Animal Husbandry Export Measures Productivity: What is the Position of the Czech Republic?

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Abstract

Efficiency, productivity and competitiveness are important indicators of any production process. Speaking of agriculture and, in particular, animal husbandry in the light of sustainable development context, the values of these indicators become of special importance. Since adequate and efficient usage of disposable labour, land and capital can play a crucial role in obtaining and preserving higher efficiency and productivity levels, the natural question arises - does any relationship exist between mentioned production factors and revealed comparative advantage?

The main aim of this research is to evaluate the relationship between export-measured productivity and comparative advantages in animal husbandry of selected European countries. The benchmark is provided in relation to the Czech Republic. To analyse productivity of agricultural and, more specifically, animal production in the European countries selected for the analysis (based on available balanced data incorporating the period from 2005 to 2017), a decision was made to trace export performance of these countries recalculated with regard to a unit of core productive factors, such as land, labour and capital. Based on the foreign trade indicators (Gruber Lloyd index, RCA index), cluster analysis was conducted, in which individual calculation was used as an input variable. Subsequently, hierarchical clustering and Ward´s method were used. The evidence from this study suggests that the revealed comparative advantage of the countries is not determined primarily by the level of export-based productivity. The relationship between these variables is rather weak and very often negative, which indicates that productivity indicators do not play a significant role in the overall competitiveness of the monitored countries.

Keywords

Introduction

Efficiency, productivity, and competitiveness are important indicators related to evaluation of labour, land, capital, production, export, and other elements. The question is whether any (concrete) relationship among these indicators can be detected. It might be assumed that productivity can be considered as an important determinant and prerequisite for competitiveness. For this reason, this paper discusses the question in the field of agri-food export of selected EU countries.

According to, for example, Latruffe (2010), competitiveness should be measured with respect to a benchmark as it is a relative concept. Firms must be compared with each other, or nations with each other. Producing absolute figures for a country or an industry seems meaningless. Thus, the relationship between efficiency in terms of productivity and competitiveness of agri-food export in selected EU countries is examined and presented in this paper. Moreover, currently many approaches to examination of efficiency, productivity and competitiveness at different levels can be found. In order to meet the main objective of this paper, a suitable method had to be identified and employed.

Fojtíková   and   Staníčková   (2017)   analyse

export competitiveness and productivity of EU member states using the Factor Analysis and Data Envelopment Analysis (DEA). The results show that the level of export competitiveness is different in individual EU member states and that it changes during the analysed period (2000 – 2015). Similarly, Serrao (2003) employs the Data Envelopment Analysis (DEA) and the Stochastic Frontier Analysis (SFA) to examine the sources of agricultural productivity growth and productivity differences among individual countries and regions of EU in the analysed period (1980 – 1998). Pokrivčák et al. (2015) employ non-parametric DEA to examine the efficiency of the agricultural sector in EU-26 countries. Significant differences among EU countries have been detected in the analysed period (2007 – 2012). In conclusion, the efficient countries have relatively large farms and considerable expenditures for agriculture. Moreover, it has been concluded that the countries' productivity is strongly influenced by utilization of inputs. Rungsutiyawiboon and Lissitsa (2007) employ a parametric distance function approach to measure the Malmquist total factor productivity index. The results show that the transition countries (defined in the analysed period (1992 – 2002)) achieve higher agricultural performance. Serrao (2003) also employs DEA and Malmquist productivity index to examine the levels and trends in the global agricultural productivity of selected European countries. The sources of productivity growth over the time and the differences among the countries and the regions are defined in the analysed period (1980 – 1998).

Csikósová et al. (2018) examines the importance of work productivity in EU-28 as an important factor that influences economic growth and is also influenced by various determinants. Based on the research, rising differences among individual countries have been detected. Similarly, Rozkošová and Megyesiová (2017) define labour productivity as probably the main determinant of economic growth, the determinant affected by other factors. Based on the examination of EU-28, the differences among the individual states are considered in the analyzed period (2005 – 2016). Wulong and Beiling (2017) analyse effective multifactor productivity (MFP) growth in Canada, USA, Australia, Japan, and selected EU countries. The results show that the increase in effective MFP is closely related to the decline in output prices and improvement in international competitiveness.

Berthou et al. (2015) evaluate competitiveness, focusing on the relationship between the productivity and export performance among European economies. The research confirms that exporters are more productive than non-exporters and, additionally, the productivity premium is rising with the firms' export experience (permanent exporters are much more productive than starters). Moreover, what can be seen is that both the level and the growth of firm-level exports rise with the firm's productivity. Finally, it has been concluded that the shape of the productivity distribution within each country can have considerable implications in terms of the dynamics of aggregate trade patterns.

Bojnec and Fertö (2014) provide an insight into export competitiveness of meat products from EU-27 member states on the global market. The RCA index is used to analyse the level, composition, and evolution of the developmental patterns in the export competitiveness of meat products. The results show that except for some niche meat products, a large number of EU-27 member states experience a comparative disadvantage on global markets in the analysed period (2000 - 2011). Moreover, the revealed comparative advantage on the global markets are most robust for Ireland, Spain, the Netherlands, France, Belgium, Denmark, Poland, Cyprus, and Hungary. However, the RCA indices and their survival rates differ across the meat product groups. In conclusion, the heterogeneity in export competitiveness of EU-27 member states indicates the importance of the differentiation of meat products in competitive export specialization on global markets. Carraresi and Banterle (2008) examine EU competitiveness at the sector level on the intra-EU market. The analysis is conducted by assessing trade indices (RCA etc.). Moreover, cluster analysis is employed to classify groups of countries with similar features in terms of competitive performance in the analysed period (1991 – 2006). In conclusion, Spain is considered as the country attaining a high level of competitiveness. Contrariwise, the United Kingdom is detected as the country with the worst performance.

Galović et al. (2017) focus on international competitiveness of analysed countries through selected indicators. The results show that despite identical trade policy, external conditions and, for numerous EU member states, the same currency, trade performance of the member states is extremely diverse. Moreover, the most developed countries within the EU are consistent in their positive values and growth. These countries also have a string inclination towards

the development, expansion, and competitiveness, and show no signs of stopping, given the positive trade balance. Bojnec and Fertö (2015) investigate competitiveness of agri-food exports of the EU-27 countries on global markets using the RCA index. The results show that in the analysed period (2000 - 2011) the majority of agri-food products in the EU-27 countries show a comparative disadvantage on global markets. It has been discovered that most old (EU-15) member states experience a greater number of agri-food products with longer duration of RCA than most new (EU-12) member states. The Netherlands, France and Spain are considered as the most successful member states in agri-food export competitiveness on global markets. Ružeková et al. (2020) assume that the higher quality of institutional environment is characterized by a higher level of competitiveness and lower transaction costs based on the belief that export performance is a reliable measure of competitiveness. However, the results demonstrate that export performance is not a universal indicator of competitiveness. Thus, it is necessary to apply other, especially multi-factor indicators. Furthermore, Nowak and Kaminska (2016) analyse competitiveness of EU-27 countries. Their research focuses on the relationship between production factors, productivity, and the importance of agriculture in international trade. In conclusion, based on the results for the analysed period (2009 -2011) the analysed countries are divided into four groups that are similar in terms of agricultural competitiveness.

