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ISSN 1804-1930
VIII, 2016, 4

International scientific journal
Prague

Agris on-line Papers of Economics and Informatics

The international reviewed scientific journal issued by the Faculty of Economics and Management of the Czech University of Life Sciences Prague.

The journal publishes original scientific contributions from the area of economics and informatics with focus on agriculture and rural development.

Editorial office

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Publisher

Faculty of Economics and Management
Czech University of Life Sciences Prague
Kamýcká 129, 165 21 Praha 6 – Suchdol
Czech Republic
Reg. number: 60460709

ISSN 1804-1930

VIII, 2016, 4
30th of December 2016
Prague

Agris on-line
Papers in Economics and Informatics

ISSN 1804-1930

VIII, 2016, 4

Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Content:

Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Categorization of the EU Countries in the Context of Agricultural Production

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Abstract

Paper provides synthesis of knowledge and empirical research on selected determinants of agricultural production and verifies the applicability of the methods of hierarchical and non-hierarchical clustering in the agricultural sector. It identifies and categorizes the EU Member States in order to their clustering based on the similarity of common features in the context of direct (gross value added, support for agriculture, agriculturally utilized land) and indirect factors (employment, gross fixed capital) affecting the total agricultural production. The aim of the paper is creation of the economically meaningful groups of the EU countries that would confirm or reject the classification of old and new member states. The results of cluster analysis divided countries into three clusters, and confirmed that second cluster was represented by the new member states, and third by the old member states. Clusters were mutually different in the indicators of labour force in agriculture, support for agriculture, and agriculturally utilized land.

Keywords

Agricultural production, employment, agricultural policy, fixed capital creation, gross value added, support of agriculture.

Andrejovská, A., Buleca, J. and Hudáková, M. (2016) “Categorization of the EU Countries in the Context of Agricultural Production", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 3 - 14. ISSN 1804-1930. DOI 10.7160/aol.2016.080401.

Introduction

The agrarian system of the individual EU countries significantly differs from the other sectors of the national economy due to its specifics. From the global aspect, the agricultural production represents the primary sector of the biological character and the areal spread of production. The share of the agriculture on the total EU budget has significantly decreased, from the maximum of 70% in the 70’s, down to around 38% nowadays. This decline reflects both, the increase of the EU’s powers in other areas, as well as the savings brought by the reforms. The main objective of the reforms was to improve the agricultural productivity, which would provide consumers with a stable supply of affordable food and the agricultural producers with the appropriate income. The efficiency of the agriculture and also the changes that are currently occurring in all EU Member States, are significant. The agro-food economy is affected by several factors, but a crucial role in this process is played by the Common Agricultural Policy, which significantly influences the situation of the agricultural businesses through individual forms of support. The European agricultural decision makers must deal with many components described in the Common Agricultural Policy in order to optimize data integration and achieve transparency (Toth and Kucas, 2016). Recent CAP reforms, including the last reform implemented in 2015, have been designed to reallocate expenditure, reduce inequality and ensure higher territorial balance. Despite the initial funding allocation, this expenditure re-distributes its effects towards richer and urban regions. This redistributive pattern depends on the magnitude and direction of intersectoral and interregional linkages (Bonfiglio et al., 2016). The key question in the context of the Common Agricultural Policy is mainly the regionalization of the EU, which creates opportunities and challenges for individual countries (Alexiadis et al., 2013). On the other side there is a risk that this regionalization may aggravate the inequalities between regions (Trouvé and Berriet-Solliec, 2010). Since each EU country

is geographically, economically and climate-specific, it is difficult to unite this heterogeneous agricultural potential.

Enlargement of the EU have amplified the diversity of European agriculture, resulting in the intensification of agricultural activities in some regions, together with marginalization of agriculture in others. For some transient economies the EU membership caused the delay in the restructuring process and some substandard businesses, thanks to the support policy, get a chance for the continued existence (Doucha, 2011). There are large differences across transition countries with respect to agricultural-sector performance and corresponding scope of farm restructuring. The territorial structure of the foreign agrarian trace is continuously concentrating on the EU-Single Market, both in terms of exports and imports (Smutka et al., 2016). Potential implications of Brexit for the EU's Common Agricultural Policy and agri-food sector will have broadly negative effects for the EU farm and food sector (Matthews, 2016).

In the investigation of the impact of gross-value-added to farm, land and labour productivity indicators significant differences between the Northern-Central counties and the continental peripheries (Mediterranean, Eastern, Northern Scandinavian) were found, and the factors behind this different performance were specified (age and training of farm population, investments to agriculture, environmental conditions and technical efficiency, utilization of agricultural land) (Giannakis and Bruggeman, 2015).

Relative macroeconomic performance and international competitiveness of the agro-food sectors differ considerably among the EU member state countries. It seems that as far as international competitiveness is concerned the CAP should be more oriented towards improving economic efficiency of the agro-food sectors, especially in the countries where the revealed competitiveness index is low (Figiel and Kufel, 2013). The agricultural sector has significantly changed its structure and position within the national economy of individual new EU member states in the 20 years since the early 1990s. The size of the agricultural sector reduced, resulting in a reduction in the value of the agricultural sector performance, but agricultural sector performance of several countries became more efficient (Svatoš et al., 2014). In other works, the workforce was defined as one of the most important factor contributing to the increase in the level of agricultural production, due to its ability to compensate for physical and material limitations and shortcomings of other factors (Davijani et al., 2016). Investigation of the impact of an ageing agricultural labour population on agricultural production showed, that in context of ageing, changes in the working-age households have a significant impact on agricultural output (Guo et al., 2015). Other authors indicated that productivity (value added and its growth) in the agricultural sector, significantly depends on relative prices of agricultural goods, quantity and quality of resources, and technical progress on production methods, especially management styles (Besharat and Amirahmadi, 2011). Income distributional effects of three main instruments of the Common Agricultural Policy (CAP) in the EU: Coupled Direct Payments (CDP), the Rural Development Programme (RDP) and the Single Payment Scheme (SPS) showed that farmers gained 66–72%, 77–82% and 93–109% from the CDP, SPS and RDP respectively. These results suggest that the initiated shift in CAP expenditure from the support of farm production activities towards supporting rural development and the provision of public goods and externalities is also in line with supporting farmers' income (Ciaian et al., 2015). Changes in production can partly be related to climatic variability and change, but also subsidies and other developments (e. g. technology, markets) are important. The initial purpose and objectives of the agricultural subsidies was to improve the income of agricultural producers with regard to the general interests of society (Foltýn, 2008).

The aim of submitted paper is, based on the methods of quantitative economics, creation of economically transparent and meaningful categorization of the EU member countries, which would confirm or reject the classification of the countries into old and new Member States according to common characteristics affecting the total agricultural production. Direct (gross value added, support for agriculture, and agriculturally utilized land), and indirect factors (employment, gross fixed capital) were included among the common determinants. The analysis was performed on the 28 EU Member States and is based on a combination of six direct and indirect variables representing the economic performance of agriculture:

1. total agricultural production (expressed in mil. €)
2. gross value added (expressed in mil. €)

3. labour force in agriculture–expressed in 1000 AWU (annual work unit, which measures the number of people working as full-timers throughout the entire monitored year)
4. support of the agricultural production (expressed in mil. €)
5. agriculturally utilized land (expressed in 1000 ha)
6. formation of gross fixed capital (expressed in mil. €)

Material and methods

The analysis was performed, and is also presented in two steps. In the first step of the research, similar clusters of countries based on variables connected to economic performance of agriculture have been identified by the applied methods of cluster analysis (Ward method, median method, k-means, and fuzzy cluster analysis) (Estivill-Castro, 2000; Suzuki and Shimodaira, 2006). The final groups of these multidimensional objects with characteristic features were compared to each other and subjected to economic verification to identify the appropriate economic categorization. In the second step of the research, final categorization of countries, confirming or rejecting the classification of EU member states to old and new ones was discussed and similarities and differences were evaluated.

The selection of indicators was performed based on the theoretical knowledge of the authors who investigated similarities or dissimilarities (distances) of examined objects using the multidimensional scaling in their studies and examined the relations and activity of the selected economic variables affecting the total agricultural production (Rimarčík, 2000; Hair et al., 1992; Pecáková, 1998; Meloun et al., 2005; Buday and Vilček, 2013; Dubravska et al., 2015; Ionescu, 2015; Mura et al., 2013; Gazda et al. 2014; Gavurová et al.,2016). As mentioned above, the categorization has been performed using several methodological approaches to the data study. The methods are mentioned mainly in the context of the problem of so-called manifold learning (Rosman et al., 2010). It is known that the concept of metrics is the common denominator of mentioned methods which are substantially different by its historical origin, objectives and procedures. For applying the methods, we used implementation in R environment. Within the methodology of the cluster analysis, it has been applied the traditional hierarchical cluster analysis which is well known within the scientific community with application of the Ward's linkage (which is the most frequently used method on this field) and the median method, both using the standard tool hclust () (R-Core Team, 2013; Řezanková, 2015). Out of non-hierarchical methods the k-means () routine and its widening by fuzzy c-means, implemented by cmeans() routine were used (Brauksa, 2013). Fuzzy c-means is specific compared to other methods, as it enables to detect so-called classification fuzzy objects by using tools k-means and fann () (Charrad et al., 2012). In all methods the Euclidean distance was used (Halkidi et al., 2001; Everitt et al., 2001). The obtained information on the structure of clusters was complemented with the dimensional scaling (called the principal coordinates analysis), which was realized using cmdscale () routine (Venables and Ripley, 2002).

Whereas the indicators acquired vastly different values, in the first step of our analysis, we decided to transform the data by conversion to the z-scores. Each item was subject to standardization/normalization by subtracting the median and dividing by the standard deviation. By this transformation we achieved zero value of median and standard deviation equal to one. Those were depicted in multidimensional scaling by cmdscale () procedure and evaluated whether the data has showed clusterization feature–aggregation. Subsequently, the transformed data were processed by the selected methods mentioned above.

The cluster analysis was conducted in the R statistical software for the EU countries for the year 2014. The quantitative data were used from the Eurostat database and from the reports of the Research Institute of Agriculture and Food Economics. The obtained results are mutually compared and taken into account in further clustering processes, which categorize the EU countries into three separate clusters, based on their similarities. The clusters' indices were re-implemented into the output of multidimensional scaling and were evaluated in terms of the countries' distribution. The paper contains the values of the final models only.

Results and discussions

1. Hierarchical and non-hierarchical cluster analysis of the income tax

The data for meta-analysis was first pre-treated by the multidimensional scaling (Figure 6).

Accordingly, the countries were classifying into three clusters. After visual evaluation we have transformed the data to z-scores and processed it by selected methods of cluster analysis (Ward's method, and single linkage clustering, also the k-means method, and fuzzy clustering). Each of the method has led to three clusters, in line with the preliminary estimate. The clusters' indices were again re-implemented into the output of multidimensional scaling and were evaluated in terms of the countries' distribution.

2. Ward's method of hierarchical clustering

This method is the most used method and also very popular among economists. It generates approximately the equal-sized clusters and reports them in the form of dendrograms (Figure 1), by using the command cutree. The analysed countries were grouped into three clusters. The first clusters consisted of the highest number of countries: Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Ireland, Greece, Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Portugal, Slovenia, Slovakia, Finland and Sweden. The second cluster included Germany, Spain, France, Italy and the United Kingdom and the last, third cluster consisted of Poland and Romania.

Figure 2 graphically illustrates the rate of mutual similarity of objects within one cluster and at the same time the rate of dissimilarity of objects from different clusters. The results of the cluster analysis show the satisfactory conclusion, as none of the clusters overlapped the other clusters and they do not have a common intersection. At the same time, the graph sketches the object of the third cluster (Poland and Romania), which is significantly different from other two clusters.

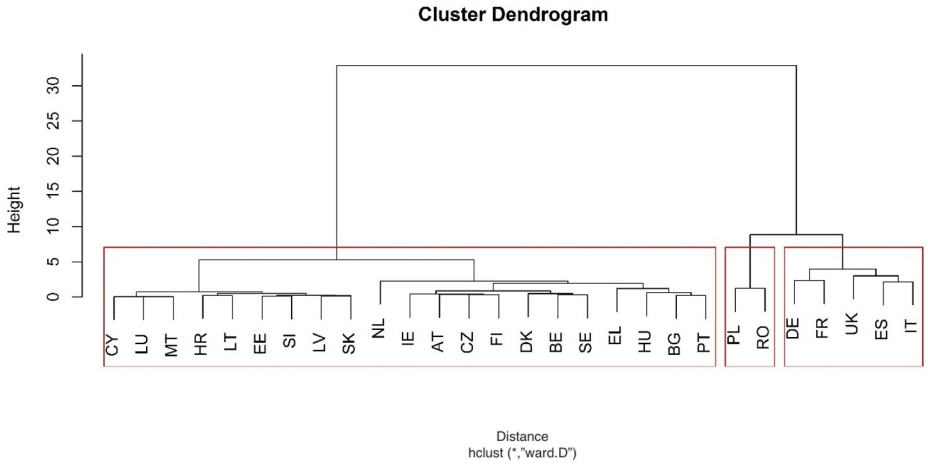

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Figure 1: Dendrogram created through Ward's method of cluster analysis for year 2014.

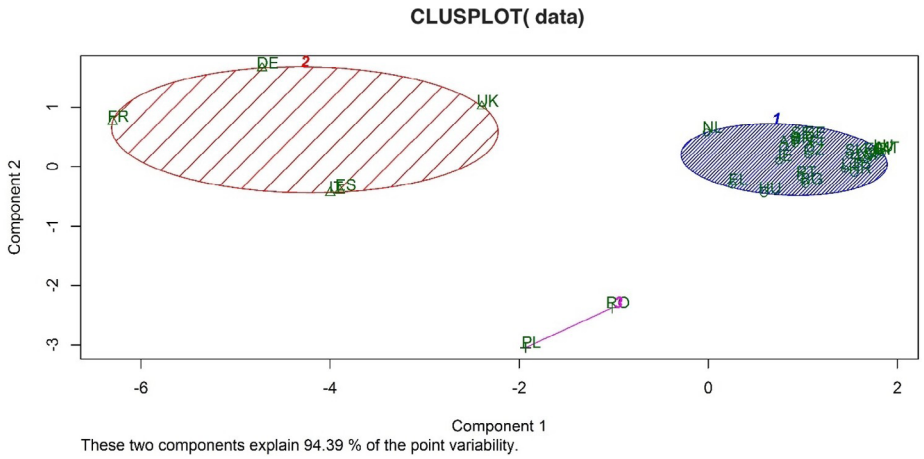

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Figure 2: Graphical representation of cluster analysis of EU member states by Ward's method.

3. Median method of hierarchical clustering

The second analysed method was the median method, which represents another hierarchical method. We determined the optimal number of clusters, which was also three, by applying the tool NbClust, as shown in Figure 3. The classification, as well as the composition of the countries within the clusters was identical to the Ward's method, despite the fact that this method primarily does not concentrate on the number of clusters, but rather focuses on the distribution of the clusters.

4. K-means method of non-hierarchical clustering

When applying k-means method, we have pre-determined the number of centroids that means the number of clusters, which should be formed from the individual objects. We have applied the methods of non-hierarchical clustering, such as k-means method and method of fuzzy clustering, for comparison purposes. The optimal number of clusters was determined visually from the graphical output of Figure 4, from which we concluded that the optimal number of clusters is three clusters, while the testing reported the optimal number of clusters in the range of one to ten clusters.

