more than two times the average. In contrast, the lowest total costs per hectare are achieved by Cluster 3 – in particular by the Baltic countries. Cluster 2 has costs up to 20 % higher than the EU average. This group also includes some of the original and largest EU countries – Germany, France, Italy and Luxembourg.

Taking into account all entries in the accounts, i.e. specific costs, overheads, depreciation, wages, rent and interest, the result of the cluster analysis is identical to that of taking into account the total cost per hectare only (see Figure 2). Again, it is possible to see a distribution into 4 clusters. Taking into account all the kinds of cost therefore yields the same results as described above.

4.2. Cost structure

The percentage values of the kinds of costs achieved by EU countries in 2004 and 2017 are shown in Table 3.

Table 3: Cost structure by country in 2004 and 2017 (%)

	2004				2017			
COUNTRY	Specific costs	Over-heads	Depreciation	External factors	Specific costs	Over-heads	Depreciation	External factors
Belgium	50.1	19.7	14.5	15.6	54.1	20.0	13.8	12.2
Bulgaria[1]	46.3	23.0	9.7	21.0	36.0	18.6	13.3	32.1
Cyprus	46.4	18.2	18.0	17.4	54.8	20.8	9.0	15.3
Czech Republic	43.8	26.3	7.7	22.2	41.4	24.0	10.9	23.7
Denmark	40.3	19.5	12.5	27.6	46.9	19.5	10.2	23.4
Germany	34.7	30.8	14.3	20.2	39.3	27.4	13.3	20.0
Greece	40.7	21.8	20.4	17.1	38.8	27.3	18.5	15.5
Spain	48.7	20.2	8.6	22.5	44.1	26.4	8.8	20.8
Estonia	49.4	23.1	11.8	15.8	42.0	26.7	12.9	18.4
France	32.0	30.2	18.7	19.1	33.6	32.0	17.2	17.2
Croatia[2]	51.5	17.3	19.5	11.7	50.2	15.9	21.7	12.2
Hungary	38.2	29.0	12.0	20.8	47.9	24.1	9.2	18.8
Ireland	41.7	25.8	20.0	12.5	55.7	25.6	9.4	9.3
Italy	47.1	19.1	17.8	16.0	46.7	23.3	12.0	17.9
Lithuania	55.9	22.8	13.7	7.6	43.7	21.4	23.2	11.7
Luxembourg	33.5	25.6	28.4	12.5	37.9	24.1	26.3	11.7
Latvia	46.9	29.3	11.2	12.5	43.6	25.3	16.1	14.9
Malta	60.0	22.7	8.9	8.4	64.5	19.5	8.2	7.7

COUNTRY	2004				2017			
	Specific costs	Over-heads	Depreciation	External factors	Specific costs	Over-heads	Depreciation	External factors
Netherlands	38.1	26.1	13.4	22.4	46.9	22.1	11.8	19.2
Austria	28.3	35.2	27.5	9.0	36.9	30.6	23.6	8.9
Poland	52.3	21.9	19.5	6.3	47.6	23.3	20.2	8.8
Portugal	44.2	20.5	20.6	14.7	49.6	20.8	13.8	15.8
Romania[1]	54.8	19.5	9.9	15.8	49.5	22.5	15.5	12.5
Finland	33.9	32.3	22.6	11.2	35.3	34.6	18.0	12.1
Sweden	38.3	27.1	19.2	15.4	44.9	26.9	12.6	15.6
Slovakia	39.1	26.3	16.1	18.5	39.4	21.9	12.6	26.1
Slovenia	30.4	28.4	36.1	5.1	41.8	24.6	30.4	3.2
United Kingdom	42.0	25.9	12.0	20.1	47.4	23.8	11.8	17.0
EU	**39.9**	**25.9**	**15.9**	**18.4**	**42.6**	**25.9**	**14.1**	**17.4**

Source: authors' calculations on FADN data; Note: 1: data since 2007; 2: data since 2013

The total specific costs include: crop-specific inputs (seeds and seedlings, fertilizers, crop protection products, other specific costs), livestock-specific inputs (feed for grazing stock and granivores, other specific livestock costs) and specific forestry costs. The average value of the share of specific costs in the total costs was 41.5 % at a growth rate of 2.7 % over the period of monitoring in the EU. The values for the EU28 (EU25 or EU27) vary between 38.8 and 43.1 %. Malta (with the value of 64.5 % in 2017) was well above this threshold followed by Belgium, Cyprus, Croatia, and Ireland with the share of specific costs above 50 % (in 2017). The share of specific costs rose at the fastest rate in Ireland (1.35 % annually), the Netherlands (0.9 %) and Hungary (0.84 %). On the other hand, their share of specific costs dropped significantly in Bulgaria (-0.75 %) and Lithuania (-0.64 %).