The results of the examination of the productivity and export competitiveness in individual countries are presented, for example, in the following publications: Tiffin (2014) emphasizes the role of innovations on the export market share rather than price-based competitiveness. The high-quality export mix and the ability of small-scale specialized firms are considered as sources of strength of Italian export. Contrariwise, structural barriers that depress productivity have also been detected. Fertö and Hubbard (2003) examine competitiveness of Hungarian agriculture and food processing in relation to EU countries based on the indices of the revealed comparative advantage. The results indicate a comparative advantage in a range of agri-food products, including animals and meat, in the analysed period (1992 – 1998). Moreover, it has been concluded that the RCA indices are stable during the period of transition, although there is evidence of weakening in the comparative advantage level as revealed in the Balassa index. Gorton et al.

(2000) analyse competitiveness of agricultural production in Bulgaria and the Czech Republic compared to international markets and EU. Their competitiveness is measured in terms of the Revealed Comparative Advantage (RCA) and Domestic Resource Cost (DRC) ratios. Among others, the results show that Czech livestock production is not competitive on the world market. Identical results are found in Bulgaria, with the exception of pork. Burianová (2010) employs the Balassa RCA index and Michaely index (MI) to analyse export performance of the Czech Republic. The results show that the commodities competitive on the EU market in the analysed period (2004 – 2008) can be found; moreover, measure of specialization is crucial in this evaluation.

Materials and methods

The main aim of this research is to evaluate the relationship between export-measured productivity and comparative advantages in animal husbandry of selected European countries. The benchmark is provided in relation to the Czech Republic (if not specified differently).

Based on the above facts, the research questions referring to the comparative advantages of the monitored countries and their position in the productivity can be formulated.

Research question 1: Comparative advantages of the monitored countries in individual commodity aggregates with regard to the productivity are currently similar.

Research question 2: The position of the Czech Republic with regard to export-based productivity is similar to that of other European countries.

Data description

To address the issue of export-measured productivity in selected EU countries representing the same climatic zone, raw data on exports in current USD prices were retrieved from UN COMTRADE, then classified and recalculated to form the following variable: Animal husbandry export of each country selected for the analysis to other EU partners (27 in total). Re-exports were not considered due to unavailable data. Since these were given in current prices, to avoid evident distortion of the results a decision was made to apply price indices (real price adjusted indices of agricultural products, output, annual data, 2010=100) and use values in constant prices for further analysis. Price

indices for each country were taken from Eurostat.

Due to a substantial difference in the extent to which the countries selected for the analysis possess agricultural land (and correspondingly in volumes of their export) a decision was made to recalculate the volume of export by each country per hectare of agricultural land available in the country. Considering that it seemed to serve no justified purpose to encumber the analysis with additional data on arable land, these were eventually not considered.

Similarly, a decision was made to recalculate export volumes per person employed in agriculture and per million USD of Fixed Capital Consumption (Agriculture, Forestry and Fishing). The data on Employment in agriculture and Consumption of Fixed Capital were retrieved from FAOSTAT.

All the data available and derived this way, along with constructed variables, were compared and balanced to avoid lacking observations and to represent the same time span for each country. Regrettably, Hungary and Italy were excluded from the analysis since no data on price indices for the period from 2005/2007 to 2010 were available. As a result, a consistent dataset of 104

observations in total, representing Austria, Belgium, Czechia, Denmark, France, the Netherlands, Poland, and Slovakia, incorporates the period from 2005 to 2017. The data for Germany were not included as these refer to a shorter period from 2010 to 2017 (again, the problem concerned unavailability of the data on price indices).

The Table 1 provides a summary of the data used in the analysis.

The export and import data were retrieved from the UN COMTRADE database as mentioned above. They are based on the Standard International Trade Classification (SITC) Rev. 2 nomenclature. A one-digit level of aggregation was used, consisting of the products mentioned in Table 2.

The initial analysis was conducted at a one-digit level of aggregation. In this regard, only four commodity aggregates that include animal husbandry were analysed in more detail. This concerns group 00, 01, 02 and 41 (Table 3).

Variable	Label	Units of measurement
Animal husbandry export	aEx	USD, constant 2010 prices
Agricultural land	land	1000 ha
Employment in agriculture	labour	1000 persons
Consumption of Fixed Capital (Agriculture, Forestry and Fishing)	capital	USD, constant 2010 prices
Animal husbandry export per ha	aEx.p.ha	USD, constant 2010 prices /ha
Animal husbandry export per person empl.	aEx.p.worker	USD, constant 2010 prices/worker
Animal husbandry export per $1 million of fixed capital consumption	aEx.p.capital	USD, constant 2010 prices

Source: own elaboration.

Table 1: Summary of created variables.

Variable	Obs	Mean	Std.Dev.	Min	Max
land	104	7300.524	9231.325	1327	29390.4
labour	104	448.14	640.76	53.02	2452.089
capital	104	3842.832	4508.11	408.88	15674.72
Variable	Obs	Mean	Std.Dev.	Min	Max
aEx	104	6.30e+09	5.01e+09	3.35e+08	1.88e+10
aExpha	104	2380.042	2999.8	131.374	10208.41
aExpworker	104	42377.73	47136.16	1046.999	163000
aExpcapital	104	2417814.60	2099174.77	624872.40	8572369.4

Source: authors' elaboration in STATA

Table 2: Descriptive Statistics of variables.

Code	Description
00	Live animals other than animals of division 03
01	Meat and meat preparations
02	Dairy products and birds' eggs
41	Animal oils and fats

Source: authors' elaboration in STATA

Table 3: Commodity groups in analysis.

Years 2005, 2010 and 2017 were selected for the analysis, since 2005 is the very first year of the Czech membership in the EU, 2010 represents the year after the financial crisis, and 2017 includes the latest full dataset available for productivity analysis.

Research methods

The objective of this research is to analyse comparative advantages at the state and European level with regard to the productivity measures. There are different assessment indicators for this comparison which were used to explore foreign trade of the monitored countries.

Firstly, traditional competitiveness indexes were calculated. These include the Balassa index that was calculated according to Laursen (2015) with the threshold effect equalling 1. RCA >1 – the country possesses a competitive advantage. RCA < the country possesses a competitive disadvantage. The RCA index was calculated in two ways. The bilateral RCA was calculated in which the situation between the Czech Republic and other countries is assessed (the Czech Republic is the benchmark) and then the position of the countries against the EU level (RCA EU).

To evaluate the intra-industry trade the Gruber Lloyd Index (GLI) (Grubel and Lloyd, 1971) was used. GLI = 1 – only intra-industry trade exists GLI = 0 – there is no intra-industry trade, only inter-industry trade. Finally, the Lafay index (LFI) was employed to assess mutual trade (Iapadre, 2001; Lafay, 1992). It attains values $<-\infty,\infty>$, if the value exceeds zero, the country possesses a comparative advantage.

Based on the above indicators, cluster analysis was conducted, in which individual calculation was used as an input variable for cluster analysis. Hierarchical clustering and Ward´s method (Ward, 1963) were used. To prevent distortion the variables were transformed using the z-score. The final step was to assess the differences between the groups.

Multidimensional scaling was used and perceptual maps were created for graphic illustration (Buja and Swayne, 2002; Torgerson, 1952).

Results and discussion

Export-measured productivity of selected agricultural sectors in EU

To analyse productivity of agricultural, specifically animal husbandry in the European countries selected for the analysis (based on available balanced data incorporating the period from 2005 to 2017), a decision was made to trace export performance of these countries recalculated on a unit of core productive factors, such as land, labour and capital. The figures below provide graphic representation of the mentioned indicators' development in time for all the countries.