The curve sharply increased to a value of three, which indicated that this value represents the optimum. Also the value of 5 possibly 7 clusters could be considered as optimal number, since these points reported also the significant increase. This step of selecting the number of clusters is thus affected by a subjective judgment of the analyst, therefore we have decided on three clusters, as it was reported in the hierarchical clustering by the Ward's method and the median method. The number of countries in each cluster was the same 21.5 and 2.

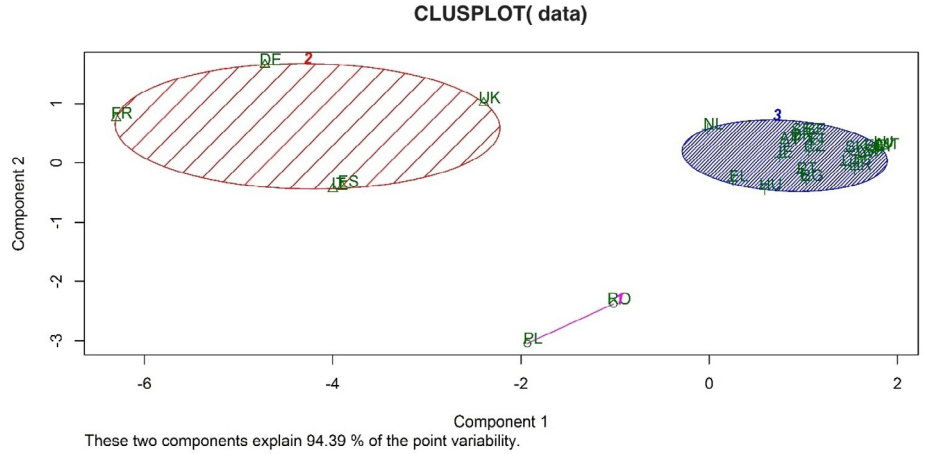

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Figure 3: Graphical representation of cluster analysis of EU member states by median method.

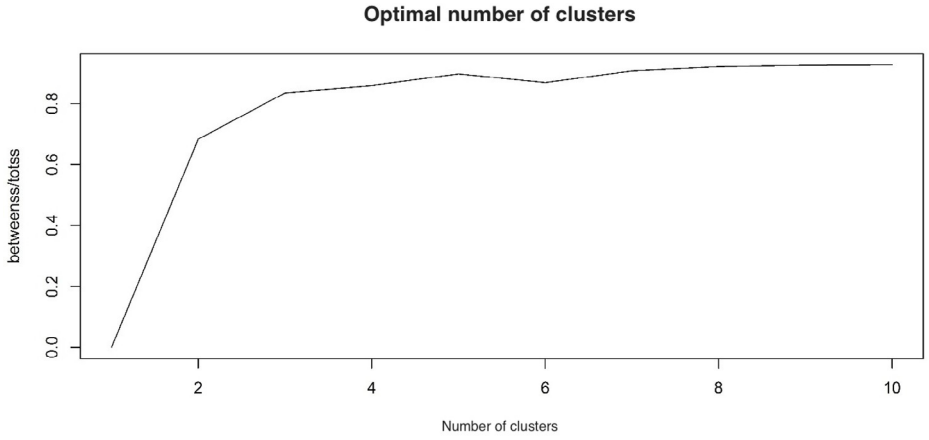

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Figure 4: Determination of optimal number of clusters by k-means method.

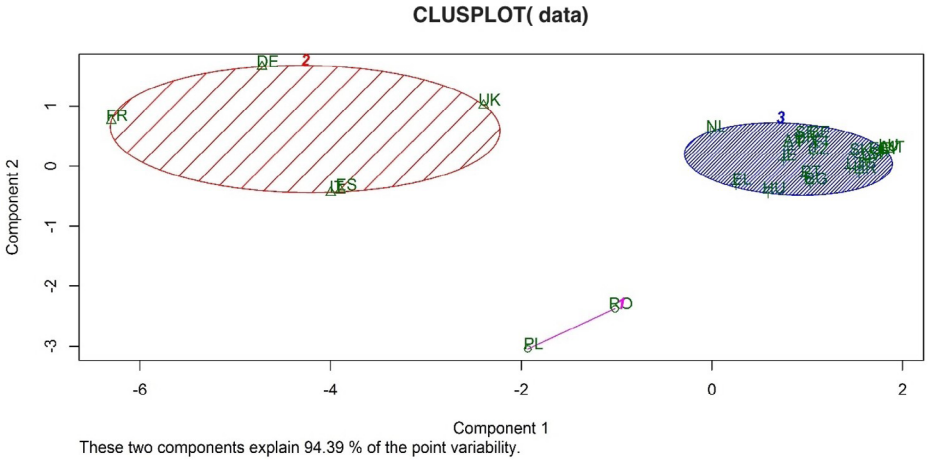

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Figure 5: Graphical illustration of the k-means method.

We have identified the match between the compared results of the k-means method and the Ward's method, which proves the appropriate classification of the Member States into individual clusters. The match was shown in the determination of the optimal number of clusters (3). Although the number of clusters was selected solely on the basis of our decision, the number of clusters in our analysis was not chosen freely, but based on the testing in the R software. The second important match occurred in distribution of Member States in individual clusters. Therefore, we can conclude that the clustering has met the requirements of clear classification, the clusters do not overlap each other and are distributed with a sufficient distance.

5. Non-hierarchical method of fuzzy clustering

The second testing method we used was the method of uncertain aggregation fuzzy k-means, which allows the country to belong simultaneously to all clusters, always with a definite or indefinite probability. Uncertain countries were the countries whose share in individual clusters was similar. Alignment of certain countries to specific cluster was more than 50%. On that basis, each country was assigned a probability value. The analysis was also expressed by multidimensional scaling (Figure 6). Overlapping expressed the percentage rate of a specific country belonging to one of the clusters (Table 1).

Affiliation rate of some objects within the data set was very high. However, some countries showed relevant signs of affiliation to multiple clusters. In classification the highest aggregation rate was showed in Estonia (83%), Slovenia (82.45%), Latvia (81.19%) and Cyprus (80.89%), all of them represent the certain countries with affiliation level higher than 50%. Although in given analysis they showed a strong affiliation to third cluster, in previous methods, these countries were clearly included in the first cluster. This is a group of the new EU member states. The uncertain countries with uniform affiliation rate to all three clusters were Romania (37.58%, 32.82% and 29.60%) and Poland (32.45%, 40.80% and 26.75%). In previous methods they constituted a separated second cluster and from other objects they considerably differ by aggregation distance. They also represent the new Member States. The old Member States showed a strong affiliation to second cluster and we can classify them as the specific countries: Germany (68.69%), Spain (72.71%), France (70.57%), Italy (68.11%) and United Kingdom (52.74%). However, when using other methods, they created the basis of the third cluster.

Results comparison of selected factors by the methods of cluster analysis

The results of the applied methods were satisfactory. The hierarchical Ward's method, as well as the non-hierarchical k-means method and method of fuzzy k-means clustering, classified the EU states into cluster identically. The average value of the original variables for each cluster, represented by the EU Member States, according to the Ward's method of hierarchical cluster analysis is shown in Table 2.

The results of the methods used were satisfactory. Hierarchical Ward; median; but also non-hierarchical k-means method has classified the EU countries completely identical. Undetermined aggregation fuzzy k-means method

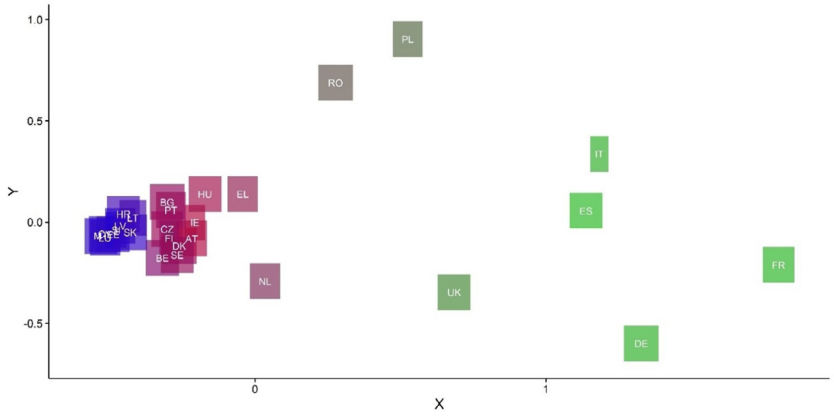

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Figure 6. Multidimensional scaling of the EU member states by fuzzy cluster analysis.

country	cluster 1	cluster 2	cluster 3	country	cluster 1	cluster 2	cluster 3
BE	51.35%	5.32%	43.33%	LT	27.89%	3.13%	68.98%
BG	57.76%	4.87%	37.37%	LU	17.38%	2.78%	79.84%
CZ	61.13%	3.51%	35.36%	HU	63.36%	7.23%	29.41%
DK	60.40%	4.64%	34.96%	MT	18.37%	3.06%	78.57%
DE	16.87%	**68.69%**	14.44%	NL	48.94%	16.86%	34.19%
EE	14.87%	2.13%	**83.00%**	AT	68.93%	4.33%	26.74%
IE	69.83%	4.50%	25.67%	**PL**	**32.45%**	**40.80%**	**26.75%**
EL	57.84%	11.58%	30.58%	PT	60.36%	4.23%	35.41%
ES	14.97%	**72.71%**	12.32%	**RO**	**37.58%**	**32.82%**	**29.60%**
FR	15.71%	**70.57%**	13.72%	**SI**	15.45%	2.09%	**82.45%**
HR	26.11%	3.39%	70.50%	SK	21.10%	2.35%	76.55%
IT	17.35%	**68.11%**	14.54%	FI	58.13%	4.82%	37.05%
CY	16.50%	2.62%	**80.89%**	SE	59.18%	5.21%	35.60%
LV	16.65%	2.16%	**81.19%**	**UK**	26.46%	52.74%	20.80%

Source: own processing

Table 1: The percentage distribution of the EU Member States in the clusters by fuzzy k-means method (in 2014).

cluster	A1	A2	A3	A4	A5	A6
1	1,879	5,540	33,095	135,047	819,666	2,302,714
2	21,619	51,843	379,804	694,400	5,969,800	19,367,200
3	7,614	19,750	58,490	1,683,000	2,240,000	13,876,500

Notes:
A1 = gross value added of the agricultural industry - producer prices
A2 = output of the agricultural industry - producer prices
A3 = gross fixed capital formation (investments)
A4 = labour force in agriculture measured in AWU
A5 = support of agricultural production
A6 = agriculturally utilized land
Source: own processing

Table 2: Quantitative characteristics of clusters formed by Ward's method for year 2014.

classified the countries to the similar structures like the previous methods. In contrast to these, however, Estonia, Slovenia, Latvia and Cyprus belonged to the third (not to the first) cluster; and Germany, Spain, France, Italy and the United Kingdom belonged to the second (not to the third) cluster. The average value of original variables for each cluster represented by the EU Member States according to Ward's method of hierarchical cluster analysis is showed in the Table 2.

The first, most populous cluster was created by countries: Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Ireland, Greece Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, the Netherlands, Austria, Portugal, Slovenia, Slovakia, Finland and Sweden. This cluster reported the lowest values of all monitored indicators. The agriculturally utilized land was at 2,302,714.29 ha, with the highest share by Ireland (2.8%), Hungary and Bulgaria (2.7%). Slovakia and Netherlands have a share of 1.1%, a little higher percentage was reported by Finland (1.3%), Denmark (1.5%), Lithuania (1.6%), Austria (1.7%) and all other countries from this cluster reported a share higher than 2%. Chrastinová et al. (2014) monitored the Slovak agriculture through the method of multidimensional scaling and found out that from the view of the indicator "Agriculturally utilized land (in thousands ha)", Slovakia is associated with geographically similar countries or partially with countries with similar political and economic development, which are Bulgaria, Germany, Hungary, Austria, Poland and Romania. The highest share of agriculturally utilized land on the total area of the country was reported for Denmark (61.4 %), Luxembourg (50.7 %), Hungary (50.4 %) and the Netherlands (50.1 %). The lowest share was in Finland (6.8 %), Sweden (6.9 %) and Cyprus (12.8%). A critical indicator of the cluster was the gross value added, which reached a value of 1,879.61 mils €. The highest value, although only (6.2 %), was in Netherlands. The share of Slovakia represented 0.4 % and on a year over year basis stayed almost unchanged. It was the lowest share among the V4 countries, right after Hungary (1.7 %) and the Czech Republic (0.9 %), which related mainly to the extent of the land usage and the achieved production. The average value of the cluster (819,666.67 mils €) was reached in the support of agriculture, which is still the decisive item of incomes for farmers in all EU countries. Slovakia received a 0.9 % of total EU–28 supports, representing 246.8 €/ha of agriculturally utilized land, which was below the average of the EU-28 countries (17.4 %), representing on average 298.8 €/ha of agriculturally utilized land. The highest amount of support, calculated per hectare of utilized land, was in Malta (1,545.5 €), Greece (820.6 €) and Finland (781.8 €). The smallest amount of support, calculated per hectare of utilized land, was received by Croatia (22.8 €), Lithuania (70.1 €) and Latvia (109.1 €). The share of persons employed in agriculture ranged from 0.2 % in Estonia and Cyprus to 4.7 % in Greece. The highest number of persons employed per 100 hectares of agriculturally utilized land (in AWU) was in Malta (45.5), Cyprus (21.2), Slovenia (17.3) and Croatia (14.7). The employment in Slovakia reached the value of 2.83 persons per 100 hectare of agriculturally utilized land, which was by 0.2 less than in the previous year. It is important to realize, that not only the number of employed persons, but also their education is important, as it is known that in agriculture employees with basic education are predominant. The crucial role of education was confirmed (Giannakis and Bruggeman, 2015). Chances to achieve a high economic performance are almost 9 times higher in the countries with the highly schooled stuff. Their analyses led to results that in the Netherlands it is 72 % and in Germany 69 %.

Similar conclusions in regards of education are stated by other authors (e.g. Stachová et al., 2015). The last monitored indicator was the agricultural production, which was in this cluster reported at the lowest level of 5,540.40 mils €. Slovakia's share on the European production represented 0.6 % with the volume of 2,284 mils. €. The highest intensity of production per hectare of agriculturally utilized land was reached in the Netherlands (14,611.4 €), Malta (11, 218.2 €), Belgium (6,280 €) and Cyprus (5,851.2 €). The lowest production per hectare of agriculturally utilized land was reported in Latvia (666.1 €), Estonia (926.4 €), Lithuania (890.2 €) and Bulgaria (890 €). Slovakia reached the production per hectare of agriculturally utilized land at 1,204.6 €, which ranks it between the countries with the lowest production and the lowest among the V4 countries.