Overheads are supply costs linked to production activity but not linked to specific lines of production (i.e. mainly contracted work, routine maintenance of machinery and equipment, fuel and lubricants, passenger car costs, routine maintenance of land and buildings, electricity, fuel, water, insurance, other overheads, building insurance). The table above shows that the average value of the share of overheads was the same in 2004 and 2017 (25.9 %). A more detailed look at its range makes clear the stability of this indicator – the minimum value for the EU28 was 25.4 % and the maximum value was 27.1 %. France, Austria and Finland have a significantly higher average share (over 30 %). On the other hand, Croatia has the lowest share (16 %). The share of overheads grew fastest in Greece (0.47 %) and Spain (0.36 %), with significant declines in Bulgaria (-0.61 % annually) and the Netherlands (-0.48 %).

Depreciation is the entry into the accounts of costs (depreciation) of capital assets over an accounting year. It is determined on the basis of the replacement value. It applies to

plantations of permanent crops, farm buildings and fixed equipment, land improvements, machinery and equipment, and forest plantations. There is no depreciation of land and circulating capital. The average share of depreciation in the total costs for the period under review decreased by 1.8 % to 14.1 %. However, in this cost item bigger differences can be observed between countries – e.g. with over 20 % there are Croatia, Luxembourg, Lithuania, Austria, Poland, Finland and Slovenia with the highest value being 30.4 % (Slovenia). For countries where the share of depreciation was increasing, it can be assumed that in recent years there has been an increase in investment activity and an increase in assets. The share of depreciation increased most during 2004-2017 in Lithuania (0.73 % annually), Romania (0.53 %) and Bulgaria (0.39 %); there was a significant decline in Ireland (-0.98 % annually) and Cyprus (-0.67 %). A downturn in terms of investment in farm assets can be assumed here.

This cost group – wages paid, as well as the other two, is part of the so-called external factors, and it includes wages and social security charges of wage earners. The amounts received by workers considered as unpaid workers (wages lower than a normal wage) are excluded. The average share for all countries was 9.4 %, with an average decrease of -0.1 % per year during 2004-2017. It can be observed that variability among the countries in the share of labour costs was higher than in the previous items (variation coefficient of 45 %). A more significant share can be observed particularly in 2017, in Slovakia (20.8 %, which also showed an annual growth by 0.26 %) and in the Czech Republic (17.8 %). In these countries there was the highest share of paid workforce in the total workforce (Slovakia 93.8 %, the Czech Republic 76.8 %). Of course, in countries with a low share of paid workforce (e.g. Slovenia 2.5 %), the share of labour costs was also low. And, of course, an important factor that explains variability in the share of labour costs is wage variability.

The costs of rent paid are an item arising from farm land and buildings and rental charges. They do not represent significant values and they amount to roughly the EU average of around 5 % of total costs, with a growth rate again of 0.04 % per year. Bulgaria has the highest share of ground rent payments (up to 18.4 % in 2017). In contrast, they do not even reach 1 % in Malta. The amount of ground rent is influenced by both the amount of land rent and the proportion of rented land. Land rent (i.e. ground rent per hectare) in 2017 ranged from EUR 41 (Latvia) to EUR 1,155 (the Netherlands) with an average of EUR 197. The share of rented land was lowest in Ireland (18.8 %) and highest in Slovakia (89.7 %) with an EU average of 54.2 %.

Interest paid is the last cost group analyzed. This includes interest and financial charges paid on loans obtained for the purchase of land, buildings, machinery and equipment, livestock, as well as circulating capital, and interest and financial charges on debts. This group is the least represented of the total costs – on average less than 3 %. It decreased from 3.3 to 2 % between 2004 and 2017. This may be due to the lower cost of borrowed capital, a reduction in investment or the preference for non-borrowed resources. The highest share of the total costs was in Denmark, which on average reached 13 %, where the share of interest steadily decreased from 21.2 % in 2008 to 8.5 % in 2017. The share of interest in costs was up to 1 % (on average) in Greece, Italy, Portugal, Spain, Slovenia, Malta and Romania. These countries are characterized by a small size of farms. They are family companies, which seem to prefer other sources of financing than loans, or they have a limited availability of loans.