Since the collected export data were initially given in current prices, to avoid evident distortion of comparison results, corresponding price indices were applied to time series of each country to express all export data in constant prices (as per 2010 year)[1].

Figure 1 illustrates the dynamics of export values in selected European countries, where individual year-to-year values are given in constant as of 2010 prices, bln. USD[2].
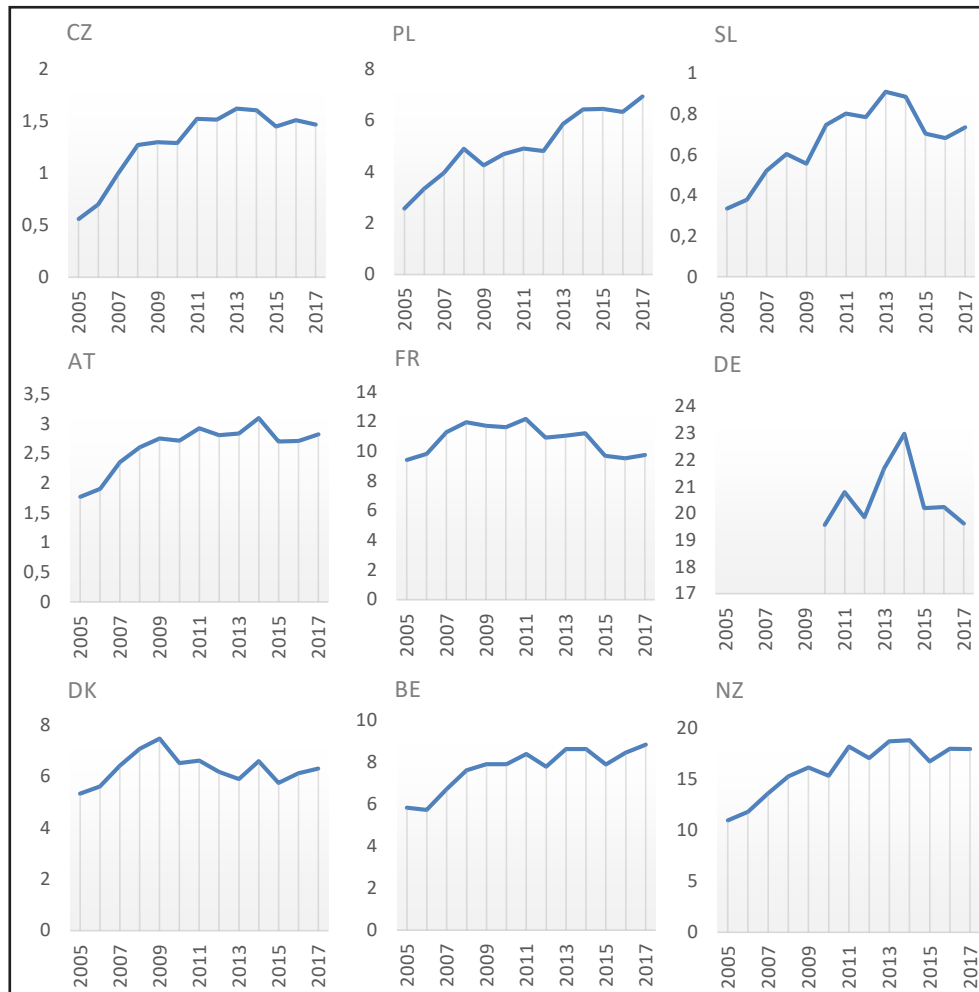
It is obvious that the values provided above cannot be compared directly (due to the countries' sizes, population densities and corresponding sizes of their agricultural lands), these numbers will be recalculated with regard to a unit of core productive factors: per hectare of agricultural land, per worker employed in the agricultural sector and per million USD of fixed capital consumption.

As a result, the next Figure 2 shows the dynamics of export values in selected European countries per hectare of agricultural land disposable for the country in question. All values are also given in constant 2010 prices, USD.

As can be seen from the Figure 2, in terms of capability of benefiting from their agricultural land (export-measured productivity), the leaders are the Netherlands, Belgium and Denmark, followed by Germany, Austria, France, Slovakia, Poland and Czechia (ranked from highest to lowest).
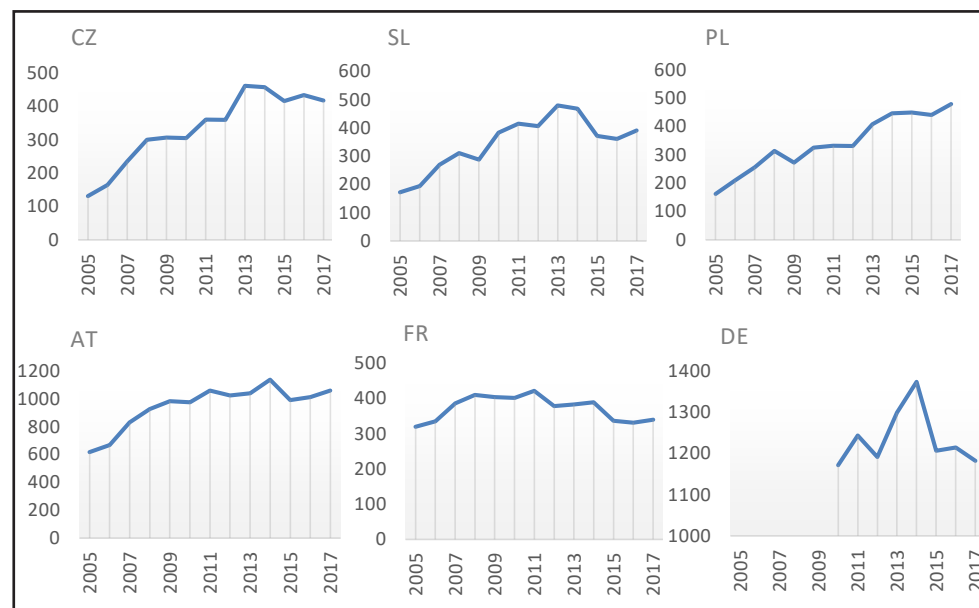
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1 Price indices were retrived from Eurostat database [5.06.2020]
2 https://ec.europa.eu/eurostat/data/database?p_p_
id=NavTreeportletprod_WAR_NavTreeportletprod_INSTANCE_
nPqeVbPXRmWQ&p_p_lifecycle=0&p_p_state=normal&p_p_
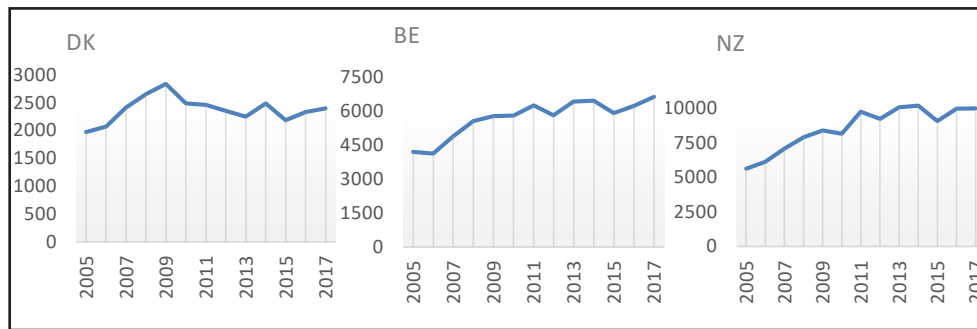mode=view&p_p_col_id=column-2&p_p_col_pos=2&p_p_col_
count=3