The second cluster was represented by the group of developed EU countries with high values of monitored indicators and a highly developed agricultural market. Based on the similarity of these countries, the cluster was formed by the old Member States such as Germany, Spain, France, Italy and the United Kingdom. The agriculturally utilized land amounted to 19.367 mils ha. The highest share of the total agriculturally utilized land in the EU-28 countries was reached by France (16.2 %), Spain (13.8 %), Germany (9.7 %) and Italy (7.5 %). The above-average values were reported for the indicator of gross value added, which had the highest value among all cluster, at 21,619.98 mils €. Its major share (83.6 %) was formed by the original EU-15, mainly Italy (17.7 %), France (15.4 %), Spain (14.0 %) and Germany (11.4 %). Also the largest part of the total support (81.7 %) was allocated into the original Member States (42.2 billion €) and that was by 8.2 % lower

volume than in previous year. The largest portion of total EU-28 support was allocated into production countries, which are France (15.8 %), Germany (14.1 %), Spain (11.9 %), Italy (8.6 %) and the United Kingdom (7.4 %).

The indicator of employment in agriculture was in this case the second highest one (694,40 persons in AWU). The agricultural employment was the highest in Italy (11.0 %), Spain (8.5 %) and France (8.0 %), which was related to the extent of the agricultural production and to a larger number of smaller individual farms in these countries. Similar results were confirmed also by other authors (Raisová, 2011; Michalski, 2008; Litavcová, 2015; Zachar et al., 2011; Šoltes et al., 2014; Hakalová et al., 2014; Grancay et al., 2015). The agricultural output was at the value of 51,843.91 mils €. The largest producers in the EU-28 were France (17.7 %), Germany (13.1 %), Italy (12.8 %) and Spain (10.6 %). In the structure of the total EU-28 production, the largest agricultural output was in cereals including rice (305.5 mils tons), where the biggest producers of wheat were France (27.1 %) and Germany (18.4 %). The third cluster was formed of the lowest number of countries, only Poland and Romania. The monitored indicators were in this cluster at the average values. The agriculturally utilized land represented in Poland 8.4 % of the EU countries area and in Romania 7.8 %. The share of the agriculturally utilized land of the total area of a given country was in Romania reported at over 50% (55.8 %) and in Poland it reached 46.2%. The gross value added was in Poland at 5.7 % and in Romania at 4.6 % of the EU countries share. Compared to the other countries, these are average indicators, since these two countries accesses the EU only in 2004, or in 2007 respectively. The agricultural support was in this cluster at the value of 2.240 mils €. When calculated to the hectares of agriculturally utilized land, the average of the EU-28 was at 298.8 € and the average of the EU-15 reported 342.5 €, while Romania reported 125.1 € and Poland 195.5 €. Overall, the number of persons working in agriculture has decreased by 1,504 thousand persons during the last 5 years (2009–2013). The agricultural employment of the EU-28 countries was in Poland at 19.9 % and in Romania at 14.9 %. Per 100 hectares of agriculturally utilized land, the number of persons employed in agriculture (in AWU) was in Poland 13.4 and in Romania 10.9. The EU-15 countries produced almost 83.4 % of the EU-28 production, which was 71.7 % in plant commodities and 84.5 % in animal commodities. The agricultural production in Romania was within the EU countries below average and reached 4.1 % and in Poland 5.7 %. Calculated per hectare of agriculturally utilized land, Poland reached the value of 1,582.5 € and Romania 1,222.1 €. The quantitative characteristics of the analysed clusters differed mainly in the indicators of labour force in agriculture, support to agriculture and agriculturally utilized land. Similar observations were concluded by Chrastinová et al. (2012). In their work they have divided countries into two groups, based on the amount of received support per hectare of agriculturally utilized land: the states reaching the EU-27 average, which are Belgium, the Czech Republic, Denmark, Germany, Ireland, Greece, France, Italy, Cyprus, Luxembourg, Malta, the Netherlands, Austria, Slovenia, Finland, Sweden and the states below the EU-27 average: Bulgaria, Estonia, Spain, Latvia, Lithuania, Hungary, Poland, Portugal, Romania, Slovakia and the United Kingdom. Dos Santos (2013) classified in his analysis 23 EU countries into four groups, according to their performance in agriculture. Slovakia and the Czech Republic formed the third cluster, characterized by the largest agricultural area. Giannakis and Bruggeman (2015) in their analysis of economic performance used similar methods (Ward's, k-means and two-step clustering methods) to classify European agriculture based on gross-value-added farm, land and labour productivity indicators. Their results revealed significant differences between the Northern-Central counties and the continental peripheries (Mediterranean, Eastern and Northern Scandinavian).

Conclusion

The analysis has confirmed that despite the continued integration within the EU, there are still differences in the agrarian policies of individual national governments. Provided cluster analysis confirmed the degree of divergence of different agricultural policies and considerable scope for the implementation of harmonization measures. Our analysis verified that EU countries could be classified into the group of the old member states (cluster 3) and the new Member States (cluster 2). The first cluster consists of both, new and old Member States, while clusplots confirmed that within this cluster there is a clear mutual proximity of clustering to overlap of the new Member States and the old Member States. Clustering similarity was achieved by all methods except the fuzzy k-means, using which the different affiliation was found (Estonia, Slovenia, Latvia and Cyprus

(the new Member countries) belong to the third (not the first) cluster; and Germany, Spain, France, Italy and United Kingdom (the old Member States) belong to the second (not third) cluster, as it was in all previous methods). Provided analysis has clearly confirmed that the EU countries and their agricultural policies, as well as the total amount of agricultural production and other agricultural determinants we studied, were classified into the new and old EU Member States. It was confirmed, that the process of integration and harmonization of agricultural policies is long-term and dynamic, and it is up to agrarian policies of individual governments, how they will manage this process and whether the agricultural market will be unified despite the specific conditions that exist in each country.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Usability Analysis of Agricultural Portal eAGRI in Terms of the General Public

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Abstract

Nowadays simple usability is one of the key tasks of web portals, especially if these are main information portals of the government. The aim of this paper is to evaluate the usability of a web portal eAGRI (eagri.cz) in terms of unregistered users. This means in terms of general public in particular. The main purpose of the testing is to highlight the issues that users may encounter on this portal and determine the level of portal usability. Our usability testing was focused on a public part of the portal. The main idea of eAGRI portal is to create a central access point to information resources of the Ministry of Agriculture of the Czech Republic and its subordinate organizations. Qualitative research methods were applied. Specifically, we used Heuristic evaluation as a usability inspection method and three methods of usability testing: 5 second test, 30 second test and Formalized think-aloud test.

Keywords

Usability analysis, eAGRI portal, heuristic evaluation, user testing, 5 second test, 30 second test.

Benda, P., Šmejkalová, M. and Šimek, P. (2016) "Usability Analysis of Agricultural Portal eAGRI in Terms of the General Public", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 15-23. ISSN 1804-1930, DOI 10.7160/aol.2016.080402.

Introduction

Usability deals with an individual's ability to accomplish specific tasks or achieve broader goals while "using" whatever it is the individual is investigating, improving, or designing - including services that do not even involve a "thing" like a doorknob or web page (Reiss, 2012). Matausch et al. (2014) states that the implementation of information that is easy-to-read and easy-to-understand and easy-to-navigate on the Web is crucial to enable the broadest user group to make use of information that is presented on Web pages. Moon Hee Jung (2015) describes that more than before, the design is being tailored to fit end user needs.

Behavior of users on the web changed rapidly during last 20 years. Users are focused on their needs and get easily frustrated if they cannot achieve these needs in simple way and really quickly (Krug, 2006). Users also take impressions and mental models from previous experiences (Page et al., 2012). Credibility of website is important too (Roghanizad, 2015). Several studies have documented that a lack of usability of user interface has an impact on actions of the users (e.g. Cervone, 2005; Tolliver et al., 2005; Clemmensen, 2009). It is also necessary to assess if the application meets the requirements on user interface, especially in the area of applicability and User Experience of the respective platform. The UX approach is suitable for testing usability of web information sources in agrarian sector and related fields (Šimek et al., 2015).

Usability testing is a technique used in user-centered interaction design to evaluate a product by testing it on users. This can be seen as an irreplaceable usability practice since it gives direct input on how real users use the system. Usability testing usually involves systematic observation under controlled conditions to determine how well people can use the product (Nielsen, 1993).

The aim of this paper is to evaluate the usability of a large web portal eAGRI (eagri.cz) in terms of unregistered users. This means in particular in terms of the general public. The main purpose of the testing is to highlight the issues that users may encounter on this portal and determine the level of portal usability.

Materials and methods

Our usability testing was focused on a public part

of web portal eAGRI. The main idea of this portal is to create a central access point to information resources of the Ministry of Agriculture of the Czech Republic and its subordinate organizations. Qualitative research methods were applied. Specifically, we used Heuristic evaluation as a usability inspection method and three methods of usability testing: 5 second test, 30 second test and Formalized think-aloud test.

Heuristic evaluation

A heuristic evaluation is a usability inspection method for computer software that helps to identify usability problems in the user interface (UI) design. It specifically involves expert evaluators examining the interface and judging its compliance with recognized usability principles - the "heuristics". Usability inspection is the name for a set of methods where an evaluator inspects a user interface. This is in contrast to usability testing where the usability of the interface is evaluated by testing it on real users (Nielsen and Mack, 1994). The list of heuristics created by Nielsen (1991) was used for evaluation. The evaluation was performed by one evaluator. Ten rules were considered during the evaluation: The rules are summed up in Table 1.

A heuristic evaluation should not replace usability testing. Although the heuristics relate to criteria that affect usability of tested, the issues identified in a heuristic evaluation are different than those found in a usability test (Molich and Nielsen, 1990).

As a complement for Heuristic evaluation, which is usability inspection method, we used three methods of usability testing. Nielsen and Mack (1994) describes usability testing as a technique used in user-centered interaction design to evaluate a product by testing it on users. This can be seen as an irreplaceable usability practice since it gives direct input on how real users use the system.

5 second test

The first usability testing method we used is a first impression test. As the name suggests, the 5-second test involves showing users a single content page for a quick 5 seconds to gather their initial impressions. The reason for five seconds is important because of research studies which demonstrate that website visitors take a very short amount of time, in some cases a fraction of a second, as little as 50 milliseconds, to judge the quality of a website (Lindgaard et al., 2006).

Five seconds may not seem like a lot of time, but users make important judgments in the first moments they visit a common web page. As well as Doncaster (2014), we used this kind of test to ask users whether they know where they are and let them to simply describe what they saw and are able to find on the portal.

30 second test

We used 30 second test to enable users to scroll and navigate the home page of the eAGRI portal briefly and get more detailed information about the portal. Then we asked them the same questions after a 5-second test.

Formalized think-aloud test

Nielsen (1993) indicates this test as the single most valuable usability engineering method. This method is used to gather data in usability testing in product design and development, in psychology

No.	Description	Recommendation
1.	Visibility of system status	provide a feedback of the system in reasonable time
2.	Match between system and the real world	use language familiar to the user, information in a natural and logical order
3.	User control and freedom	help user to deal with mistakes and turns, support undo and redo
4.	Consistency and standards	follow the convention, use consistent styles and actions
5.	Error prevention	eliminate errors and prevent problems, ask for confirmation before complicated tasks
6.	Recognition rather than recall	make options visible, don't force user to remember information about different parts of a dialogue
7.	Flexibility and efficiency of use	system with options for inexperienced and experienced user
8.	Aesthetic and minimalist design	only insert important and relevant information in dialogues
9.	Help users recognize, diagnose, and recover from errors	indicate the problem and suggest a solution
10.	Help and documentation	provide help and documentation with the easy access to information and logical structure

Source: Nielsen (1991), adapted by author

Table 1: The list of ten heuristic rules.

and a range of social sciences for many years. The think-aloud method was introduced in the usability field by Clayton Lewis (1982). The method has a host of advantages. Most important, it serves as a window on the soul, letting to discover what users really think about the design of the web. In particular, it is possible to hear misconceptions of users which usually turn into actionable redesign recommendations: when users misinterpret design elements, it is necessary to change them. Even better, it is possible to learn why users guess wrong about some parts of the user interface and why they find others easy to use. Being cheap and robust are huge upsides of qualitative methods such as Thinking-aloud method is, but the flip side is that the method does not lend itself to detailed statistics. (Nielsen, 1993). The principle of this method is really simple. Users which are testing the system saddles loud their thoughts on the application while executing a set of tasks. During this test we also observed time consumption of each task. This was evaluated using the following scale:

- 0 = user did not complete the task (> 3 min);
- 1 = user completed the task in a very long time (> 90 sec and ≤ 3 min);
- 2 = user completed the task slowly (> 30 sec and ≤ 90 sec);
- 3 = user task completed quickly (≤ 30 sec).

All observed results were subsequently summarized into the table (Table 2).

Process

Our user testing was attended by a total of 5 users (testers), four men and one woman. 3 users were aged 20-30 years, two aged 30-40. Neither of the users had previous experience with eagri. cz web portal. Testing was conducted individually with sufficient time allotment. So users could not being stressed by performance of others. Therefore the age diversity also had no significance. Possible stress factors which indicates Sonderegger et al. (2016) were thus been eliminated. Users also did not know that their assessment will be marked as invalid, when using more than three minutes on a task or even how their testing is going to be evaluated. The Heuristic evaluation was performed by one expert evaluator. All users used the same PC with MS Windows 7 operating system, Google Chrome web browser and 1920x1080 pixel screen resolution. After completion of the whole testing, we conducted a group sessions with all testing participants, so all the users and usability expert. The aim of the session was to summarize the findings and feelings of testing and the eAGRI portal as a whole.

Nielsen and Landauer (1993) and Krug (2006) both discuss the benefits of testing with a smaller number of users. Nielsen and Landauer (1993) show that testing with five users should find approximately 85 percent of the problems, and that testing with 15 users should find 100 percent of the problems. Generally, it is more Website redesign with a usability consultant cost-effective to test fewer people and have more tests than to test a lot of people just once (Krug, 2006; Nielsen and Landauer, 1993).

About 80%, of usability issues are observed with the first five participants (Lewis, 1994; Nielsen and Landauer, 1993; Virzi, 1992). One of the most important ways to figure out how many participants are needed in a usability test is to measure *p*, or the probability of a usability issue being detected by a single test participant – Probability of detection. It's important to note that this p is different from the *p value* used in statistical tests of significance. The probabilities vary from study to study, but they tend to average around 0.3, or 30% (Tullis and Albert, 2013).

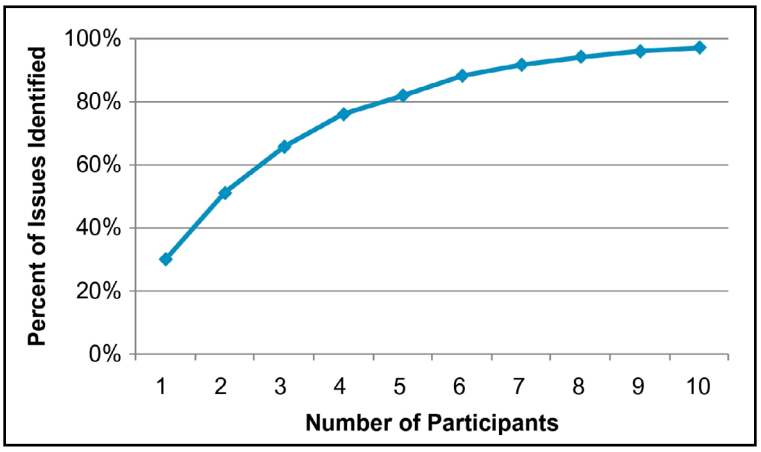
Virzi (1992) outlined a Predicted probability formula $1-(1-p)^n$ where *p* means the probability of detecting a given problem and *n* refers to the sample size.