Using cluster analysis can make it possible to get an idea of relatively similar EU states in terms of their cost structure (Figure 3). The assessment used 4 clusters that group states together which have the same development of the share of all the assessed cost types:

Cluster 1 includes France, Luxembourg, Austria, Finland and Slovenia. This cluster is characterized by a low share of specific costs and wages and a high share of overheads and depreciation.

Cluster 2 includes Greece, Croatia, Ireland, Lithuania, Latvia, Poland, Portugal, Romania, Sweden and the United Kingdom. This cluster is characterized by a higher share of specific costs and depreciation, while overheads and wages are at an average level.

Cluster 3 includes Belgium, Cyprus and Malta. This cluster is characterized by a high share of specific costs and a low share of overheads and depreciation.

Cluster 4 includes Bulgaria, the Czech Republic, Denmark, Spain, Estonia, Hungary, Italy, Germany, Slovakia and the Netherlands. The states in this cluster have a lower share of specific costs and depreciation, average overheads and high wages, rising rents and declining interest rates.

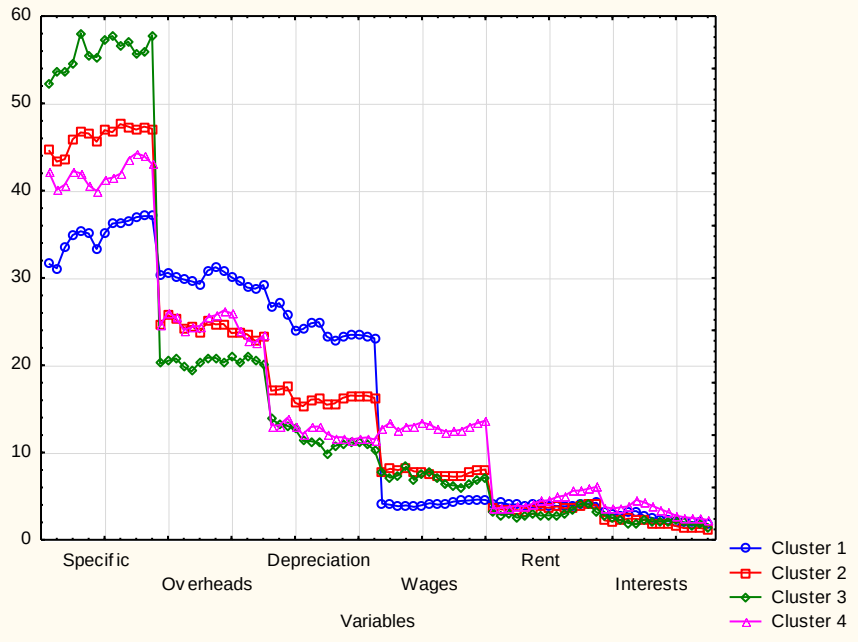

Figure 3: Cluster means
Source: authors' calculation on FADN data.

The largest disproportions in the cost structure are clearly in Cluster 3, which has the highest specific costs but, in contrast, achieves the lowest overhead costs per hectare. At the same time, costs due to depreciation and wages are rather low. The opposite situation is in Cluster 1, where the countries achieve the lowest direct costs, but overheads and depreciation are the highest. In terms of wages, the highest costs are in Cluster 4. A very similar development in all the clusters is seen in the costs of rent and interest, but their share in the total costs per hectare is very low.

4.3. Assessment of the total cost/revenue ratio and cost-effectiveness

The total cost/revenue ratio compares costs (inputs) and outputs (production) and it is therefore a cost assessment on a larger scale (Figure 4).