Source: authors' elaboration

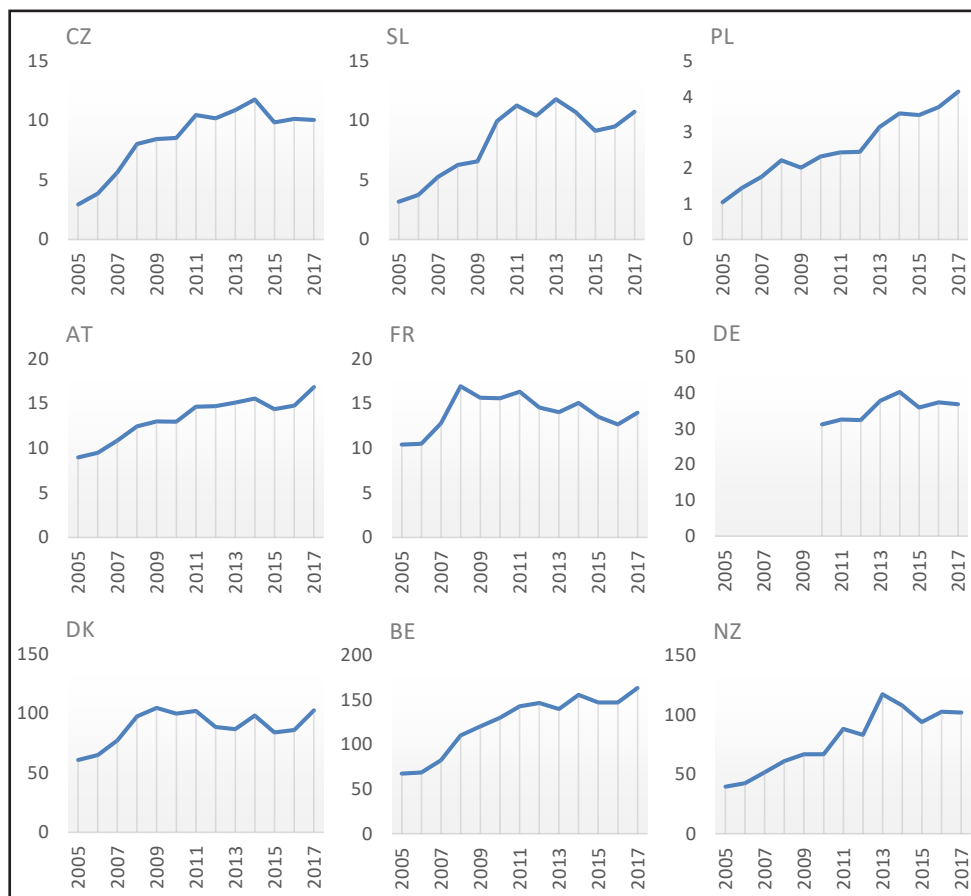Figure 1: Animal husbandry exports, in bln. USD (constant 2010 prices).

Source: authors' elaboration

Figure 2: Animal husbandry export per 1 ha, USD (constant 2010 prices) (to be continued)

Source: authors' elaboration

Figure 2: Animal husbandry export per 1 ha, USD (constant 2010 prices) (continuation).

Source: authors' elaboration

Figure 3: Animal husbandry export per 1 worker employed, thousands USD (constant 2010 prices).

Regarding the values of Animal husbandry export per worker employed, the situation is slightly different, although the overall composition of leaders is almost identical: Belgium, Denmark and the Netherlands are followed by Germany, France, Austria, Czechia, Slovakia, and Poland. Figure 3 provides graphs corresponding to each country.
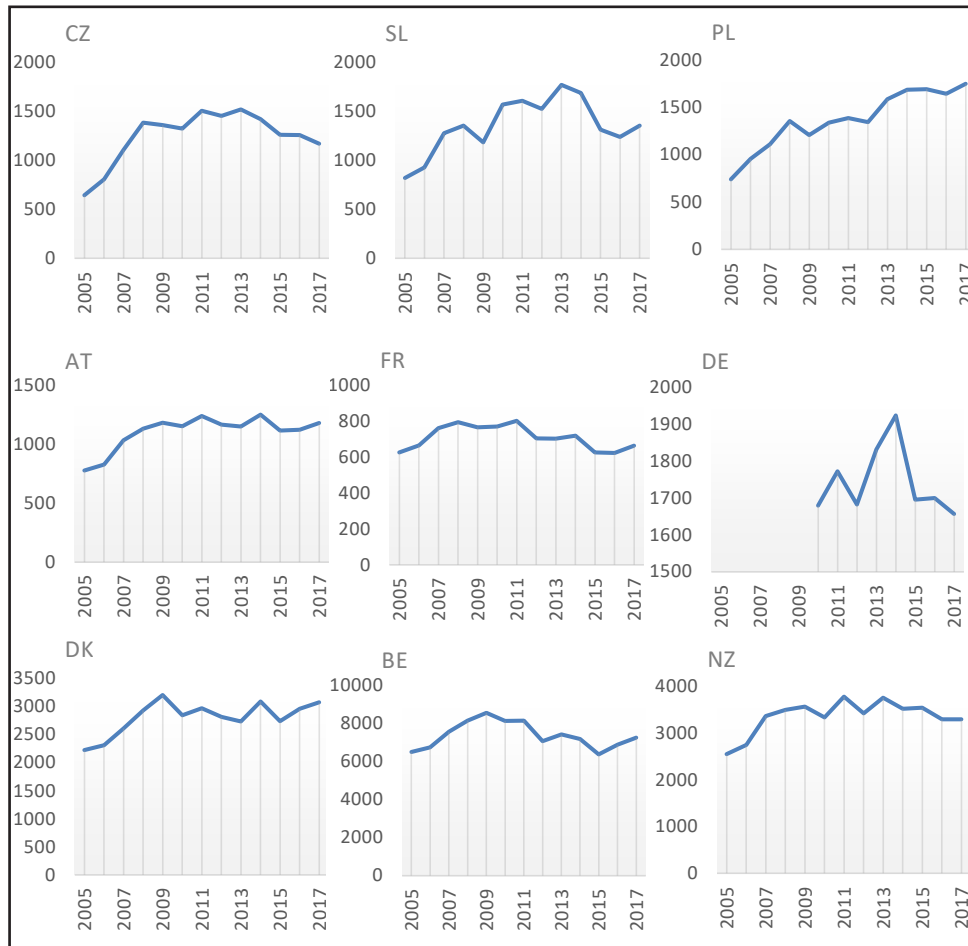
When considering the countries' capability of benefiting from their fixed capital available for the agricultural sector, Belgium is the evident leader among the countries selected for the analysis. Approximately twice as low values of export per million USD of fixed capital consumption are recorded the Netherlands and Denmark, followed by Germany. During the analysed period, Poland and Slovakia displayed almost identical values, whereas Czechia, which surpassed Austria, attained export values per million USD of fixed capital consumption 1.75 times higher than France.