Number of usability problems found in a usability test with n users by Nielsen and Landauer, (1993) is adapting the formula of Virzi (1992):

Problems found = $N(1-(1-L)^n)$

where *N* is the total number of usability problems in the design and L is the proportion of usability problems discovered while testing a single user. In a seminal paper, Nielsen and Landauer (1993) found an average probability of 31% based on 11 different studies. This basically means that with each participant, about 31% of the usability problems are being observed.

Figure 1 shows how many issues are observed as a function of the number of participants when the probability of detection is 30%. After the first participant test, 30% of the problems are detected, but the difference between zero and even a little bit of data is astounding. The second user does some of the same things as the first user, so there is some overlap in findings, but the second user adds some amount of new insight, but not nearly as much as the first user did. The third user does many things that was already observed



Source: Tullis and Albert (2013)

Figure 1: Example showing how many users are required to observe the total number of issues in a usability study, given a probability of detection.

with the first user or with the second user and even some things that have been already seen twice. Plus, of course, the third user will generate a small amount of new data, even if not as much as the first and the second user did. After the third participant, about 66% of the problems are observed. After the fifth participant, about 83% of the problems have been identified. Many web usability professionals only test with five or six participants during an iterative design process. In this situation, it is relatively uncommon to test with more than a dozen, with a few exceptions. If the scope of the product is particularly large or if there are distinctly different audiences, then a strong case can be made for testing with more than five participants (Nielsen and Landauer, 1993; Tullis and Albert, 2013).

Results and discussion

In our study, we focused on testing of first impressions of users who have no previous experience with eAGRI portal. Furthermore, we conducted user centered usability testing in terms of a few simple tasks. As part of the testing there was conducted an evaluation by the expert evaluator who evaluated the portal in terms of unregistered and unknowing users. Results of applied testing methods are shown below.

Heuristic evaluation

Because of the eAGRI portal size a large percentage of users might use the search option. Search results are clear and well organized. There is an option to change the number of results on page, but it is limited to 3 variants – 10, 20 and 50. Links to next pages are on the top and on bottom of a page. On the other hand search results also include breadcrumbs navigation, title of paper and a short excerpt from the article. That make list of results unclear.

An option for language change is placed on the top of page. Icons of flags are missing. This is only cosmetic problem, but fixing it would help users find this option easily. But the fundamental problem is that after the transition to the English version, the portal does not show the same or at least about the same translated content. Rather the web of the Ministry of Agriculture is displayed, but in the Czech version, this web is only sub-portal of the main eAGRI portal. By the language change the user is also moved to the inner part of the portal, but the user is not able to realize it.

Inexperienced users should have a problem finding the category they are looking for by “eAGRI guidepost”. The “eAGRI guidepost” represents a major problem in usability of this portal. It is going to be major problem not only for inexperienced users but also for regular users when they try to find something new or returning after an extended period.

Feedback of the system and undo and redo functions are supplied by internet browser. The portal does not provide any information about redo and undo functions. eAGRI portal supports feedback by changing the style of the activated links.

The main page of the eAGRI portal includes specific on page areas - boxes with contact information how to reach the Czech Ministry of Agriculture and how to connect it on the social networks, news and actions, etc. This information are visible only on the main page, but most of the user never visit the main page. On the other hand this kind of information should be achievable on the Ministry

sub-portal, but there is none. From this perspective, it is not clear whether the eAGRI portal is the web portal about Czech Ministry of Agriculture or complex portal of agricultural sector of the Czech Republic. These two lines of information are still blending each other on the main portal and also on sub-portals, but it is not clear where that belongs and where it is headed.

Language used on the portal is easily comprehensible considering the thematic focus. Texts in links, in menus and in the header are short and fitting. eAGRI portal provides an error page with information in Czech and English language and with help to user of how to recover from a mistake. There are options – "go back", "try the search page" or contact administrator. The portal has a site map to help users in orientation on the portal, but it is placed on the bottom of page only, so many users will not find it.

Logo of the eAGRI portal becomes smaller after accessing the page of resort organization or section of the sub-portal included in the "eAGRI guidepost" and a new link is added in the header. Color and background picture of the header is changing as well.

The eAGRI portal uses breadcrumb navigation.. It is placed between the header of the page and the menu and the main part of a page and it is used on each level of navigation, but there are serious problems in the navigation and structure of eAGRI portal itself. E.g. complete database of employees of Czech Ministry of Agriculture and agendas of other resort organizations are included in the portal. This amount of information and pages has impact on the navigation. Constant changes in the layout for different parts of the portal make work with the portal and looking for information very difficult. User must remember the complete way of how to reach the information they are looking for.

5 second test

Before the first view of eagri.cz web site users did not even know what site they will test. So, users have the first contact with this web during 5 second test. After a 5 seconds on eagri.cz portal all participants said they noticed the eAGRI logo. Two users said that they are familiar with this abbreviation and they know that it is a portal of the Ministry of Agriculture. Three users who do not know the abbreviation, stated identically that it was probably a website dedicated to healthy eating in schools. The reason is the fact that on the eagri.cz alternates several different images with news within the main banner and this images are exchanged just after 5 seconds. Therefore users were able to see just the first image with the information: "The Ministry of Agriculture project "Honey breakfast" this year involved 40schools." In addition, the image showed girlish face at breakfast.

Consequently, users noticed photo of Marian Jurečka. Two users correctly identified man in the photo as Minister of Agriculture. But three users considered him as Secretary of State, because this information is presented on the website next to the minister photo.

Source: **http://eagri.cz** (November 2016)

Figure 2: Screenshot of the website – part with the image of minister.

30 second test

After 30 seconds, which the participants were able to spend on portal pages, they all stated that the portal is called eAGRI and focuses on the complex issues of agriculture and the most likely this web site is managed by the Ministry of Agriculture of Czech Republic. Within these 30 seconds, only two users clicked through to another portal web pages. Specifically, there were "Contacts" web page where user verified who manages this portal. In the second case it was a web page "About the portal" where the second user tried to find the same information like the first one, but this user chose the preferable solution which is in addition essentially hidden in the footer.

After completing the 30 Second Tests, users were asked whether they have previous knowledge of the tested portal. All responded negatively.

Formalized think-aloud test

As a part of this testing we presented to each user 7 tasks they had to fulfill. During the addressing these challenges users described aloud their activities

and feelings. The scenario in the form of individual tasks and most distinctive findings of users is described below.

Task 1

You have to attend a business meeting at the Ministry of Agriculture. But you are unsure where the Ministry is housed. So, you use web Search Engine with “MZE address” keyword and you follow the link to web site eagri.cz. Are you able to find specific address of Ministry of Agriculture on this web?

Result:

Most users quickly and easily clicked in the main menu on "Contacts" menu item where they found the address of the Ministry of Agriculture. Among other findings, in the list with the address, there is also mentioned www address of the ministry which is eagri.cz. Only one user has solved this task in 42 seconds. The reason was the fact that the user scrolled down on the web page slightly and was unable to see the top menu.

Task 2

You are a resident of Prague 6 - Suchdol. On land adjacent to you, there was a significant fertilization applied. The smell bothers you and you have decided to find a number, and the owner of the land, so you can complain at the municipal office. This is the land among the streets “Kamýcká”, “Dvorská” and “Na Parcelách”. Can you find detailed information on these lands, or at least their numbers, at the eAGRI portal?

Result:

None of the users was able to solve this task in 3 minutes. Three users gave up this task after about 6 minutes. Two users were able to find this information after the 7 and 11 minutes. The reason is the fact that the general public does not know the term LPIS. Both users who fulfilled this task were able to find proper information in complicated way by internal search of the portal.

Task 3

You are looking for internship at the Ministry of Agriculture. What internships Ministry of Agriculture currently offers?

Result:

Two users were unable to find this information in 3 minutes and were frustrated. Another two users found this information by clicking the portal navigation on the edge of the time limit. The last user managed this task in about a minute. After several failures he used internal search with keywords “MZE internships”. The user clicked subsequently on the first search result, but that has concerned the evaluation of research program and was wrong. The user used the "Back" button of the web browser and subsequently clicked on the fourth search result that has finally led to the desired information.

Task 4

You would like to find a general report on the state of agriculture in the year 2015. Can you find it?

Result:

One user was not able to trace this document within the time limit. It was a user who frequently used internal search of the portal during testing. In this case the user was unable to find proper keyword which may lead to the needed information. This user was really upset by this situation and gave up the task after 7 minutes. Other users found the information at the edge of time. One user managed the task under 90 seconds.

Task 5

As an enthusiast of Agriculture you would like to be regularly informed about the news. You decide to subscribe the newsletter of eAGRI portal. Where you can subscribe the newsletter? If there is an alternative to this action, how it can be realized?

Result:

Two users were unable to solve this task. The reason is the fact that to simply subscribe to the newsletter of eAGRI portal is not possible. The other three users know the RSS technology which is offered by the portal and can be used as an alternative to the newsletter subscription.

Task 6

You represent a company that would like to participate in the public tender for the implementation of the Nitrates Directive. Where you can find detailed information about this public contract?

Result:

Only one user was able to find this information in 3 minutes. The main problem of navigation was the fact that most users clicked on the top menu at the "Public Procurement" and then click on the menu on the left hand side of the portal. But in this manner users got constantly into blind alleys. Only one user noticed that the link to the Public procurement system is included in the main content of the portal web page within the text about the Contracting entity profile. This

link is therefore really hidden.

Task 7

In television news you saw a brief information about the changes in Ministry of Agriculture approach to the issue of Property settlement with the churches. You decide to trace the detailed information on the eAGRI portal. Can you find this information?

Result

One of the users was not able to find this information. Two users found this information fairly quickly using the internal search. Two users clicked gradually through the eAGRI newsletter where they had noticed the menu on the left hand side previously. This menu contains a link named "Property settlement with the churches."

Complete results of testing are illustrated in the Table 2.

To verify that the user testing by 5 users was adequate we need to adapt the formula of Virzi (1992). The aim is to determine how many people are needed for a 90% chance of finding errors. Based on our research, we found that average proportion of task failure is 0.429. Thus our users failed on average in 3/7 tasks. The procedure is as follows:

0.9 (likelihood of error detection) = $1-(1-0{,}429)^n$;

$0.9 = 1-(0.571)^n$;

$0.1 = 0.571^n$;

log(0.1) = n(log(0.576));

n = log(0.1) / (log(0.576);

n = 4.174.

The result proves that the use of five users for our testing of eAGRI portal is sufficient.

Group session

During a group discussion all users and the expert who carried out the heuristic analysis, agreed on several findings:

eAGRI portal does not shows to the first coming user what is this web site about. A user have to find this information on his own or understand this information from the context of the portal.

Users not "land" necessarily on the eagri.cz home page, but on any other sub-sites. For that reason they have little chance to realize that they are at the one large and a single portal. The reason is that in a subsequent clicks they may come to a different part of the portal which varies significantly in appearance which is confusing.

Internal search of the eAGRI portal is functional and transparent, but often does not lead to the desired result even if the user frequently changes the keyword of intended phrase.

Usability experts said that "eAGRI guidepost" is very difficult to use and confusing. Users subsequently described their experience when they basically were not use the "eAGRI guidepost". No one could accurately determine the right reason. During solution of test tasks, users have created their own schemes for the use of the portal and "eAGRI guidepost" was not included. This navigation solution is not spontaneously used by users.

The structure of the portal is really complicated and the user, despite the use of breadcrumb navigation, is often lost. Especially, he is not able to remember how he got to the page he is. The most of users are blindly clicking on "Back" button of the web browser or click on the eAGRI logo to reach the home page and start his search again.

Conclusion

This paper describes the results of a usability study focused on agrarian eAGRI portal. The results show that the usability of the portal in terms of unregistered user, thus the general public, does not reach a sufficient level. Performed Heuristic analysis revealed several weaknesses. Subsequent user testing, especially Formalized think-aloud test method, confirmed this result. The main problem

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Proportion
User 1	3	0	2	0	1	0	1	0.429
User 2	3	0	1	2	1	0	0	0.429
User 3	3	0	0	1	1	0	2	0.429
User 4	2	0	0	1	0	0	2	0.571
User 5	3	0	1	1	0	1	1	0.286
						Average proportion		**0.429**

Source: Own research

Table 2: Complete results of the Formalized think-aloud test.

is the extensiveness of the portal and hence its complex structure. Placement of information into different segments or sub-segments of the portal that do not have a unified concept is also confusing. Searching for information on the portal is highly complicated. The user is not able to easy navigate the portal and use of internal search, despite the fact it is functional and uncluttered, is often not able to help the user. Based on the think-aloud test results we can indicate the time, what user needs to trace searched information on the portal, as catastrophic. Measured value of modus is 0. Therefore in the largest number of cases the user was unable to find the information in 3 minutes. Value of median is 1. In half of the cases users spent more than 90 seconds searching for information. If the one of the aims of eAGRI portal is to inform general public about news and issues related to agrarian sector, it will be necessary to apply fundamental changes in the logic of the portal as a whole.

Acknowledgements

The knowledge and data presented in the present paper were obtained as a result of the Grant number 20151007 of the CULS Prague Internal Grant Agency titled „Innovative approaches to the use of ICT in education for mitigation of social exclusion" and the FEM CULS Prague Internal Grant Agency grant number 20151032 titled „UI/UX issues in relation to application for rural development and associated fields".

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Convergence of Market Concentration: Evidence from Czech Food Processing Sectors

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Abstract

The aim of the paper is to evaluate the market concentration in the Czech food and beverages industry over the period of 2003-2014, to quantify disparities among particular sectors and to investigate the trend of market concentration. The concept of convergence is applied when investigating the trend in the long term. The market concentration in the Czech food and beverages industry has increased on average. In sectors with relatively low market concentration in 2003, the values of concentration increased more rapidly after 2003. On the contrary, the most concentrated sectors tend to change slowly over time and the concentration in some sectors even declined. On the basis of the absolute β-convergence model estimation, it was concluded that there is a trend for convergence of the market concentration in the long run to one and the same point for all sectors of the industry.

Keywords

Market concentration, food and beverages industry, concept of convergence.

Blažková, I. (2016) “Convergence of Market Concentration: Evidence from Czech Food Processing Sectors", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 25 - 36. ISSN 1804-1930, DOI 10.7160/aol.2016.080403.

Introduction

Agribusiness sector is undergoing significant changes – changes in market structures on agribusiness markets, in geographic location of production and processing, changes in characteristics of agricultural and food products, in global distribution and consumption and changes in technologies. These changes have impact on the increase in concentration in the food processing sector (Rogers, 2001) and primarily in the retail sector (McCorriston, 2002; Reardon et al., 2003), on the increasing emphasis on product quality and food safety (Saitone and Sexton, 2010) and on the rapid growth of vertical coordination and integration (MacDonald and Korb, 2011; Swinnen and Maertens, 2007).

At present, the key players on the food markets are multinational corporations. As reported by Daniels (2008), the structure and quality of food produced is determined by supermarkets and other transnational actors, often organized into large corporations, which currently can easier succeed in the competition, pricing policies and legislation regarding food quality and safety than small local enterprises. Implications of these features on the changing patterns of competition and the impact on food producers, supplier competition and economic welfare are discussed by many authors, e.g. Dobson et al. (2003), Regmi and Gehlhar (2005), Boehlje,et al. (2011), Sexton (2012).