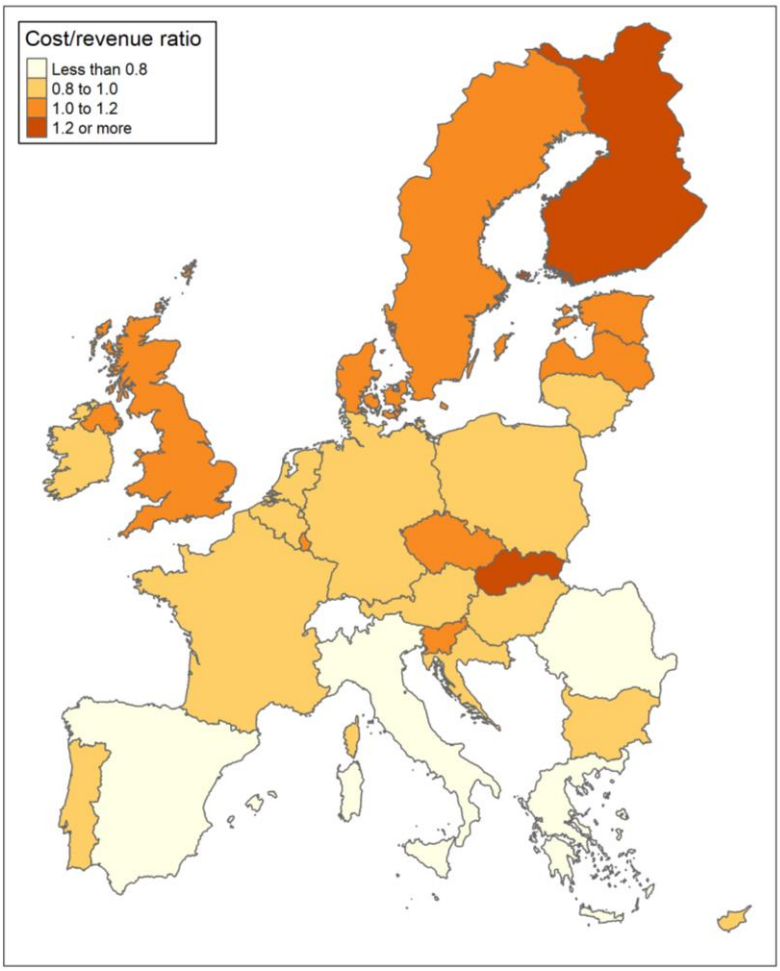

Figure 4: Average total cost/revenue ratio in the EU28
Source: authors' calculations on FADN data; Note: statistics for Bulgaria and Romania since 2007, for Croatia since 2013.

If the indicator value is up to 1 (or 100 %), a company makes a profit. If the value is 1 (or 100 %), it then falls into a loss. In view of this and the results obtained, the EU member states were divided into two profitable groups (up to 20 % and over 20 % profits) and the other two groups which contain loss-making companies (again with figures of up to 20 % and over 20 % loss, Figure 4). Countries such as Bulgaria (0.018 annually), Lithuania (0.016) and Estonia (0.015) show a rapid increase in the total cost ratio, while Ireland (-0.012 annually), Slovakia (-0.011) and Hungary (-0.011) saw a significant decrease in the total cost ratio.

Italy, Spain and Greece are therefore assessed very favourably in terms of the total cost ratio – which can be attributed mainly to their favourable climatic conditions, which allow high production intensity and a specific production focus on export commodities. For instance, olives and olive oil take up 20 % in Greece, wine takes up 15 % in Italy, vegetables take up 14 % in Spain, and vegetables and flowers take up 33 % in Malta. In the case of Spain, the low total cost ratio is mainly influenced by the low cost level. An increase in the

total cost ratio can be seen with increasing latitude. The highest total cost ratio was observed in Finland and Slovakia. Surprisingly, Finland also produces vegetables with a share of 16.5 %. The high total cost ratio in Slovakia is not caused by high costs but by low production levels. Of course, price levels, self-sufficiency of the countries concerned, purchasing power of the population and the application of the Common Agricultural Policy instruments – in particular in the sphere of subsidy policy – also play an essential role.

Cost-effectiveness is in a positive correlation with farm size (r = 0.62). The issue of whether small farms have a higher performance than large farms is often debated. Bojnec and Latruffe, (2013) argued that small farms are not affected by problems related to labour supervision and organization, and that family workers are highly motivated by farm profits. The inverse relationship is regularly questioned, as large farms should achieve economies of scale, and benefit from preferential access to output and input markets.

4.4. Assessment of cost-effectiveness

One of the most common questions about assessing the economics of production is to assess whether increasing production volumes is economically effective. Basic knowledge of this is provided by the degrees of cost-effectiveness. The degrees of cost-effectiveness show different qualitative development tendencies issuing from the dependence between production volume and costs. These tendencies influence the essential changes in the dynamics of the profitability ratio, profit/loss volume and production volume (Střeleček et al., 2010).

The individual degrees of effectiveness are characterized by different results of individual economic effects (the effect of the total cost ratio and the effect of production expansion). The assessment of the cost-effectiveness of an average farm by individual EU countries is shown in Table 4, which lists the partial indicators determined for their overall assessment according to the methodology.