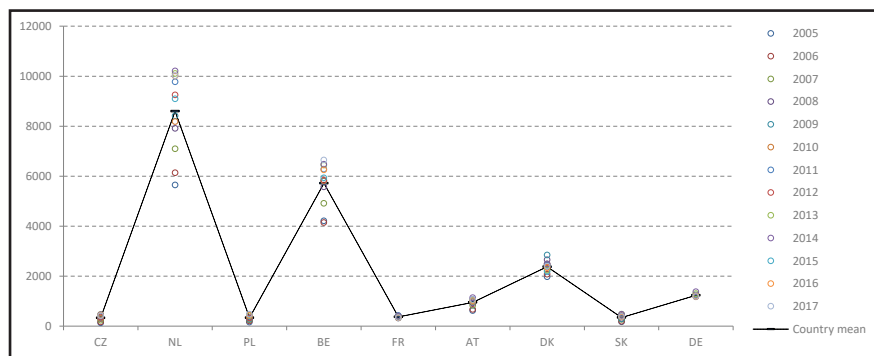The corresponding graphs are provided in Figure 4.

Simultaneously, in order to clearly illustrate the borders within which the observed values of exports per unit of core productive factors fluctuate along with inter-country annual mean values and year-on-year mean values per country, the following figures are provided: Figure 5 which shows the comparison of mean values of each country's export per hectare for the entire analysed period from 2005 to 2017, Figure 6 in turn illustrates the comparison of export values per hectare among all 8 countries for each year along with the inter-country annual mean values.

Source: authors' elaboration

Figure 4: Animal husbandry export per $1 million of fixed capital consumption, thousands USD (constant 2010 prices).

Note: In case of Germany the analysis covers the period from 2010-2017
Source: authors' elaboration.

Figure 5: Animal husbandry export per 1 ha and countries' mean values calculated for the period from 2005 to 2017, in USD (const. 2010 prices).
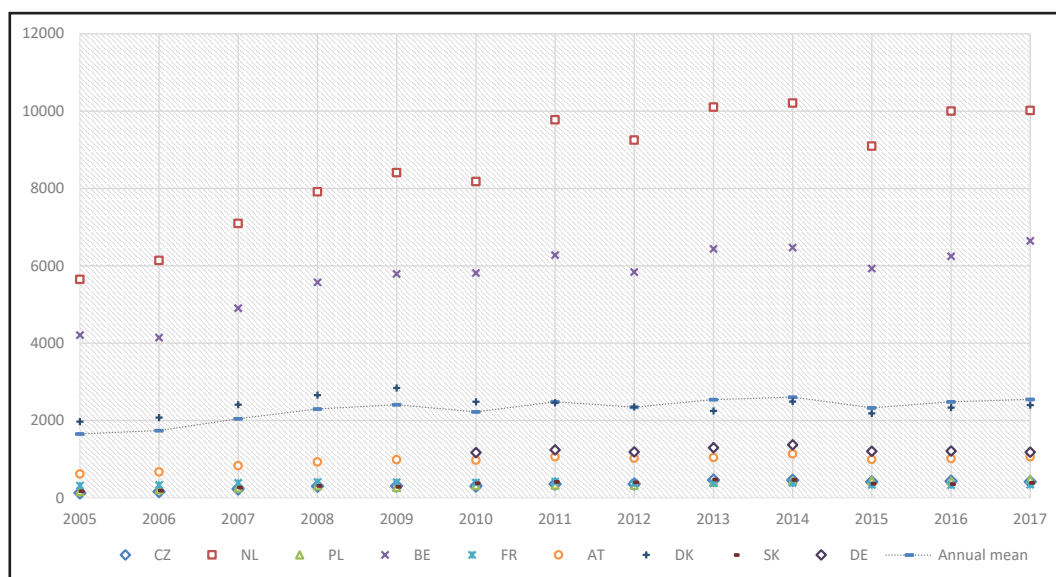
As can be seen from the Figure 5, there is a considerable gap between the countries' mean values, which indeed suggests the very existence of space to improve export-measured productivity for countries such as Czechia, Poland and Slovakia, as the lowest mean values of export per hectare were recorded in these countries. France, Austria, Germany and Denmark can potentially increase their productivity as well.

However, it is worth mentioning that in contrast to the absolute values of exports per unit of core production factors, the highest on average year-on-year growth rates in exports within the analysed period were recorded in Slovakia, Czechia and Poland. The summary Table 4 below provides the average year-on-year growth rates in exports per hectare of agricultural land, per worker employed in the agricultural sector and per million USD of fixed capital consumption.

Considering the above values of year-on-year growth rates, it is possible to assert that Slovakia, Czechia and Poland are the countries with the highest potential to achieve better export-measured productivity in the following years, they appear to be in pursuit of enhancing their export productivity per unit of core production factors.

The most considerable decline in export volumes

Note: In case of Germany the analysis covers the period from 2010-2017
Source: authors' elaboration.

Figure 6: Animal husbandry export per 1 ha and inter-country annual mean values, in USD
(const. 2010 prices).

Average growth rate in exports per 1 ha of agricultural land		Average growth rate in exports per 1 worker employed		Average growth rate in exports per $1 million of fixed capital consumption	
13.56	**SK**	17.71	**SK**	9.76	**SK**
13.23	**CZ**	15.17	**CZ**	8.65	**CZ**
9.44	**PL**	11.93	**PL**	7.41	**PL**
5.44	AT	8.33	BE	4.28	AT
5.08	NL	8.17	NL	2.86	DK
4.18	BE	5.11	AT	2.48	NL
1.88	DK	4.74	DK	1.60	BE
0.70	FR	2.98	FR	0.70	FR
0.20	DE	1.44	DE	0.02	DE

Note: In case of Germany the analysis covers the period from 2010-2017
Source: authors' elaboration.

Table 4: The average values of year-on-year growth rates in Exports per a unit of core productive factors for the period from 2005 to 20171), in %.

during the analysed period was registered in almost all the countries in the same year, 2015, when the Russian embargo was imposed on the European partners as a direct response to the European sanctions against Russia due to different attitudes to the Crimean events. Table 5 summarizes the most significant negative year-on-year growth rates in the countries' exports observed within the period from 2005 to 2017 and a particular year when this decline occurred.

Multidimensional scaling was applied to the above productivity indicators connected to foreign trade to determine the main groups of countries (Figure 7).
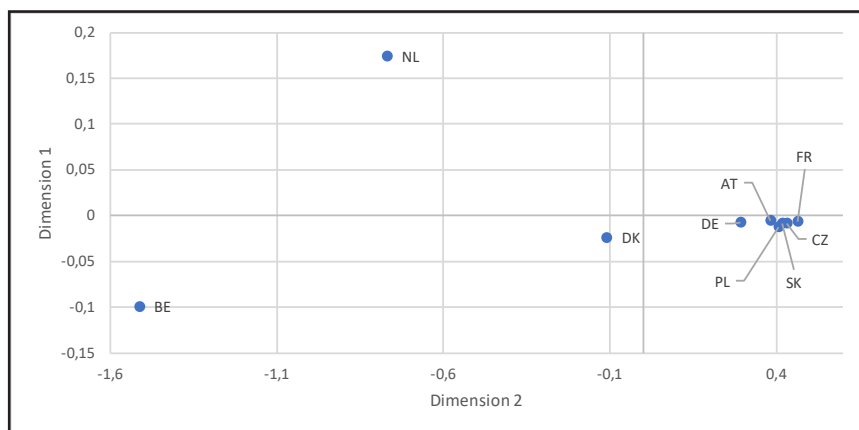
Based on the multidimensional scaling, the countries can be divided into two groups. The descriptive analysis of both is included in Table 6. The first group, which consists of Belgium, the Netherlands and Denmark,