The recent literature states that concentration and consolidation takes place in both food processing industry and retailing sector through mergers and acquisitions (Dobson et al., 2003; Swinnen and Vandeplas, 2010); where large food companies are also increasingly spreading globally through foreign direct investments, which contributes to increased concentration outside their home markets, as mentioned by Clarke et al. (2002).

The market concentration is of interest to economists in the long-term due to its possible effects on the efficiency and welfare of the economy. There are arguments supporting the positive impact of high concentration on the efficiency of the firms in the market, and on the other hand, arguments against the high concentration exist as well.

Basic economic theory suggests that high market concentration will lead to market power and thus inefficiencies, since the possible existence of market power of large enterprises may lead to lower competition, higher prices and cause

welfare losses. Swinnen and Vandeplas (2010) even used the term "double market power" for the situation – when companies in concentrated sectors use their buyer power to negotiate lower prices from suppliers, but also use their selling power toward customers or downstream industries to impose higher customer prices than in the competitive case. However, as some authors argue, higher market concentration does not necessarily mean high market power and the abuse of this power, and on the contrary, it may improve welfare (e.g. Clarke et al., 2002; Shervani et al., 2007). Higher concentration means the use of economies of scale in the production of a single product and the economies of scope in the production of multiple products, which has a positive effect on costs of the firms. A certain degree of concentration may be also necessary for investments in research and innovation. Moreover, the effect of concentration on efficiency and prices depends on the rest of the commodity vertical – for example, retail concentration may lead to lower consumer prices due to higher buyer power and better bargaining position of retail towards suppliers, which occurred in the Czech Republic after the entry of multinational retail chains into the Czech market and resulted in a beneficial situation for end consumers with regard to lower price and increased variety of food (Blažková and Chmelíková, 2014).

As stated by Sexton (2012), farmer and consumer welfare as well as the general welfare are linked to the competitive structure in the up- and downstream areas of agriculture. Boehlje et al. (2011) emphasized that consolidation and alteration of vertical and horizontal limits of firms in food and agribusiness sector affect vast parts of the supply chain. There is evidence that large retailers and food companies are depressing farm prices as a result of their market power (Swinnen and Vandeplas, 2010). Therefore, increased concentration and market power caused the competition policy in agri-food chains to be an important issue.

Agribusiness firms in the Czech Republic are facing ongoing changes in competition and market conditions. While the decrease of the number of firms and the development of market concentration in the whole manufacturing industry and in the retail sector has been subjected to research (see e.g. Zemplinerová and Stibal, 1994; Dries et al., 2004), the development of market concentration in the food industry seems to be less investigated (see e.g. Blažková and Chmelíková, 2014).

This paper deals with the trend of market concentration on the food processing market, which can have a significant influence on the development of relations and the price formation at different levels of the commodity verticals, as mentioned by Blažková and Chmelíková (2014). The aim of the paper is to evaluate the market concentration in the Czech food and beverages industry, to quantify disparities among particular sectors of the food and beverages industry and to investigate the trend of market concentration. The question that should be answered when concerning the evolution of the market concentration on the Czech food and beverages market is whether the dispersion of this variable across particular sectors tends to decrease over time. Or, in other words, whether sectors with lower market concentration tend to catch up with sectors with higher market concentration. The concepts of convergence implicit in these questions are called σ-convergence and β-convergence (Sala-i-Martin, 1996). Although these concepts are primarily used and applied in determination of the convergence of per-capita income or product across countries or regions, in practice a number of other variables can enter a convergence model significantly (e.g. market concentration as presented in this paper).

While previous studies have looked at market concentration on selected markets in the Czech Republic, no study to my knowledge comprehensively investigated market structure measures within this important stage of the commodity vertical – food and beverages industry. Previous studies either focused on a single sector of the Czech food and beverages industry (e.g. Řezbová et al. (2015) focused on the sugar market or Čechura et al. (2015) examined dairy industry), or observed the whole manufacturing industry (e.g. Zemplinerová and Stibal, 1994). Thus, the results of the analysis of market concentration development and trend in the Czech food and beverages industry can be seen as worthwhile. Describing and explaining the development of market concentration and its distribution across sectors could provide a view of the competitive situation in agribusiness, answer the questions about the possible evolution of the market structure in the future and therefore, provide some suggestions that can be of interest to policy makers with respect to competition and industrial policy.

Materials and methods

Data

The empirical analysis is based mainly on the data obtained from the database Albertina – Gold Edition (Bisnode, 2015). The dataset covers

the period from 2003 to 2014 and includes final accounts of enterprises operating in the Czech food and beverages industry. Markets are defined based on the 3-digit level of the Classification of Economic Activities (CZ-NACE). The sample is made of 13,667 observations across 12 years and 10 food sectors in the Czech Republic, namely CZ-NACE 101 Production, processing, preserving of meat and meat products; CZ-NACE 102 Processing and preserving of fish and fish products; CZ-NACE 103 Processing and preserving of fruit and vegetables; CZ-NACE 104 Manufacture of vegetable and animal oils and fats; CZ-NACE 105 Manufacture of dairy products; CZ-NACE 106 Manufacture of grain mill products, starches and starch products; CZ-NACE 107 Manufacture of bakery and farinaceous products; CZ-NACE 108 Manufacture of other food products; CZ-NACE 109 Manufacture of prepared animal feeds; CZ-NACE 110 Manufacture of beverages. All firms with main activities in any official CZ-NACE food and beverages industry that had available data were considered.

The shares of observations by sectors in the sample with those in the population are compared in Table 1 to see whether the sample adequately represents the population of Czech food processing firms and that representation of observations is evenly distributed to all subsectors. The size distribution of the enterprises in the sample is shown in Table 2 that reports the average shares of observations in particular size groups of enterprises within the subsectors over the years 2003-2014. Companies are classified in four size groups defined according to the number of persons employed – with 0-19, 20-49, 50-249 and 250 or more persons employed. It follows from Table 2 that representativeness of the sample is strengthened by including also small enterprises (with 0-19 persons employed) in the analysis (49.7% observations in the analysed sample), since they are in the food industry represented in large numbers.

In order to have information on total sales of own products and services for particular sectors, the data published by the Ministry of Agriculture of the Czech Republic (Ministry of Agriculture of the Czech Republic, 2008; Ministry of Agriculture of the Czech Republic, 2015) were employed.

	2003		2004		2005		2006		2007		2008	
	Population	Sample	Population	Sample	Population	Sample	Population	Sample	Population	Sample	Population	Sample
CZ-NACE	(N=6,326)	(N=691)	(N=6,317)	(N=828)	(N=6,630)	(N=931)	(N=6,550)	(N=1007)	(N=6,560)	(N=1116)	(N=6,351)	(N=1,161)
101	15.7	16.6	18.2	17.5	16.5	16.2	16.4	15.2	16.1	15.1	18.9	15.7
102	0.8	1.4	0.5	1.6	0.3	1.4	0.3	1.2	0.4	1.2	0.3	1.1
103	2.2	2.9	1.6	3.5	3.3	3.2	3.4	3.3	3.3	3.1	2.2	3.1
104	0.3	1.3	0.3	1.2	0.3	1.1	0.3	0.9	0.3	1.1	0.3	1.0
105	5.7	8.7	5.0	8.0	3.0	6.8	2.9	6.7	2.9	6.5	2.5	5.9
106	4.6	5.4	2.6	4.7	2.2	4.6	2.2	4.5	2.2	4.3	2.0	4.2
107	41.9	22.0	41.8	22.7	41.9	24.6	41.4	25.4	40.6	25.9	36.4	25.5
108	11.7	15.5	13.2	15.1	13.8	15.7	14.2	16.7	15.1	17.2	17.3	17.7
109	3.3	8.0	3.0	7.7	3.7	8.2	3.9	7.6	3.8	7.3	3.8	7.4
110	13.8	18.2	13.8	18.0	15.2	18.3	15.1	18.6	15.3	18.4	16.3	18.2
	2009		2010		2011		2012		2013		2014	
	Population	Sample	Population	Sample	Population	Sample	Population	Sample	Population	Sample	Population	Sample
CZ-NACE	(N=6,829)	(N=1,487)	(N=7,740)	(N=1,526)	(N=8,362)	(N=1,430)	(N=8,527)	(N=1,374)	(N=8,432)	(N=1,173)	(N=8,806)	(N=942)
101	18.2	14.9	18.6	14.9	20.2	15.1	20.1	15.2	20.3	16.2	20.2	15.4
102	0.3	0.9	0.3	0.9	0.3	1.0	0.3	0.7	0.3	0.8	0.2	0.7
103	2.1	2.9	2.1	2.9	1.9	2.7	1.7	2.9	1.6	3.2	1.5	3.6
104	0.3	1.0	0.3	0.9	0.3	1.0	0.2	1.1	0.2	1.1	0.2	1.3
105	2.4	4.8	2.7	4.8	2.4	4.6	2.2	4.3	2.1	4.3	2.1	4.4
106	2.1	4.6	2.1	4.6	2.1	4.1	2.4	4.8	2.3	4.8	2.5	4.4
107	37.3	25.9	35.0	25.8	35.6	25.9	34.9	25.2	35.1	22.9	34.5	25.2
108	16.9	19.7	18.1	20.1	17.2	20.9	19.1	21.4	18.8	21.2	20.2	19.2
109	4.1	7.3	4.9	7.4	4.9	7.5	4.7	7.1	4.4	7.2	4.1	7.6
110	16.3	18.2	15.9	17.8	15.1	17.3	14.3	17.2	15.0	18.4	14.4	18.3

Note: Population refers to all firms active in the Czech food and beverages industry.
Source: own calculation based on Bisnode (2015) and Ministry of Agriculture of the Czech Republic (2008, 2015)

Table 1: Shares of observations by subsector within the population and in the sample (%).

	0-19	20-49	50-249	250+
CZ-NACE 101	47.70	22.42	21.46	8.42
CZ-NACE 102	45.48	25.53	23.47	5.52
CZ-NACE 103	44.49	19.01	31.22	5.28
CZ-NACE 104	38.19	22.62	24.59	14.60
CZ-NACE 105	31.71	11.38	43.79	13.12
CZ-NACE 106	49.00	17.37	33.63	0.00
CZ-NACE 107	46.44	22.33	23.84	7.39
CZ-NACE 108	48.74	21.26	24.86	5.14
CZ-NACE 109	46.84	23.11	23.78	6.27
CZ-NACE 110	62.07	14.63	18.87	4.43

Source: own calculation based on Bisnode (2015)

Table 2: The size distribution of the enterprises in the sample (%).

Variables

Market concentration was calculated in the Czech food and beverages industry as a whole and within the particular food sectors. Market concentration was expressed by two most common measures of concentration – the Concentration Ratio (hereinafter referred to as "*CRm*") and the Herfindahl-Hirschman Index (hereinafter referred to as "*HHI*"). To determine the market structure, it is advisable to use both indicators that complement each other – while *CRm* describes the market share of *m* largest companies in the industry, *HHI* shows the inequality of distribution of market shares among all firms in the industry.

The concentration ratio for four largest firms (*CR4*) in the whole Czech food processing industry and in particular subsectors was calculated as the percentage of market shares held by four largest firms in an industry (Viscusi et al., 2005). The Herfindahl-Hirschman Index (*HHI*) was calculated as the sum of the squares of the market shares of the firms within the industry (Viscusi et al., 2005), where the market shares are expressed as fractions. The formulas for the overall *CR4* and *HHI* in the Czech food processing industry are as follows:

$$CR4 = \sum_{i=1}^{4} S_i$$

$$HHI = \sum_{i=1}^{n} (S_i)^2$$

where S_i denotes the individual market share, i.e. the percentage of the *i*-th firm in the Czech food processing industry calculated as the production of the *i*-th firm divided by the sum of production of all firms in the Czech food processing industry and *n* denotes number of firms in the industry, for which *HHI* is calculated.

The formulas for subsectoral *CR4* and *HHI* are as follows:

$$CR4j = \sum_{i=1}^{4} S_{ij}$$

$$HHI_j = \sum_{i=1}^{n} (S_{ij})^2$$

where S_{ij} denotes the individual market share, i.e. the percentage of the *i*-th firm in the *j*-th subsector of the Czech food processing industry calculated as the production of the *i*-th firm in the *j*-th subsector divided by the sum of production of all firms in the *j*-th subsector of the Czech food processing industry and n denotes number of firms in the *j*-th subsector, for which *HHI* is calculated.

In this paper, the market concentration was calculated on the basis of sales data, i.e. sales of own products and services, because this indicator seems to explain more about the market share than the output. For the concentration ratio it is valid that the higher *CR4* is, the higher market power is concentrated among the four largest firms. The higher the *HHI* is, the higher the inequality among market shares of firms is, in other words, the situation is distinct from equal market shares. *HHI* index ranges from 0 (no concentration and highly competitive system) to 10,000 (pure monopoly).

Table 3 shows that the data is relatively heterogeneous, with high standard deviations and coefficients of variation for the variables. The average of *CR4*, which is 38.58%, can be considered as loose oligopoly, the average *HHI* classifies the food sectors as an unconcentrated market with significant positions of several

	Mean	Standard Deviation	Coefficient of Variation	Minimum	Maximum
CR4	39.27	19.54	49.75	12.58	96.24
HHI	928.15	1281.09	138.03	85.46	6332.12

Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own calculation

Table 3: Descriptive statistics of the variables in the period of 2003-2014.

companies (according to the Horizontal Merger Guidelines (U.S. Department of Justice and the Federal Commission, 2010)[1]).

Methods

To assess the trend of market concentration in the markets for all sectors of the food and beverages industry in the Czech Republic, the theory of absolute β-convergence was used – as described by Sala-i-Martin (1996) and used e.g. by Setiawan et al. (2012). Based on this theory it is investigated whether there is a tendency for the market concentration in the Czech food and beverages industry to move to a certain value. The absolute convergence model can assess whether there is a trend for the convergence of the market concentration in the long run to one and the same point for all sectors of the industry, i.e. whether there is a tendency towards the equalisation of concentration ratios within the sample. The assumption about the same stable state of particular sectors in the long run is relevant due to the fact that all sectors in the Czech economy face the same business characteristics at the same time.

The absolute β-convergence approach was verified by an econometric modelling technique, namely with the use of cross-sectional linear regression analysis. Cross-sectional regression is drawn by an effort find out whether the convergence process is present among particular sectors within the Czech food processing industry or there are more divergence tendencies. For the analysed sectors, annual time series of two indicators of market concentration were used – *CR4* and *HHI*.

The absolute β-convergence model of cross-section data for the sectors is as follows:

$$\frac{Ln\ MS^{j}_{t_n} - Ln\ MS^{j}_{t_0}}{T} = \beta_0 - \beta_1 Ln\ MS^{j}_{t_0}$$

where j = 1, 2, …10 indexes sectors, t_0 is the initial year of observation, i.e. 2003, and t_n is the last year of observation, i.e. 2014. MS^{j}_{t} is the market structure of the sector j in the period t, which is represented by either *CR4* or by *HHI*. The parameters of the linear regression model of the cross-section data are estimated using the least-squares method (OLS). According to the theory of absolute convergence, sectors show convergence in market structure if the estimated coefficient of β_1 is positive. Statistical data, calculations and graphs were processed with the use of the software Gretl. Statistical significance of the model was tested using the F-test. Individual model parameters were tested by the t-test. Model (for both *CR4* and *HHI*) as a whole is statistically significant at 5% level of significance. The econometric verification included the White Heteroskedasticity test and Jarque-Bera test of residuals normality. No multicolinearity was detected. At the 5% level of statistical significance the model can be considered homoscedastic and normal distribution of residuals is observed.