Table 4: Assessment of cost-effectiveness of an average farm in EU countries in the period of 2004-2017

Country	*IR*	*IC*	c_0	c_1	*dc*	ΔC_c	ΔC_R	ΔP_R
Austria	1.81	1.76	0.93	0.90	0.86	-2 926	40 440	3 251
Belgium	1.57	1.63	0.81	0.84	0.90	8 133	77 083	17 658
Bulgaria	3.75	4.56	0.84	1.02	1.09	12 400	42 001	7 933
Croatia	1.10	1.05	0.93	0.89	0.49	22 541	2 183	164
Cyprus	1.21	1.03	0.97	0.82	0.12	-6 059	6 876	225
Czech Republic	1.36	1.53	1.03	1.16	1.52	41 478	88 088	-2 895
Denmark	2.08	1.85	1.09	0.97	0.85	-53 958	252 273	-20 012
Estonia	2.47	2.80	0.95	1.08	1.17	16 326	72 222	3 699

Country	*IR*	*IC*	c_0	c_1	*dc*	ΔC_c	ΔC_R	ΔP_R
Finland	1.85	1.76	1.36	1.29	1.22	-6 893	67 084	-17 683
France	1.44	1.40	0.98	0.96	0.90	-4 625	57 595	1 075
Germany	1.63	1.57	0.99	0.95	0.89	-10 190	99 957	1 349
Greece	1.18	1.40	0.64	0.75	1.40	2 803	2 327	1 333
Hungary	1.61	1.43	1.04	0.92	0.72	-9 563	31 360	-1 287
Ireland	2.16	1.86	0.97	0.83	0.71	-10 220	39 255	1 410
Italy	1.45	1.33	0.69	0.64	0.51	-4 054	14 889	6 542
Latvia	1.96	2.05	0.97	1.02	1.06	2 666	28 715	769
Lithuania	2.80	3.54	0.77	0.98	1.09	8 091	19 571	5 803
Luxembourg	1.66	1.74	1.02	1.07	1.15	10 198	84 344	-1 832
Malta	1.25	1.32	0.76	0.80	0.98	1 889	6 373	2 051
Netherlands	1.86	1.74	0.91	0.85	0.78	-31 389	220 774	21 225
Poland	1.54	1.73	0.77	0.86	1.03	2 695	7 840	2 382
Portugal	1.56	1.33	0.89	0.75	0.52	-4 586	11 161	1 446
Romania	1.07	0.82	0.91	0.70	-2.29	-2 786	794	76
Slovakia	1.46	1.59	1.13	1.23	1.44	61 394	223 631	-25 586
Slovenia	1.66	1.69	1.02	1.04	1.07	552	9 898	-160
Spain	1.75	2.11	0.60	0.72	0.89	10 076	20 711	13 814
Sweden	2.06	1.81	1.21	1.06	0.92	-34 269	143 838	-24 643
United Kingdom	1.65	1.51	1.08	0.98	0.84	-24 464	111 649	-7 893
EU	1.26	1.26	0.88	0.88	0.87	-48	13 638	1 919

Source: authors' calculations on FADN data; Note: statistics for Bulgaria and Romania since 2007, for Croatia since 2013.

In all the countries without exception, production volume increased in the period under review. The resulting assessment can then be classified into several groups according to the evolution of efficiency, which are characterized by common characteristics of a given degree. Based on this assessment, the individual EU countries were classified as follows:

- **Increasing cost-effectiveness with profit growth** is achieved in the following group of countries: Cyprus, Germany, France, Croatia, Ireland, Italy, the Netherlands, Austria, Portugal, Romania + the EU as a whole. Achieving this degree of cost-effectiveness means reducing the total cost ratio of a company, i.e. relative cost savings due to the total cost ratio. The differential cost is lower than the total cost ratio during the basic period, and profitability increases. For profitable production during the basic period (2004 or 2007 to 2013), companies realize an increase in profits from production expansion. The total profit increase is calculated as a sum of an increase of the profits from the returns to scale and relative cost savings influenced by the total cost ratio. Decreasing the total cost ratio causes progressive profit increase.
- **Increasing cost-effectiveness with loss reduction** is achieved in the following group of countries: Denmark, Hungary, Finland, Sweden and the United Kingdom. Achieving this degree of cost-effectiveness also means reducing the total cost ratio of a company, so there are relative cost savings due to the total cost ratio ($\Delta C_c < 0$). The differential cost is

lower than the total cost ratio during the basic period, and profitability increases. For loss-making production during the basic period, relative cost savings reduce the loss or generate profit. The loss volume decreases with increasing production volume. The influence of the cost decrease results in a more severe effect than the relative loss increase due to revenues.