Maximal negative growth rates in exports per 1 ha of agricultural land			Maximal negative growth rates in exports per 1 worker employed			Maximal negative growth rates in exports per $1 million of fixed capital consumption		
SK	-20.44	**2015**	CZ	-16.40	**2015**	SK	-22.17	**2015**
FR	-13.40	**2015**	SK	-14.70	**2015**	BE	-13.37	2012
PL	-13.30	2009	DK	-14.42	**2015**	FR	-12.96	**2015**
AT	-12.81	**2015**	NL	-12.97	**2015**	DE	-11.85	**2015**
DK	-12.48	2010	FR	-10.78	2012	DK	-11.41	**2015**
DE	-12.15	**2015**	DE	-10.70	**2015**	CZ	-11.22	**2015**
NL	-10.90	**2015**	PL	-9.11	2009	PL	-11.00	2009
CZ	-9.24	**2015**	AT	-7.58	**2015**	AT	-10.75	**2015**
BE	-8.39	**2015**	BE	-5.56	**2015**	NL	-9.48	2012

Note: In case of Germany the analysis covers the period from 2010-2017
Source: authors' elaboration.

Table 5: The biggest negative year-on-year growth rates in exports per a unit of core productive factors registered in the period from 2005 to 20171), in %.

Source: authors' elaboration

Figure 7: Multidimensional scaling of productivity indicators related to foreign trade (2017).

	aEx.p.ha_const.pr.	aEx.p.worker_const.pr.	aEx.p.capit._const.pr.
Mean group 1 (NL, BE, DK)	6 353.38	122 579.81	4 544 669.05
Mean group 2	645.56	15 436.59	1 295 493.34
Std. Deviation group 1	3 815.64	35 374.41	2 356 148.20
Std. Deviation group 2	374.15	11 335.66	392 156.47

Source: authors' elaboration.

Table 6: Descriptive analysis of the productivity indicators related to foreign trade (2017).

is rather heterogenous with regards to their productivity. Belgium attains the highest productivity level per worker and capital. The average productivity in this group is multiple times higher than in the second. The standard deviation is rather high, maximum for capital and the lowest for land. Therefore, the means of the indicators in this group differ significantly from those in the second group, which are very similar and concern Austria, the Czech Republic, France, Germany, Poland, and Slovakia.

When comparing the situation in 2005 and 2010, only slight differences are detected between the years. There is an increase in standard deviation and the mean of these variables. In relative numbers, the highest increase in standard deviation is for labour productivity, followed by land and the lowest relative increase is for capital.

When the countries are divided into "old" and "new" member states, what can be observed is that the highest relative increase of standard deviation for the "new" member states concerns productivity of capital, which is followed by labour. In the case of the "old" member states, it is the capital followed by land. It could thus be concluded that there is an important increase in the productivity of capital and labour in the new member states.
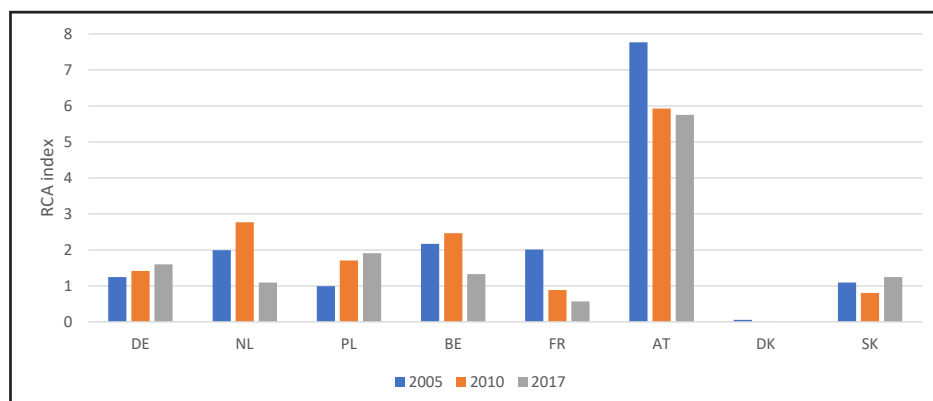
Indicators of competitiveness

RCA – bilateral – the relationship to the Czech Republic (comparative advantage of the Czech Republic over the examined countries)

Figure 8 displays the comparison of the RCA index for live animals. It is evident that the Czech Republic possessed a comparative advantage over Austria in 2017; however, compared to 2005,

it witnessed a slight decrease. The results also show a strong position of the Czech Republic against the Netherlands, Belgium or Poland. A very high RCA over Austria relates to the structure of the production since Czechia exports enormously high volumes of live animals to Austria where slaughterhouses with higher redemption price than in Czechia are located. When comparing the situation between 2005 and 2017, Czechia increased its comparative advantage in three states (DE, PL, SK) and decreased its position in 5 cases (NL, BE, FR, AT, DK). This might be alarming for the future.
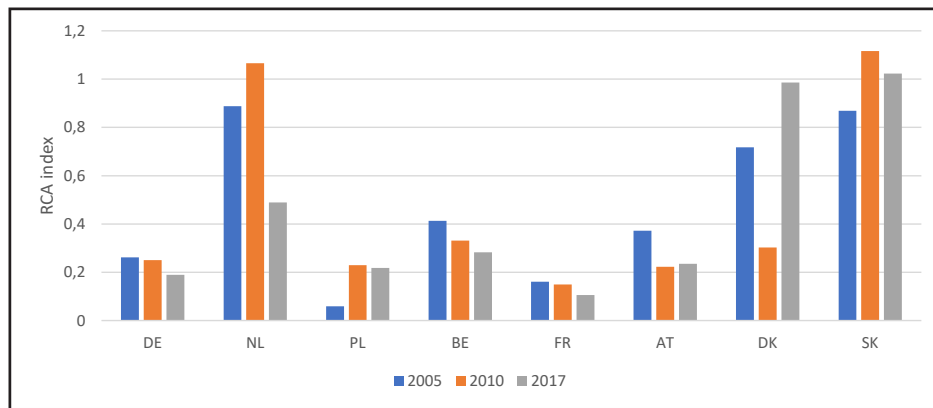
The situation is similar in the case of meat and meat preparations. The Czech Republic has decreased its comparative advantage over 7 countries and increased only over Denmark and Slovakia. The situation is relatively stable for the future long-term period and the RCA is relatively high. The value of RCA is lower, and the distribution is more homogenous than in the case of live animals. However, the Czech Republic's RCA > 1 only over Slovakia and reaches approximately the same value as Denmark. Regarding other states, the Czech Republic does not possess a comparative advantage in meat and meat preparations.