Results and discussion

The general concentration in the Czech food and beverages industry in the period 2003-2014 grew (see Table 4) even though the number of firms increased in this industry. The number of food enterprises increased between 2003 and 2014 by around 39% (Ministry of Agriculture of the Czech Republic, 2015; Ministry of Agriculture of the Czech Republic, 2008). The increase was observed in all sectors of the industry, the most significant increase was in the number of enterprises operating in the sector of meat processing (CZ-NACE 101), in the sector of manufacture of prepared animal feeds (CZ-NACE 109) and in the sector of manufacture of other food products (CZ-NACE 108), where the number of enterprises has approximately doubled.

Nevertheless, the concentration in the Czech food and beverages industry is still low in comparison with the subsequent vertical stage, i.e. retail (*CR5* indicator was 14.45% in the Czech food and beverages industry in comparison with 45.50 %

[1] According to the classification defined by the US Department of Justice and the Federal Trade Commission (2010), *HHI* lower than 100 means a highly competitive market, *HHI* ranging from 100 to 1,500 indicates an unconcentrated market with significant positions of several companies, the values of the *HHI* from 1,500 to 2,500 reveals significant market concentration (mostly monopolistic competition) and *HHI* above 2,500 indicates a highly concentrated market (mostly oligopoly). *HHI* close to 10,000 suggests a monopoly.

in the Czech retail sector in 2013). As stated by Blažková and Chmelíková (2014), this fact causes the Czech food processing enterprises to often accept the disadvantageous delivery terms and conditions including various fees for introduction of goods into chains of stores, participation in advertising, or suffering long maturity invoices. At the same time, the food processors are under pressure to supply wholesale prices and quality. On the other hand, from the perspective of end consumers, the concentrated market structure of final segments of agribusiness may show a positive element in the short-term period, as explained by Bečvářová (2007). According to Bečvářová (2007), the positive impact of an imperfectly competitive environment on the consumer surplus due to the savings from a large-scale production and higher work productivity based on the modernization of production facilities and faster application of the results of research and development in large enterprises was observed on the markets of transitive economic systems such as the Czech Republic.

Based on the analysis, it can be concluded that the concentration process is different depending on the sector (see Table 5). The box-and-whisker diagrams in Figures 1, 2, 3 and 4 depict the subsectoral *CR4*, resp. *HHI*, distribution across time (see Figure 1, resp. 2) and *CR4*, resp. *HHI*, distribution across subsectors in the period 2004-2014 (see Figure 3, resp. 4). The bottom and top of the box represent the first and third quartiles, the band inside the box is the median, and the ends of the whiskers represent the minimum and maximum of the data.

The degree of dispersion of the values of *CR4* indicator among sectors within particular years is relatively stable (see Figure 1), in the case of *HHI* the dispersion among sectors is slowly increasing in the recent years (see Figure 2). The outlier, which can be seen in both Figures 1 and 2, is the sector of manufacture of vegetable and animal oils and fats (CZ-NACE 104), which is highly concentrated in the whole observed period (the indicator *CR4* was 92.53% in 2014) – on the Czech market there are only a few large enterprises.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CR4 [%]	9.81	10.01	10.86	11.61	11.24	10.41	11.57	11.29	11.30	11.85	12.07	13.34
HHI	52.92	57.97	68.01	73.74	71.35	66.53	72.91	79.83	81.26	81.92	87.89	93.36

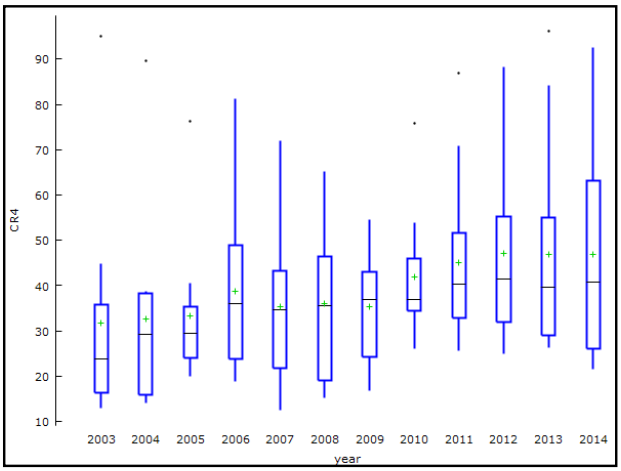
Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own calculation

Table 4: Concentration in the Czech food and beverages industry.

		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CZ-NACE 101	CR4	16.26	14.08	20.03	18.77	19.06	16.82	16.72	26.09	25.61	25.04	26.30	24.77
	HHI	110	97	169	151	157	132	139	274	264	258	278	238
CZ-NACE 102	CR4	16.28	16.39	20.13	65.03	49.78	65.22	54.48	53.84	87.00	84.95	84.28	83.33
	HHI	85	90	161	2058	1174	1958	1311	1334	5331	5223	5253	5497
CZ-NACE 103	CR4	20.98	32.97	28.41	34.68	34.16	38.72	38.58	43.27	44.45	44.39	44.93	45.32
	HHI	155	395	290	458	451	542	565	744	785	737	741	782
CZ-NACE 104	CR4	95.01	89.51	76.39	81.34	71.98	59.76	46.26	75.92	70.80	88.27	96.24	92.53
	HHI	4212	3615	2889	2894	2260	1503	893	2849	3573	4510	6332	3389
CZ-NACE 105	CR4	26.72	32.76	30.40	37.65	37.79	38.05	36.85	34.72	34.13	33.20	35.16	37.83
	HHI	270	399	404	489	494	494	498	472	474	458	459	518
CZ-NACE 106	CR4	20.69	22.64	25.36	25.14	22.83	19.89	23.38	36.41	29.79	28.49	28.30	21.49
	HHI	213	246	251	305	280	218	347	678	438	405	379	233
CZ-NACE 107	CR4	31.05	25.93	33.65	25.05	29.36	30.97	24.57	34.63	34.01	39.43	29.34	26.43
	HHI	309	221	353	208	278	306	253	376	370	477	276	195
CZ-NACE 108	CR4	44.91	38.01	31.12	37.62	35.34	31.89	34.24	34.24	37.87	40.37	37.36	36.50
	HHI	669	494	328	474	437	400	384	396	464	514	489	464
CZ-NACE 109	CR4	13.04	14.94	26.23	19.71	12.58	15.14	36.92	37.60	45.38	45.24	41.90	56.40
	HHI	101	119	297	234	103	146	879	771	860	868	816	1648
CZ-NACE 110	CR4	32.82	38.72	40.61	43.43	40.99	42.11	42.01	42.19	42.88	42.53	45.42	43.58
	HHI	409	623	698	803	706	745	769	761	784	759	840	821

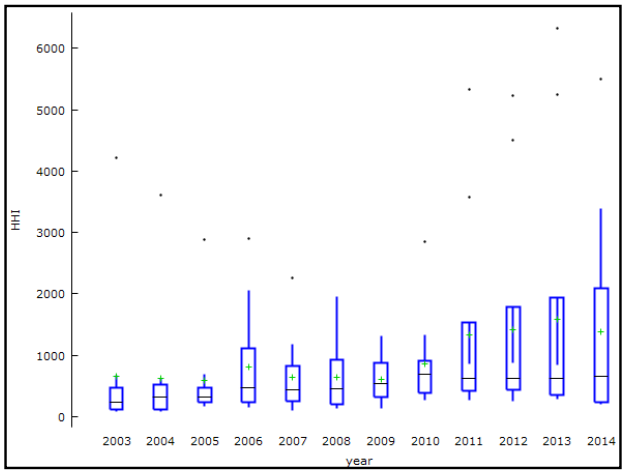
Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own calculation

Table 5: Subsectoral CR4 (in %) and HHI over years 2003-2014.



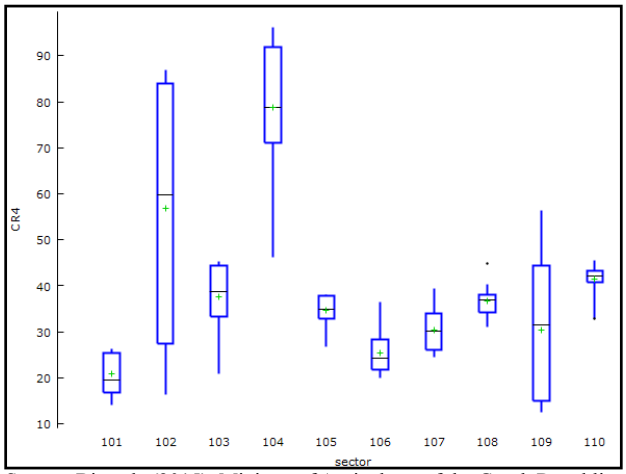
Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own processing

Figure 1: Subsectoral *CR4* distribution across time (*CR4* in %).



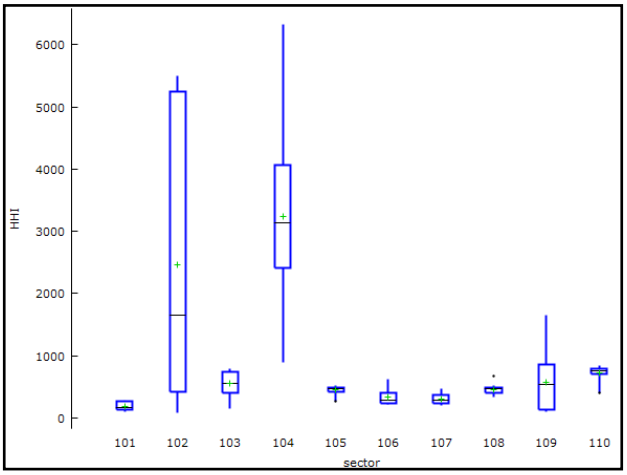
Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own processing

Figure 2: Subsectoral *HHI* distribution across time.



Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own processing

Figure 3: *CR4* distribution across subsectors in the period 2004-2014 (*CR4* in %).



Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own processing

Figure 4: HHI distribution across subsectors in the period 2004-2014.

From Figures 3 and 4 it is obvious, that the development of both *CR4* and *HHI* differs across sectors. During the observed period the market concentration increased significantly, especially in the sector of processing and preserving of fish and fish products (CZ-NACE 102) – *CR4* increased from 16.28% in 2003 to 83.33% in 2014, and in the sector of manufacture of prepared animal feeds (CZ-NACE 109) – *CR4* increased from 13.04% in 2003 to 56.40% in 2014. It is worth mentioning the fact that the sector of processing and preserving of fish and fish products (CZ-NACE 102) is the least significant food sector in the Czech Republic (the share of the sector revenues on the revenues of the whole Czech food industry in 2014 was only 0.70%), and the import is significant in this sector (Ministry of Agriculture of the Czech Republic, 2008; Ministry of Agriculture of the Czech Republic, 2015), which indicate significant lowering of the value of the concentration ratio *CR4* after foreign trade adjustment. The sector of manufacture of vegetable and animal oils and fats (CZ-NACE 104) also shows higher variability of the level of the market concentration during the observed period – it is not caused by increasing trend during the whole period, but it is due to lower values of concentration indicators in years 2008 and 2009 (in these years the largest company, whose market share was around 40% in 2007, was transformed into several new enterprises).

Table 6 shows results of the estimation of absolute β-convergence model in the Czech food and beverages industry. The estimated coefficient for market concentration is negative (which implies $\beta_1>0$); therefore, there is an absolute convergence of market concentration in the long run and the market concentration tends to converge to one and the same value for all sectors of the Czech food and beverages industry. The results are in harmony e.g. with the findings of Setiawan et al. (2012), who investigated the Indonesian food industry.

The variability of particular sectors concentration decreases, which is also confirmed by Tables 7 and 8. In sectors with relatively low market concentration in 2003, the values of concentration increased rapidly after 2003 – especially in the sector of fish processing (CZ-NACE 102), in the sector of manufacture of animal feed (CZ-NACE 109) and in the sector of processing of vegetable and fruits (CZ-NACE 103), as seen in Table 7. On the contrary, from Table 8 it is obvious that the most concentrated sectors tend to change slowly over time and the concentration in some sector even declined – namely in the sector of bakery products (CZ-NACE 107) and in the sector of manufacture of other food products (CZ-NACE 108).

The analysis has shown that the average growth rate of market concentration in the observed period was higher among less concentrated sectors in the initial period compared to more concentrated sectors in the initial period, where there was only a slight increase or even decrease in the level of concentration.

Independent Variable	**Dependent Variable:** *CR4*	**Dependent Variable:** *HHI*
	Coefficients	Coefficients
Constant	0.24628	0.48086
	(0.07877)	(0.16537)
Ln*CR4*… ($-\beta_1$)	-0.06351 **	
	(0.02369)	
LnHHI… ($-\beta_1$)		-0.07091 **
		(0.02879)
R-squared	0.4733	0.4311
F-statistic	7.1898 **	6.0629 **
p-value	0.0279	0.0392

Note: Standard Errors are in parenthesis, *** stat. significance at 1% level, ** stat. significance at 5% level, * stat. significance at 10% level.

Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own calculation

Table 6: Absolute convergence of market concentration in the Czech food and beverages industry.

Sector	*CR4*		Average Change	*HHI*		Average Change
	2003	2014		2003	2014	
CZ-NACE 109	13.04%	56.40%	12.98%	101.34	1647.72	26.16%
CZ-NACE 101	16.26%	24.77%	3.57%	109.90	237.90	6.65%
CZ-NACE 102	16.28%	83.33%	14.58%	85.46	5497.42	41.48%
CZ-NACE 106	20.69%	21.49%	0.32%	213.41	233.12	0.74%
CZ-NACE 103	20.98%	45.32%	6.63%	155.18	782.17	14.43%

Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own processing

Table 7: Average change of market concentration in less concentrated sectors in 2003.

Sector	*CR4*		Average Change	*HHI*		Average Change
	2003	2014		2003	2014	
CZ-NACE 104	95.01%	92.53%	-0.22%	4212.18	3388.67	-1.80%
CZ-NACE 108	44.91%	36.50%	-1.72%	668.79	463.80	-3.00%
CZ-NACE 110	32.82%	43.58%	2.39%	409.18	821.35	5.98%
CZ-NACE 107	31.05%	26.43%	-1.33%	308.84	195.47	-3.74%
CZ-NACE 105	26.72%	37.83%	2.94%	269.57	517.73	5.59%

Source: Bisnode (2015), Ministry of Agriculture of the Czech Republic (2008, 2015) - own processing

Table 8: Average change of market concentration in more concentrated sectors in 2003.

Conclusions

The paper has investigated the trend of market concentration in the Czech food and beverages industry in the period 2003-2014. The concept of convergence was applied in order to draw conclusions as to what future development of market structures within food and beverages industry is likely.

The results of the analysis show that the market concentration in the Czech food and beverages industry has increased on average in the period covered by the data but the situation is different in particular sectors. The level of concentration has grown the most in the sectors with relatively low concentration in the initial year of observation, i.e. 2003, in comparison with the most concentrated sectors in 2003, where only a small increase or even decrease of concentration was observed. These observations were validated by the application of the absolute β-convergence model – initially low-concentrated markets tend to concentrate faster until they catch up with the high-concentrated ones and in the long run, expected concentration indicators are the same for all sectors, independently of their initial value. However, the convergence to the steady state is an extremely slow process, as pointed out by de la Fuente (2000).