- **Decreasing cost-effectiveness with degressive profit growth** is achieved in the following group of countries: Belgium, Spain and Malta. Companies or countries characterized by this degree of effectiveness achieved a declining cost-effectiveness associated with degressive growth in profit volume. The differential cost is higher than the total cost ratio during the basic period, and lower than 1, and profitability decreases. It is an increase in the total cost ratio of a company due to relative cost overruns and a degressive increase in profit is achieved. The increase in profits from production expansion is reduced by the loss resulting from the relative cost overruns due to the total cost ratio). Relative profit increase due to revenues is higher than relative profit decrease due to the total cost ratio. Degressive profit growth dependent on the effect of increased production is the result.
- **Decreasing cost-effectiveness with profit decrease** is achieved in the following group of countries: Bulgaria, Estonia, Greece, Latvia, Lithuania and Poland. This level is also defined by decreasing cost-effectiveness. The differential cost is higher than 1 and profitability decreases. It is an increase in the costs of a company due to an increase in the total cost ratio that is not eliminated even by increasing production when production is profitable during the basic period. The relative profit increase due to revenues is lower than the relative profit decrease due to the total cost ratio. This is the reason for the total profit drop.
- **Decreasing cost-effectiveness with growth in loss** is achieved in the following group of countries: the Czech Republic, Luxembourg, Slovakia and Slovenia. The last level is also characterized by declining cost-effectiveness. The differential cost is higher than 1 and the resultant loss continues to increase. There is also an increase in the costs of a company due to the total cost ratio, which is also accelerated by the negative effect of production expansion. Loss increases are caused by the relative loss increase due to revenues and by the relative loss increase due to the total cost ratio. Absolute loss volume increases.

The association between the categorization of a state in a cluster and the degree of cost-effectiveness can be examined using association coefficients. However, based on the

classification of a particular country in a cluster (the clusters grouped according to cost structure), it is not possible to estimate the degree of cost-effectiveness (Goodman-Kramer's τ = 0.123) and, in contrast, a country cannot be classified into cost-structure groups based on the degree of cost-effectiveness (τ = 0.175).

5. Conclusions

From the analysis of the Farm Accountancy Data Network data recorded by DG AGRI of EU for the years of 2004-2017 for EU member states it was possible to determine the total costs in an average EU farm, which reached the level of EUR 67 thousand in the last year of monitoring (at a growth rate of 1.8 %). The gradual increase of costs is understandable given the general rise in input prices as occurred in other sectors of the EU economy. The conversion of costs per hectare of agricultural land reflects their more accurate assessment relative to the basic production factor for agriculture, and in the EU28 this value was EUR 1,914/ha of UAA in 2017. The Netherlands and Malta show the highest costs in agriculture (approximately EUR 11 thousand /UAA), which are more than 6 times higher than the EU average. It is necessary to assess costs in relation to the specificities of the countries concerned – in particular their climatic conditions and the structure of production. The countries with the highest hectare costs in agriculture are focused on the production of vegetables and flowers, and thus have a very intensive way of farming characterized by high inputs but also with high outputs. The fastest growth in the total costs is seen in the countries with the lowest hectare costs, i.e. the Baltic States, where the costs are around EUR 700/ha. In terms of production structure, these countries are focused on the production of cereals and milk. In this case, the increase is more related to the change in external husbandry conditions.

The largest disproportions in the cost structure are clearly in Belgium, Cyprus and Malta (Cluster 3). These countries have the highest share of specific costs (the EU28 average is around 42 %), but in contrast they have the lowest share of overhead costs per hectare (the EU28 average is 26). At the same time, depreciation is lower (the average share of the total EU costs is 15 %). The opposite situation exists in France, Luxembourg, Austria, Finland and Slovenia (Cluster 1). These countries have the lowest direct and labour costs, but their share of overhead costs and depreciation is the highest.

Labour costs account for approximately 10 % of the total costs, with the highest share of labour costs in Slovakia (20.8 %) and the Czech Republic (17.8 %). The issue of labour costs is a very specific one for these countries and it has an impact in the following

assessment. In these countries, agriculture has the highest share of paid labour in the total workforce (Slovakia 93.8 %, the Czech Republic 76.8 %), which is related to the historical development of agriculture during the period of forced agricultural collectivization. As a result, the EU has an unusual size structure for farms, e.g. in the Czech Republic, farms with a size greater than 500,000 ESUs (European Size Unit) that make up 10.4 % of the total farms cultivating 62.9 % of UAA.