The number of Czechia´s comparative advantages of dairy products and eggs has also declined over time. In 2017, the Czech Republic possessed a comparative advantage only over two countries – Germany and Slovakia, while in 2005 it was four. The country has lost its position against the Netherlands or Denmark, which is rather alarming.
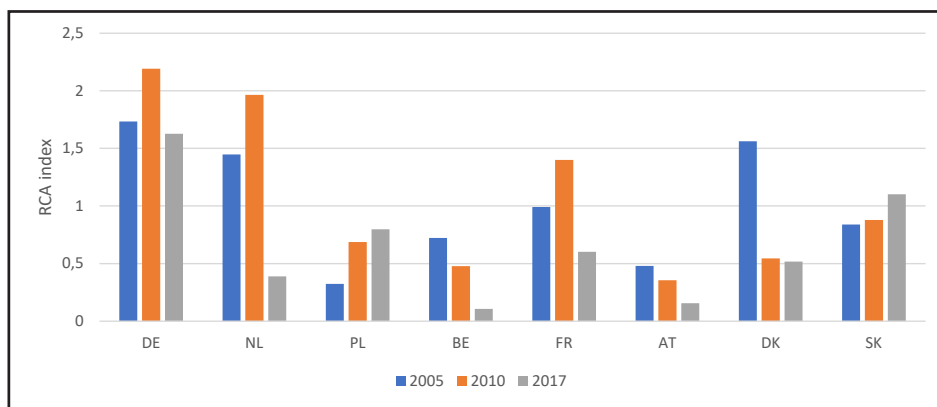

Source: authors' elaboration

Figure 8: RCA index live animals – comparison (2005, 2010, 2017).

Source: authors' elaboration.

Figure 9: RCA index Meat and meat preparations – comparison (2005, 2010, 2017).

Source: authors' elaboration

Figure 10: RCA index Dairy products and birds' eggs (2005, 2010, 2017).

RCA – relationship at the European level

Figure 11 displays the distribution of comparative advantages of the selected countries on the European market. The median value is quite similar for all the analysed years and commodity groups; however, the distribution changed during the monitored years. In general, it can be stated that the smallest differences are between the commodity aggregate dairy products and birds' eggs (S3-02). The comparative advantage of all the European countries is rather similar. The most significant changes have been monitored for the commodity aggregate live animals (S3-00).

Correlation analysis was applied to the RCA indexes (European level) and export measured productivity indicators. This analysis includes CZ, DE, NL, PL, BE, FR, AT, DK, and SK.
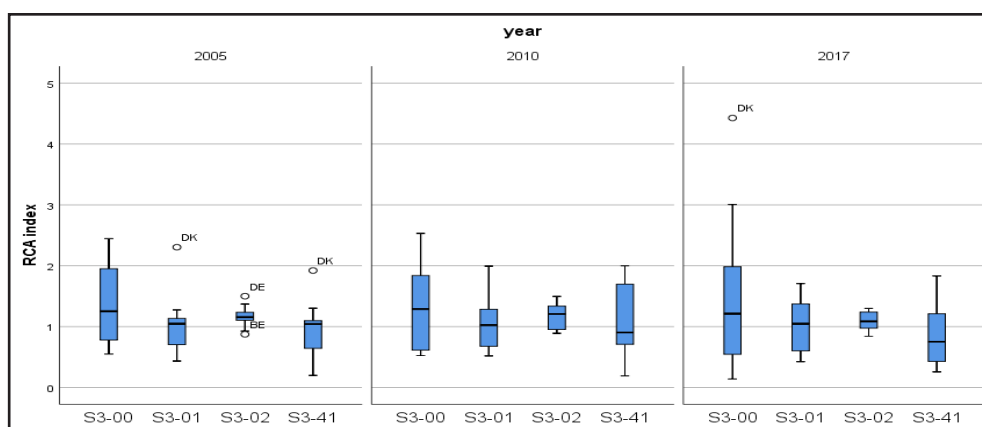
A correlation exists between RCA indexes (European level) and export measured productivity indicators. There is a negative correlation between live animals (S3-00) and all productivity indicators, although only land is statistically significant.

A similar situation exists between dairy products and birds' eggs. In this case the only significant correlation is between capital and RCA. The most considerable significance is between RCA of animal oils and fats and labour productivity.

What could be stated is that the factor of productivity does not influence the comparative advantage of these states.

After assessing the comparative advantage of the Czech Republic over the European Union during the monitored years it might be concluded that there is a slight decrease in live animals and dairy products and birds 'eggs. These two commodity aggregates possess a comparative advantage on the European market. Regarding meat and meat preparations and animal oils and fats, the Czech Republic does not possess a comparative advantage.

When comparing the remaining European countries, it is evident that Denmark possesses the most significant comparative advantage in the case of live animals.
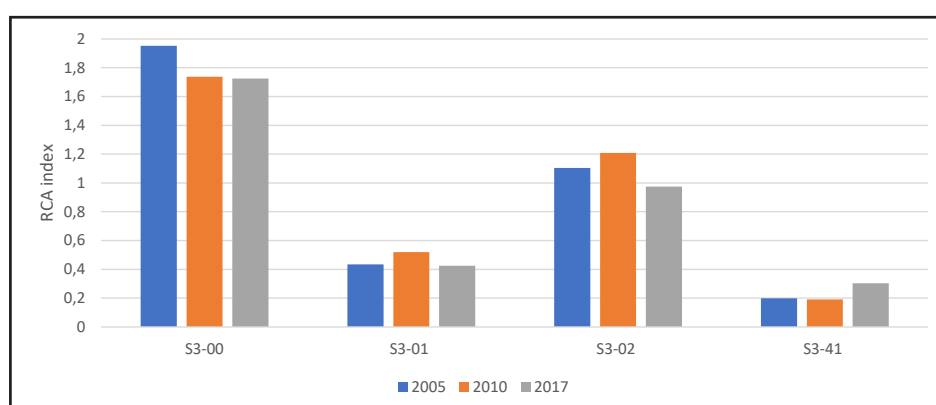
Source: authors' elaboration

Figure 11: Distribution of RCA index with regards to the European level.

	aEx.p.ha_const.pr.	aEx.p.worker_const.pr.	aEx.p.capit._const.pr.
RCA S3 - 00	-.386*	-.160	-.342
RCA S3 - 01	.391*	.256	.374
RCA S3 - 02	-.248	-.162	-.395*
RCA S3 - 41	.299	.490**	.223

Note: * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)
Source: authors' elaboration

Table 7: Correlation between RCA index and export measured productivity indicators.

Source: authors' elaboration

Figure 12: Evolution of RCA´s of the Czech Republic x EU.

Division of the countries according to export-based productivity measures

Before applying the clustering procedure, correlation analysis was applied to determine the connection between the original variables. Based on this, the LFI indicator was excluded due to a high correlation between the RCA and LFI. Based on the hierarchical clustering technique and Ward's method, similarities between the monitored countries were identified.

The commodity aggregate S3-00 - Live animals (Tables 8, 9, 10) does not witness any significant changes in the monitored period. The first group of countries consists of France, Slovakia, Germany, and Poland. The group mostly possesses a comparative advantage in this commodity group. The productivity connected with land is lower than in the second and third group. The standard deviation for productivity measures with regard to land is lower. The highest productivity is recorded in Germany.

The situation in the second group, which includes Austria only, has already been mentioned above. The reason why Austria is separated is a very high

DESCRIPTION	GROUP 1	GROUP 2	GROUP 3	GROUP 4
00 Live animals other than animals of division 03	FR, SK, DE, PL	AT	NL, BE, DK	
01 Meat and meat preparations	PL, FR, DE, AT	DK, SK	NL, BE	
02 Dairy products and birds' eggs	PL, SK, FR	AT, DK	DE	NL, BE
41 Animal oils and fats	PL, FR, AT	DE, SK	DK	NL, BE

Source: authors' elaboration

Table 8: Division of countries (2017).