Nevertheless, the level of concentration

of the Czech food market is still low in comparison with the subsequent stage of the commodity chain, i.e. retail, which may cause a worse market position of food processors and disproportions in profits of processors and traders. Therefore, increasing concentration on the food processing market may help processors to better face the concentrated retail and to have better bargaining position when negotiating prices. On the contrary, the processors' higher market power due to the increased market concentration may lead to the abuse of this market power relative to farmers, e.g. downward pressure on prices of agricultural producers, which can negatively influence the Czech agriculture. As mentioned by Swinnen and Maertens (2007), farmers may benefit from competition between processing firms due to more equal rent sharing reflected in higher producer prices and more services to farmers. Since the food industry is an important part of the commodity vertical with significant influence on the performance and competitiveness of the Czech agriculture, policies should be designed for development of a market structure to promote competition.

The development of the market structure at particular stages of the commodity chain influences the formation of all price levels within the chain and has an impact on all participants in the production of food products – suppliers of raw materials for food production, food manufacturers, retail and wholesalers, consumers, policymakers and also state control authorities. Therefore, this area of research is important in agribusiness and a deeper view on the impact of market structure development on the price levels and performance of agribusiness enterprises in the long run would be interesting.

Acknowledgements

The paper was developed within the Research Project of MENDELU in Brno, MSM 6215648904, as a part of the solution to thematic direction No. 4 "The development tendency of agribusiness, forming of segmented markets within commodity chains and food networks in the process of integration, globalization and changes of agrarian policy".

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Factors Affecting Information Security Focused on SME and Agricultural Enterprises

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Abstract

Progress in the field of information and communication technology is a source of advantage that improves quality of business services; increases productivity levels and brings competitive advantage to enterprises and organisations related to agricultural production. However, the use of information and communication technology (ICT) is connected with information security risks that threaten business continuity and information assets. The ICT in small and medium-sized enterprises (SME) and agricultural enterprises is the source of several advantages as well as the risks resulting from information security violation and security incidents. This paper aims at the current situation of information security in SME and agricultural enterprises. Furthermore, the paper provides results of a survey focusing on identification and evaluation of the effects of internal and external factors affecting existence of risks in information security in Slovak SME and agricultural enterprises. Until now, there had not been a similar survey carried out.

Keywords

Information security, security incident, risk, factors, SME, agricultural enterprises.

Bolek, V., Látečková, A., Romanová, A. and Korček, F. (2016) “Factors Affecting Information Security Focused on SME and Agricultural Enterprises", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 37 - 50. ISSN 1804-1930, DOI 10.7160/aol.2016.080404.

Introduction

Significance of ICT has been growing exponentially for the last few years. The need for ICT is unquestionable as it improves quality of services and productivity levels in organisations and businesses in various sectors including agriculture. Investments in information technology have become a dominant part of capital allocation for many organisations. The use of ICT is a source of advantage for organisations and businesses, as well as risk of information security breaches and security incidents. The objective of this paper is to present results of a research studying the effects of selected factors (internal and external) affecting the existence of information security risks and security incidents in small and medium-sized enterprises (SME) and agricultural enterprises in the Slovak Republic (SR), and a comparison with other studies researching the issue.

Nowadays, the issue is of great importance in the agricultural enterprises. These enterprises more often implement mobile technologies, smart devices, GPS trackers, etc. The use of mobile devices in the agricultural enterprises is growing in all countries of the world. Importance and relevance of implementation of the mobile devices and applications were pointed out in the studies of Qiang (2011) and Stočes et al. (2015). The mobile technologies are different from personal computers in their connectivity in particular, which is the most important contribution to the agricultural enterprises. The mobile devices are increasingly becoming vulnerable to possible infiltrations and security breaches. Therefore, the information security issue relates to such devices as well.

Information security has been discussed since the origin of the first computers. Nowadays, it concerts each country, the discussion has become international. The worldwide importance of information security and data protection is growing in parallel with increasing number of attacks and security incidents. Security policies of organisations are not innovated in accordance with technological progress because predicting

further development remains difficult. Theoretical background presents a comparison of academic and professional perceptions of the information security terms and defines the factors used in the survey conducted in Slovak SME.

Information security

Information security, which has become a crucial component of good corporate governance, is a discipline responsible for protecting organisations' information assets against business risks (von Solms and von Solms, 2005). The family of standards ISO/IEC 27000 (2014) considers information security as a preservation of confidentiality, integrity and availability of information. Moreover, additional properties, such as authenticity, non-repudiation, accountability and reliability may also be involved. From a different perspective, information security is the process of protecting information and information infrastructure from unauthorized access that results in disclosure, modification or destruction of information, and modification or disruption of IT services (Ng et al., 2014). The process of information security requires constant attention (Hochmann et al., 2011). Previously, information security issues were treated by technological solutions (Singh et al., 2013). However, growing security needs have extended organisations' attention to explore the management role in information security (Soomro et al., 2016; Siponen et al., 2014; Singh et al., 2013). According to Albrechtsen and Hovden (2010) a performance of information security is based on knowledge and behaviour of various ICT users.

A single or a series of unwanted or unexpected information security events is called an information security incident (ISO/IEC 27000, 2014). An incident is a violation or imminent threat of violation of computer security policies, acceptable use policies or standard security practices (NIST, 2012; Hansman, Hunt, 2005). Therefore, denial of service, unauthorized revelation of sensitive information, a malicious attack on a computing system or network and the unintentional deletion of an important document all qualify as incidents (Ahmad et al., 2015). Many organisations perceive incidents as the activity of a human threat agent (ISACA, 2015). Security incidents are the causes of information security threats in organisations.

A combination of consequences of a security incident and the associated likelihood of occurrence creates an information security risk (ISO/IEC 27005, 2011).

The occurrence of security incidents and information security risks is affected by several external and internal factors. The nature of ICT shows that it is impossible to entirely prevent incidents from occurring. In addition to preventive controls aimed to avoid security incidents, the following elements of incident management are significant – the ability to detect and to evaluate incidents properly, and to implement the appropriate corrective actions (Hochmann et al., 2011). Šindlerová and Butorac (2008) argue that while the importance of risk management has been growing in the process of globalisation, businesses learn to accept risks not just passively, but perceive risks as an opportunity to improve their prosperity. Pačaiová and Markulík (2003) stress that the risk management focuses on ensuring security and stability of a managed system, risk analysis and possible threats. Furthermore, it seeks appropriate corrective and preventive controls to minimise negative impacts of security events and their overgrowth to danger or crisis. It is a process of risk identification, analysis, evaluation and definition of the optimal treatment in order to minimise losses and maximise opportunities (Pačaiová and Markulík, 2003; Tichý, 2006, Kračmár, 2012). Kračmár (2012) understands the optimal treatment as dealing with risks at minimal management costs while respecting business objectives. The following section examines the importance of internal and external factors affecting information security risks in Slovak enterprises.

Factors affecting information security risks

Risk management represents the basis for information security management. It is necessary to meaningfully and effectively manage information security without knowing the risks to confront. Regular risk analysis updates enable to adjust information security strategy when necessary. According to Hamranová (2013), Business Intelligence applications are also significant in the issue as they assist to map security threats, assets and actions related to elimination of risk. Such applications serve to create a possible simulation of a security policy. The occurrence of individual security risks is affected by several factors as follows.

Internal factors:

Ignorance of employees – lack of employee knowledge in the issue might cause great damage and enable irreversible processes. Hamášová and Gerhátová (2012) emphasize the obligation

of employee trainings which clarify procedures to protect sensitive data from undesirable leaks and explain employees' adherence to a security policy of the organisation. In general, theft, misuse and unauthorised manipulation of information (data) are often directly or indirectly accompanied by employees' ignorance of basic principles related to information security. Even if employees are commonly considered as one of the weakest points in the issue, it is often neglected and requires a special approach. Ignorance may only be removed by a targeted training and education with a cooperation of all stakeholders.

Employee behaviour – behaviour and activities of employees and employers in relation to the safety at work have to be deliberately influenced. Employee behaviour represents a set of trained activities. This is reflected in the thought process and determines human thinking and feeling. "When assessing security, it is necessary to recognise that each system is only as strong as its weakest point. In case of information system security, the weakest point is clearly the user" (Tvrdíková, 2008). Human factor is the weakest element in security systems, especially for unconscious behaviour (CFO, 2013). Employees are threatened by infected e-mails and flash drives, they connect to enterprise servers via public Wi-Fi networks, use the same passwords as in the social media accounts, etc. In such cases, the latest security technology and applications against data leak attacks remain helpless to enterprises. Given that attackers are a step forward, it is crucial to arouse prudent user behaviour in enterprises.

Absence of ICT department – importance of ICT department in various business sectors is diametrical. It is obvious that business management efforts should be focused on connecting information strategy and business strategy. If this objective is met, ICT will be more involved in improving business performance and ICT department with business informatics will grow in importance. ICT will become a key component of entrepreneurship and enterprise. Pour and Voříšek (2007) argue that ICT management must reach a level where the continuity of business is not disturbed, because ICT failures might cause a fatal impact on the enterprise. If the senior management wishes to increase the importance of ICT department, it is appropriate to perceive it as a department of high-priority.

Lack of senior management support – information security risk management should be one of the pillars of enterprise information strategy that is directly linked to a strategic plan and a business strategy. Underestimating the importance of information security by the senior management might cause serious and unrecoverable consequences.

Insufficient technical equipment – scientific and technological progress is constantly raising the level of technical equipment, as well as miniaturisation, smart devices, innovative technologies. Using outdated technology has a negative impact on various economic indicators of enterprises and their performance. The use of obsolete hardware makes business informatics vulnerable to new threats. Therefore, it is insufficient to use modern software without adequate hardware equipment that correctly cooperates with software.

Technology faults (hardware, software) – fault is a characteristic difficult to detect prior to technology implementation and thus an assistance of experts is needed. If there are any doubts about a correct operation of technology, the fault must be immediately eliminated. Technology failure causes serious problems that start a chain reaction.

Insufficient software equipment – software must meet enterprise's requirements. It is not sufficient to own only basic computer programs and update software irregularly. Moreover, redundant software means a risk of information security breaches and security incidents as well.

Absence of internal guidelines and standards – growing significance of ICT indicates that a completely prevented occurrence of security incidents is impossible to achieve. In addition to preventive controls, an important element of information security management is the ability to recognise and evaluate security incidents and to implement appropriate corrective actions. We claim that adherence to guidelines and standards systematically protects information assets and effectively responds to security incidents.

Lack of financial resources dedicated to information security management – lack of funds might directly affect a security level and cause a complete failure of information security. Failure of information security arises as a result of underinvestment in software, hardware and education.

External factors:

Certification – a family of standards ISO/IEC 27000 deals with an information security management system (ISMS) and provides a general

and complete overview of information security risk management for different organisations (enterprises, government agencies, non-profit organisations and others). Organisations choose to establish the ISMS and get certified for many different reasons. Based on the Makatúra's classification (2014), the following reasons are defined: ensuring a market and efforts to comply with legal requirements or a market regulator. ISMS supports the organisations' ability to protect information assets, thus assures that confidentiality, integrity and availability of information is preserved. ISMS is the recognized proactive system of information security management within the organisation.

Legislation – in terms of information security, legislation is a subject of many discussions in various international forums. Slovak legislation is directly affected by documents adopted by the European Union and the NATO. Internationally, multilateral agreements are promoted by institutions such as the OSN, OBSE, resp. OECD. Legislation must take into account: ICT owners' concerns, ICT users' needs and rights of both natural and legal persons whose data is processed by ICT. Legislative requirements are often the most important aspect of organisations paying attention to information security (Hochmann et al., 2011).

Governmental support for information security – need for information security has been realised by national governments and intergovernmental organisations, such as the OECD, NATO, United Nations, Group of Eight and international and European organisations for standardisation, which have created various institutions and institutional arrangements for ensuring the protection of information, e.g. European Agency for Network and Information Security (ENISA), Computer Security Incidents Response Teams (CSIRT), etc., and have determined strategic objectives many of which have already been implemented.

Technological progress – currently, the impact of new ICT on business and society is immense. Progressive technologies are applied in all areas of life and business. Zelená (2005) states that especially for ICT, which has now become a phenomenon, equipments that had been experimentally deployed as large-scale, energy-intensive,unreliable and difficult-to-operate, have become small, friendly, highly reliable and energy-efficient. However, the trend grows together with the information security risk and the number of tools and techniques aimed to disrupt information security. Some people are not able to respond to the progress alone, but proper deployment of ICT can help them overcome this handicap.

Natural disaster risk – natural disasters and accidents represent a permanent threat to life or property by their unpredictability and large-scale consequences. Disasters might cause a physical disruption of technical equipments.

Third-party service delivery failure – service delivery and quality of services agreed in contracts must be ensured, applied and followed by the third party. According to Kaluža (2011), the best way to monitor contract compliance is a communication at all levels of governance. Regular reports of activities, audits, inspection dates and a system of multi-level controls are appropriate communication tools.

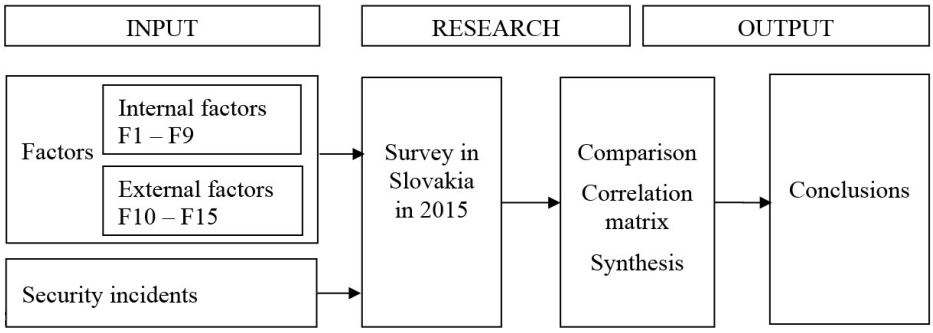
Materials and methods

Based on analysis of theoretical background and conducted surveys in the field of information security, we defined the factors affecting the formation of security incidents and identified that the survey focusing on information security in Slovak SME was missing. In our research, we are more focused on the agricultural enterprises.

Our survey was conducted in 2015. Data were received by an occasional selection of small and medium-sized enterprises in SR segmented by a number of employees. 83 respondents answered the survey in the form of a questionnaire, out of which 20+15 (42.17%) were focused on agricultural production. 20 enterprises were surveyed through the questionnaire and we implemented a structured interview on 15 enterprises.

When designing the questionnaire, valid construct, content and criteria were justified. The questionnaire included open and closed questions. Respondents were asked about their perception of factors that influence the existence of security incidents on a point scale from 0 (insignificant) to 7 (very significant). Research model variables are divided into internal and external factors (Figure 1).

The survey's content and structure are proposed on the basis of the security incidents' current state comparison and the factors affecting the incidents. Data evaluation is performed by using statistical methods, descriptive statistics and the application of quantitative and qualitative statistical methods. Relations between different factors and a formation of security risks are identified by a correlation



Source: own processing

Figure 1: Research model.

analysis at the significance level α = 0.05 and α = 0.01. New information is formulated by comparing the results of the sectional problem areas. A method of comparison serves as a verification tool for theoretical assumptions and survey's results. We use a conceptual approach as the main research method (Balashova et al., 2015).