Very similar is the development of the share of ground rent costs (5 % for the EU) and interest (2-3 % for the EU). The size of farms is an important factor here. Small farm sizes are typical for Greece, Italy, Portugal, Spain, Slovenia, Malta and Romania. Except for Spain, the size of UAA of an average farm in these countries is well below the EU average (34.87 in 2017). They are mostly family companies, which seem to prefer other sources of financing than loans, or they have limited availability of loans.

In terms of the total cost ratio, where costs are measured in relation to production, it can primarily be seen that only 17 out of the 28 EU countries achieve a value that is lower than 1 (i.e. companies are profitable). Unfortunately, this cannot be considered a positive finding. It is necessary to add that we deal here with gross profitability (excluding the balance of operating subsidies and taxes). Southern European countries (Spain, Italy, Greece and Romania), with a specific production structure focused on wine, vegetables and olives, show a total cost ratio below 0.8. It is particularly in the countries of northern Europe (Finland, Sweden, Estonia, and Denmark) where the total cost ratio is higher than 1. Furthermore, it is also the case in Slovakia and the Czech Republic, where the causes of negative results have already been mentioned.

Another relationship in cost assessment is the use of judging whether increasing production volumes is economically effective. In all the states without exception, production volume increased in the period under review. However, the assessment made it possible to further quantify this growth in production, as to whether the effectiveness achieved from it is increasing or decreasing. Increasing effectiveness is achieved in 15 EU countries. There are countries, such as the Netherlands or Cyprus discussed above, which have the highest total costs, but which are able to be very profitable countries in the agricultural sector due to intensive production and probably higher prices of their specific commodities. An average agricultural company in the EU achieved increasing cost-effectiveness with profit gains. During the period under review, there was a relative cost saving of EUR 48 due to a decrease in the total cost ratio and an increase in profit of EUR 1,919 due to an increase in production.

6. References

BOCHTIS, D.; SORENSEN, C. A. G.; KATERIS, D. *Operations Management in Agriculture.* Academic Press. 2018.

BROUWER, R. Market integration of agricultural externalities: a rapid assessment across EU countries. *Report for European Environment Agency, Copenhagen.* 1999.

CARTER, M. R. Identification of the inverse relationship between farm size and productivity: an empirical analysis of peasant agricultural production. *Oxford Economic Papers*, v. 36, n. 1, p. 131-145. 1984.

CIUTACU, C.; CHIVU, L.; ANDREI, J. V. Similarities and dissimilarities between the EU agricultural and rural development model and romanian agriculture. challenges and perspectives. *Land use Policy*, v. 44, p. 169-176. 10.1016/j.landusepol.2014.08.009. 2015.

KNOWLER, D.; BRADSHAW, B. Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food policy*, v. 32, n. 1, p. 25-48. 2007.

KRAUSE, J.; MACHEK, O. A comparative analysis of organic and conventional farmers in the Czech Republic. *Agric. Econ. – Czech*, v. 64, n. 1, p. 1-8. 2018.

KROUPOVÁ, Z., MALÝ, M. Analysis of agriculture subsidy policy tools - Aplication of production function. *Politická ekonomie*, v. 6, p. 778-798. 2010.

LEWIS, T. R. Protecting the environment when costs and benefits are privately known. *The RAND Journal of Economics*, p. 819-847.1996.

MACHADO, N. M.; FRANCO, C.; ANUNCIATTO, K. M.; ROCHA, M. A. Production costs in the milkmaid activity in santo afonso/mt. *Custos e @gronegócio on line*, v. 14, p. 2-26. 2018.

MANJUNATHA, A. V.; ANIK, A. R.; SPEELMAN, S.; NUPPENAU, E. A. Impact of land fragmentation, farm size, land ownership and crop diversity on profit and efficiency of irrigated farms in India. *Land Use Policy*, v. 31, p. 397-405. 2013.

PELLERIN, S.; BAMIÈRE, L.; ANGERS, D.; BÉLINE, F.; BENOIT, M.; BUTAULT, J. P.; ... DOREAU, M. Identifying cost-competitive greenhouse gas mitigation potential of French agriculture. *Environmental science & policy*, v. 77, p. 130-139. 2017.

PRETTY, J. N.; BALL, A. S.; LANG, T.; MORISON, J. I. Farm costs and food miles: An assessment of the full cost of the UK weekly food basket. *Food policy*, v. 30, n. 1, p. 1-19. 2005.

PRETTY, J. N.; BRETT, C.; GEE, D.; HINE, R. E.; MASON, C. F.; MORISON, J. I. L.; ... & VAN DER BIJL, G. An assessment of the total external costs of UK agriculture. *Agricultural systems*, v. 65, n. 2, p. 113-136. 2000.