DESCRIPTION	GROUP 1	GROUP 2	GROUP 3	GROUP 4
00 Live animals other than animals of division 03	DE, SK, FR, PL	AT	NL, BE, DK	
01 Meat and meat preparations	DE, PL, AT, FR, DK	BE	NL, SK	
02 Dairy products and birds' eggs	AT, SK, PL, DK	BE	DE, FR, NL	NL, BE
41 Animal oils and fats	PL, FR, DE, AT	SK	NL, DK, BE	NL, BE

Source: authors' elaboration

Table 9: Division of countries (2010).

DESCRIPTION	GROUP 1	GROUP 2	GROUP 3	GROUP 4
00 Live animals other than animals of division 03	PL, SK, FR, DE	AT	BE, DK, NL	
01 Meat and meat preparations	PL, FR, DE, AT	DK	NL, BE, SK	
02 Dairy products and birds' eggs	DE, DK, NL, BE	FR, SK, AT, PL		NL, BE
41 Animal oils and fats	DE, FR, AT, PL,	SK	NL, DK, BE	NL, BE

Source: authors' elaboration

Table 10: Division of countries (2005).

level of the RCA index as well as the existence of a comparative advantage. The last group of countries includes the Netherlands, Belgium and Denmark. All of these reach a high productivity level with regard to factors of production.

The second commodity aggregate includes meat and meat preparations. The division of groups changed in the monitored years; the first group contains Poland, France, Austria and Germany, while in 2010 it also included Denmark. The median value of productivity of land is the lowest of all the monitored countries and the standard deviation is also relatively low, thus this is a relatively homogenous group. Moreover, productivity per worker is the lowest of all the monitored groups with the lowest standard deviation. This group has the lowest median value of RCA with very low dispersion. This group might be referred to as the countries possessing a relative comparative disadvantage over the Czech Republic with weak export-based production performance.

The second group of countries (Denmark and Slovakia) is rather heterogenous with regard to export-based production performance, except for land. The RCA is the highest of all the monitored groups. The third group (the Netherlands and Belgium) records very strong

export-based production performance gaining a comparative disadvantage only over the Czech Republic. These two groups changed during the analysed years.

Dairy products and birds' eggs (S3-02) and animal oils and fats (S3-41) have developed as the most diverse commodity aggregates. In 2017, they were divided into 4 sub-groups.

In the case of dairy products and birds' eggs, there were only two groups in 2005, three in 2010, and four in 2017. This indicates that that the export-oriented production performance and indicators of competitiveness changed in the monitored years. The first group includes Poland, Slovakia and France and has the lowest mean for productivity indicators; however, it also has a relatively high RCA (the highest value of all the selected groups). The mean value of GLI is approximately 0.6. All the indicators have the lowest standard deviation. The second group includes Denmark and Austria which have the highest GLI with a very high mean value of labour productivity. The last group includes the Netherlands and Belgium and has the strongest export-based production performance with the lowest GLI and bilateral RCA over Czechia.

The final group of products is specific in that its production fluctuates enormously between the years.

Discussion

The existing literature express a clear connection between international trade (especially exports and factor productivity and its growth (Bhagwati, 1978). However, the theoretical and empirical literature focusing on agricultural factor productivity related to foreign trade is rather limited (Sunge and Ngepah, 2020).

The presented results clearly show that in the monitored group of EU countries there is a within-country difference in factor export-measured productivity indicators as well as in revealed comparative advantages. However, it cannot be concluded that these differences in animal production export measures differ only between the old and the new member states. There are countries like France, Austria, or Germany where factor productivity is more similar to the new member states. On the other hand, the new member states have witnessed a considerably higher average growth rate in export per hectare of agricultural land, per worker employed or per fixed capital consumption. Based on the average growth rate three main groups can be identified. The first includes the new member states with the highest growth rate (SK, CZ, PL), followed by middle growth countries NL, BE, AU, and DK. France and Germany record the lowest growth rate. The findings support the idea of Kijek at al. (2019) about convergence in agriculture and lower productivity growth of Germany and France. It is quite interesting because when the export-based productivity performance is analysed, these two countries are more similar to the new member states than to the Netherlands, Belgium, and Denmark.

The productivity of animal husbandry differs across the monitored countries. The reason why it can vary significantly includes technology transfers, resource allocation, competition, or the use of economies of scale. On the other hand, gains resulting from international trade are connected with the existence of comparative advantages and the utilisation of economies of scale and thus increasing return to scale or openness of economy. Contrary, (Ciaian et al., 2009 have discovered that the revealed comparative advantage does not depend solely on economies of scale but also on the type of the farm, since family farms focus more on labour intensive products and can have comparative advantages compare

to corporate farms which are more capital intensive. It also supports the finding about the situation in the Czech Republic that there is a greater concentration of animal producers.

Consequently, factor productivity influences effective results of foreign trade and vice versa. However, Tong Soo (2013) argues that the gain for small countries is always more considerable than in large countries. This would mean that the Czech Republic should be able to use its productivity better than for example Poland. When comparing the position of the Czech Republic and Poland in terms of their comparative advantage, the findings indicate that in the case of their bilateral agreement there is a comparative advantage with regard to live animals over the majority of the analysed countries except Denmark and France. The problem of the Czech agricultural production is deterioration of its position in the case of Meat and meat preparations and Dairy products and birds' eggs at the European level. In comparison with live animals, where the latter records a revealed comparative advantage, the country has lost its comparative advantage which has become a disadvantage. These two commodity aggregates consist of products with a slightly higher value added than live animals only. It might be stated that the situation with the comparative disadvantage is more stable and it does not fluctuate as much as the comparative advantage. The same has been observed by (Qineti, Rajcaniova and Matejkova, 2009) in the case of Slovakia.

(Abizadeh and Pandey, 2009) have discovered that trade openness does not have a positive effect on factor productivity in agriculture, although it has a positive impact on an entire national economy.

However, one of the factors that influence the position of the country on the international market is the existence of retail companies which might have both positive and negative impact on the overall competitiveness of the country on the international market. The question is whether it is, in fact, the factor productivity, economies of scale and specialization that affect competitiveness of countries on international markets or whether there are other business powers that might influence the situation of agricultural sectors.

Conclusion

In this paper data for 9 EU member states have been used to investigate the relationship between factor export measured productivity indicators and the revealed comparative advantage for

animal husbandry. Years 2005, 2010 and 2017 have been compared and an existing gap in literature has been highlighted, which implies that it does not focus on the connection between these indicators and comparative advantages together with competitiveness.

The evidence from this study suggests that the revealed comparative advantage of these countries is not determined primarily by the level of export measured productivity. The relationship between these variables is rather weak and very often negative. This means that productivity indicators do not play a significant role in the overall competitiveness of the monitored countries. The sectors of animal husbandry in which the Czech Republic has a comparative advantage have been identified and the fact that, concerning the production itself, Czechia focuses more on products without higher added value (life animals) has been emphasised.

When the countries are divided according to their export-based productivity performance it might be stated that there are similarities between them. It is rather surprising that France and Poland are indicated in one group (with the Czech Republic as the benchmark), very often accompanied by Slovakia, Germany, and Austria. In contrast, Belgium and the Netherlands are also in the same position. Based on the above results, it might be concluded that there are differences between the countries and that the Czech Republic has a unique position with regard to export-based productivity performance.

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