PRETTY, J.; HINE, R.; GEE, D.; VAZ, S. The externalities of European agriculture: towards fair and efficient pricing. *European Environment Agency, Copenhagen.* 1999.

REN, C.; LIU, S.; VAN GRINSVEN, H.; REIS, S.; JIN, S.; LIU, H.; GU, B. The impact of farm size on agricultural sustainability. *Journal of Cleaner Production.* 2019.

RIOS, A. R.; SHIVELY, G. E. Farm size and nonparametric efficiency measurements for coffee farms in Vietnam. *American Agriculture Economics Association. Rhode Island.* 2005.

ROUGOOR, C. W.; TRIP, G.; HUIRNE, R. B.; RENKEMA, J. A. How to define and study farmers' management capacity: theory and use in agricultural economics. *Agricultural economics*, v. 18, n. 3, p. 261-272. 1998.

SEUFERT, V.; RAMANKUTTY, N.; FOLEY, J. A. Comparing the yields of organic and conventional agriculture. *Nature*, v. 485(7397), 229. 2012.

STŘELEČEK, F.; LOSOSOVÁ, J.; ZDENĚK, R. Size and structure of return to scale in revenue function and cost function. *Acta Universitatis Agriculturae Et Silviculturae Mendelianae Brunensis*, v. 58(6 PART 2), p. 491-502. 2010.

STŘELEČEK, F.; ZDENĚK, R.; LOSOSOVÁ, J. Influence of the production change on the return to scale. *Agric. Econ. – Czech*, v. 57, n. 4, p. 159-168. 2011.

SYNEK, M.; DVOŘÁČEK, J.; DVOŘÁK, J.; KISLINGEROVÁ, E.; TOMEK, G. *Managerial economics.* Praha: Grada. 2011.

ŠPIČKA, J.; JELÍNEK, L. Energy analysis of farms – methodical approach. *Ekonomika a Management.* 3. 2008.

TEGTMEIER, E. M.; DUFFY, M. D. External costs of agricultural production in the United States. *International Journal of agricultural sustainability*, v. 2, n. 1, p.1-20. 2004.

THE FARM ACCOUNTANCY DATA NETWORK (FADN): standard results. [on-line]. [cit. 2019-02-19] Available at http://ec.europa.eu/agriculture/ricaprod/database/database_en.cfm. 2019.

VOŠTA, M. Common agricutlural policy of the EU and their aplication in the Czech Republic. *Současná Evropa,* v. 2, p. 127-142. 2010.

WAGNER, S.; ANGENENDT, E.; BELETSKAYA, O.; ZEDDIES, J. Assessing ammonia emission abatement measures in agriculture: Farmers' costs and society's benefits–A case study for Lower Saxony, Germany. *Agricultural Systems*, v. 157, p. 70-80. 2017.

WAIBEL, H.; FLEISCHNER, G.; BECKER, H. ABHANDLUNGEN-The Economic Benefits of Pesticides: A Case Study from Germany. *Agrarwirtschaft*, v. 48, n. 6, p. 219-229. 1999.

BOJNEC, Š.; LATRUFFE, L. Farm size, agricultural subsidies and farm performance in Slovenia. *Land use policy*, v. *32*, p. 207-217. 2013.

DAVIDOVA, S.; GORTON, M.; RATINGER, T.; ZAWALINSKA, K.; IRAIZOZ, B.; KOVÁCS, B.; MIZO, T. An analysis of competitiveness at the farm level in the CEECs. *Joint Research Project IDARA, Working Paper*, v. 2, n. 11. 2002.

LU, H.; XIE, H.; HE, Y.; WU, Z.; ZHANG, X. Assessing the impacts of land fragmentation and plot size on yields and costs: A translog production model and cost function approach. *Agricultural systems*, v. 161, p. 81-88. 2018.

RENCHER, A. C. *Methods of Multivariate Analysis*. (2nd ed.). Hoboken: Wiley. ISBN 0-471-41889-7. 2002.

ŘEZANKOVÁ, H.; HÚSEK, D.; SNÁŠEL, V. *Cluster analysis of data.* (2nd ed.). Praha: Professional Publishing. ISBN 978-80-86946-81-8. 2009.

7. Acknowledgment

The authors thank the Ministry of Education of the Czech Republic for financial support, Research Program of the Department of Accounting and Finance (RVO160). The authors thank Gregory Thomas Akehurst-Moore for English proofreading.