Moreover, we conducted the structured interviews with managers, identified problems and analysed causes through discussions in the 15 selected agricultural enterprises.

Results and discussion

The concept of security incident can be viewed from multiple angles. However, the nature remains the same. We agree with the definition that a deviation from established rules and standards might lead to information security breaches by the action of security incidents.

More than 20% of enterprises recorded the security incident, which causes the information security breach. Respondents of small enterprises lack a security policy. Only 14% of small businesses implemented the policy.

Security incidents were not experienced by 79.52% of the surveyed enterprises. Out of 35 respondents of the agricultural enterprises, only 2 of them observed security incidents. The high percentage may indicate that the SME do now own the tools to record and assess security incidents or they do not pay much attention to risk management. These results are evidenced by 55.42% of SME which evaluate the information security risks only once a year (this group includes the agricultural enterprises) and 14.46% which do not evaluate the risks at all.

All cases of information security incidents came from external environment. 72% of small enterprises that recorded the security incident indicated the maximum rate (very often) of the emergence of security incidents in their business.

The objective of our survey is to analyse the significance of individual security incidents that concerns the researched enterprises (Table 1).

Enterprises attach the greatest importance to unauthorized penetration into ERP (Enterprise Resource Planning system), M = 5.92, SD = 1.49, and to unauthorized modification of sensitive information, M = 5.90, SD = 1.41. Business information assets (e.g. business secrets, knowledge, financial and management data, personal information, etc.) are crucial to create added value for the business. Theft or any change of such assets might lead to loss of credibility, business know-how and competitiveness. The most important data is stored in ERP systems. For this reason, the greatest threat to businesses is the security incident directed to the business information system. All of the presented security incidents are considered significant by the respondents as they exceed the average value of significance, M = 3.5. Unavailability of ICT services has the lowest mean score M = 4.82, SD = 1.88, but it belongs to significant security incidents as well. Positions of security incidents' concerns are similar considering the agricultural enterprises. Based on the structured interviews, the enterprises indicated that they fear the internet banking penetration and the ERP violation due to ignorance of their employees. Most business processes depend on continuous operation of ICT services. Otherwise productivity decreases, unforeseen downtime arises and normal operation of the business fails. Results of enterprises' risk likelihood perception are shown in Table 2.

Several factors affect the occurrence, respectively the emergence of information security risks. We inquired respondents about their perception

Security incident	N	Min	Max	Mean	Std. Deviation
Malware	83	0.00	7.00	5.1807	1.92001
Botnet	83	1.00	7.00	5.8795	1.53335
Unwanted content (defacement, spam..)	83	2.00	7.00	5.4458	1.84294
Techniques of obtaining information (phishing, social engineering...)	83	0.00	7.00	5.3253	1.96375
Asset vulnerability	83	1.00	7.00	5.0361	1.90280
Unauthorised modification	83	2.00	7.00	5.9036	1.41089
Unavailability of ICT services (DoS, DDoS...)	83	1.00	7.00	4.8193	1.87503
Attempt to penetrate ICT	83	1.00	7.00	5.1446	1.71174
Unauthorised penetration into ERP	83	1.00	7.00	5.9157	1.49148

Note: 0 (insignificant) – 7 (very significant) scale
Source: Authors´ own

Table 1: Significance of security incidents.

Information security risk	N	Min	Max	Mean	Std. Deviation
Disclosure of confidential data	83	0.00	6.00	2.0964	1.74338
Disclosure of business secrets	83	0.00	6.00	2.0120	1.72141
Enterprise brand damage	83	0.00	7.00	3.2651	2.04274
Loss, destruction or damage of personal data	83	1.00	6.00	2.6386	1.92910
Unavailability of ICT services (e-mail, internet, remote access, cloud, website...)	83	1.00	6.00	2.5783	1.38916
Interruption of employee performance	83	0.00	6.00	2.2892	1.82483
Interruption of business operation	83	0.00	6.00	1.6386	1.68623
Hardware failure	83	1.00	4.00	2.7229	1.15096
ERP failure	83	0.00	4.00	1.9277	1.23746
Specialised software failure	83	0.00	4.00	1.9639	1.12017
Office software failure	83	0.00	5.00	2.3133	1.58443
Security system failure	83	0.00	4.00	1.8554	1.27960
Theft of enterprise ICT	83	1.00	5.00	2.1928	1.47713
Power outage	83	1.00	7.00	3.8193	1.64646
Natural disaster (flood, fire, lightning,...)	83	0.00	4.00	1.8313	1.05714

Note: 0 (insignificant) – 7 (very significant) scale
Source: Authors´ own

Table 2: Perception of risk likelihood

of the effect of selected factors on the emergence of information security risks. Internal and external factors of the research model were subjected to statistical research. Partial results of descriptive statistics are presented in Table 3.

Respondents consider the technological progress as the most significant factor, M = 3.98, SD = 2.11. Technological progress in ICT changes the structure of not only economy, but also a number of business areas. It has a significant impact on the lives of individuals and shapes society. The current state of technological progress is resolute. It has great potential, facilitates business management and enriches the lives of individuals. However, there are lots of risks that create opportunities for the emergence of security incidents.

Employee behaviour is the most significant internal factor, M = 3.93, SD = 2.28. In the field of information security, employee education and raising their awareness traditionally produces disinterest, resp. meeting the legal requirements. However, targeted training and education are beneficial in terms of increasing the level of employee information literacy and knowledge of various threats. According to several surveys, most security incidents emerge from ignorance of employees. The only effective control is a comprehensive staff training program.

The third most significant factor is the third-party

Factors		N	Min	Max	Mean	Std. Dev.	Rank
Internal	F1 - Ignorance of employees	83	0.00	7.00	3.3012	1.85929	5.
	F2 - Employee behaviour	83	0.00	7.00	3.9277	2.28347	2.
	F3 - Absence of ICT department	83	0.00	6.00	2.3855	1.69527	13.
	F4 - Lack of senior management support	83	0.00	6.00	2.1566	1.82451	15.
	F5 - Insufficient technical equipment	83	0.00	6.00	3.1325	2.51712	7.
	F6 - Technology faults	83	0.00	7.00	3.2048	2.66302	6.
	F7 - Insufficient software equipment	83	0.00	6.00	3.5181	2.05629	4.
	F8 - Absence of internal guidelines and standards	83	0.00	6.00	2.4096	1.95708	12.
	F9 - Lack of financial resources dedicated to ISMS	83	0.00	7.00	2.2169	1.80817	14.
External	F10 - Certification	83	0.00	7.00	2.5422	1.98961	10.
	F11 - Legislation	83	0.00	5.00	2.7590	1.58184	9.
	F12 - Governmental support for information security	83	0.00	7.00	2.4699	2.13757	11.
	F13 - Technological progress	83	0.00	7.00	3.9759	2.10676	1.
	F14 - Natural disaster risk	83	0.00	7.00	2.9398	1.88931	8.
	F15 - Third-party service delivery failure	83	1.00	7.00	3.8675	2.12862	3.

Note: 0 (insignificant) – 7 (very significant) scale
Source: Authors´ own

Table 3: Factors affecting the emergence of security risks.

service delivery failure, M = 3.87, SD = 2.13. Failure of third-party deliveries might bring irreversible consequences. Enterprises often cannot reverse the process. Therefore, it is important to ensure appropriate and accurate selection of the business partner before any contract is concluded.

The technological progress is the most important factor when analysing the results of the survey conducted in agricultural enterprises. These enterprises do not often have enough financial resources to implement new software applications and modernise hardware equipment to protect enterprises' confidential information, know-how or personal data. Another serious factor is ignorance, respectively the low level of workers' information literacy. It is usual to observe the absence of specific trainings focusing on the use of ICT and the information security.

In addition to respondents' perception of security risk likelihood, we examined the correlation and significance of various factors and information security risk (Table 4).

We conclude that the correlation between internal factors and the security risk is significant at the significance level $\alpha = 0.05$ for F8 - Absence of internal guidelines and standards, $p = 0.022$. The correlation is significant for factors F3 - Absence of ICT department, $p = 0.007$, and F4 - Lack of senior management support, $p < 0.000$, at the significance level $\alpha = 0.01$. Absence of internal guidelines and standards increases the risk of the incident occurrence. Enterprises that do not comply with the guidelines or have not implemented any of them are unable to systematically and adequately protect information assets and effectively prevent security incidents. Proper implementation of the guidelines, standards and policies should be a priority for the senior management. ICT department having sufficiently qualified personnel is responsible to deal with information security management. Absence of the ICT department in the enterprise increases a possibility of the information security risk. Eventually, the senior management that does not support information security risk management creates a space for the emergence of risks and security incidents. If the management underestimates the importance of information security, serious, possibly unrecoverable consequences are caused. Therefore, it is crucial to perceive the information security management as a fundamental pillar of the information strategy, which is a part of the business strategy.

When examining the correlation of external factors and the emergence of security risk, we identified a significant effect of factors F10 - Certification, $p = 0.026$, F12 - Governmental support for information security, $p = 0.034$, and F13

Factors		Information security risk		N
		Pearson Correlation	Sig. (2-tailed)	
Internal	F1 - Ignorance of employees	-0.031	0.780	83
	F2 - Employee behaviour	-0.08	0.472	83
	F3 - Absence of ICT department	0.293**	0.007	83
	F4 - Lack of senior management support	0.438**	0.000	83
	F5 - Insufficient technical equipment	0.082	0.464	83
	F6 - Technology faults	-0.024	0.832	83
	F7 - Insufficient software equipment	0.059	0.597	83
	F8 - Absence of internal guidelines and standards	0.251*	0.022	83
	F9 - Lack of financial resources dedicated to ISMS	0.141	0.203	83
External	F10 - Certification	0.245*	0.026	83
	F11 - Legislation	0.149	0.180	83
	F12 - Governmental support for information security	0.233*	0.034	83
	F13 - Technological progress	0.221*	0.044	83
	F14 - Natural disaster risk	0.004	0.971	83
	F15 - Third-party service delivery failure	0.334**	0.002	83

Note: * Correlation is significant at the 0.01 level (2-tailed).
** Correlation is significant at the 0.05 level (2-tailed).
Source: Authors´ own

Table 4: Correlation of factor effects and the emergence of security risk.

- Technological progress, $p = 0.044$, at the significance level $\alpha = 0.05$. Effect of the factor F15 - Third-party service delivery failure on the emergence of security risk is significant at the significance level $\alpha = 0.01$.

Summary of findings and discussion

EY's (2015) Global Information Security Survey was conducted between June 2015 and September 2015. Participants included 1755 respondents from 67 countries and across all major industries. Compared with 2014-2015, the top two vulnerabilities are:

- Careless or uninformed employees
- Outdated information security controls or architecture

In 2014 these same two vulnerabilities were perceived to be high priorities, but the degree of vulnerability organisations feel has decreased in these areas. Today, only 44% feel vulnerable in relation to uninformed employees, compared with 57% in 2014; only 34% feel vulnerable due to outdated systems, compared with 52% in 2014. This shows that organisations believe they are covering their vulnerabilities more effectively. However, when we look at the top two threats today:

- Phishing
- Malware

These threats ranked 5th and 7th in 2014, with the theft of financial information, the threat of fraud, espionage and zero-day attacks all seen ranked higher.

The survey of Eurostat (2011) shows the state of information security in 27 countries of the European Union. The share of large enterprises that had a formally defined ICT security policy was three times more than the share of small ones. The highest proportion of enterprises having such a policy (52%) in the EU-27 was reported within the sector Information and Communication activities. The lowest proportions, less than one quarter of enterprises, were registered in the sectors Transportation and Storage, Construction and Accommodation and Food Service activities. In January 2010, the highest proportions of enterprises having a formally defined ICT security policy with a plan for regular review were registered in Sweden and Norway (both 46%) followed by Denmark (43%). In more than half of the countries, Information and Communication activities had the highest percentage of enterprises with an ICT security policy. The lowest percentage for enterprises

with such a policy was reported in Accommodation and Food Service activities in a majority of the countries. Less than 10% of the enterprises in Romania, Hungary and Bulgaria reported that they had a formally defined ICT security policy. Another survey will be carried out in 2016. In 2009, the incidents most commonly reported by enterprises were those resulting in unavailability of ICT services, destruction or corruption of data due to hardware or software failures, with shares above 20% registered in Cyprus, Portugal and Finland (26% of enterprises respectively), Denmark (24%), Greece (23%), the Czech Republic (22%) and Slovakia (20%). The highest proportion of enterprises reporting ICT incidents resulting in the destruction or corruption of data due to malicious software infection or unauthorised access was registered in Slovakia (16%), Portugal (14%), Spain (11%) and Greece (10%). The share of enterprises reporting unavailability of ICT services due to an attack from outside was highest in Slovakia (11%) and the Netherlands (7%). In the majority of EU countries, the disclosure of confidential data due to intrusion, pharming or phishing attacks was reported by 1%.

The last information security survey in SR was conducted in 2011 (Hochmann et al., 2011). The survey covered 180 respondents. Decline in the share of enterprises, that recorded the existence of a security incident, from 55% in 2009 to 37% in 2011, is considered as a positive finding. The most common security incidents are malware (43%), software failure (38%), power outage (14%), hardware failure (12%) and network connectivity failure (8%). Other security incidents, such as user error, theft of equipments, information leaks, external attacks, misuse of devices and user password disclosure, occur less frequently (5%).

In each survey, the significance of individual security incidents is assessed. However, the structure and perception are different because of the scope of each survey. Table 5 compares the order of incidents' significance in conducted surveys (E&Y, 2015; Eurostat, 2011; Hochmann et al., 2011).

A specific survey focusing on the analysis of factors affecting the existence of security incidents was found absent. Not only in relation to SME, but also focusing on the enterprises engaged in agricultural production. This fact resulted in implementation of a new survey. The significance of individual factors perceived by SME is presented in the results. The current state of significant factors affecting

Security incidents	RANK			
	Ernst&Young 2015	Eurostat 2011	MF SR 2011	Own research 2015
Destruction of hardware		1	4	6
Destruction of software			2	
Data destruction	4			
Malicious software	2	2	1	5
Unauthorised access	3	2		4
Loss of confidential data	4	3	7	6
Unavailability of ICT services due to external attacks		1		7
Botnet				2
Unauthorised modification				1
Attempt to penetrate enterprise ICT	6		8	5
Power outage			3	
Network connection failure			5	
Internal attacks (user error)	6	2	6	
Natural disasters	6			
Spam	6			3
Fraud	5		7	
Zero-day attacks	2			
Phishing	1	3	10	4
Theft of financial information	3			

Source: E&Y, 2015; Eurostat, 2011; Hochmann et al., 2011

Table 5: Significance of security incidents – a comparison of surveys.

the existence of security incidents in Slovak enterprises is influenced by the current state abroad due to open economy. Enterprises undertake numerous measures to comply with standards, guidelines and security policies while their interest in certification is growing. Observance of standards and policies reduces the likelihood of security risks. However, certification is not mandatory as organisations might meet the requirements and objectives of information security management without any need to possess the ISMS certificate. Studying recent findings of the International Organisation for Standardisation's survey that counted certified organisations in accordance with the ISO/IEC 27001 standard in 2014, it is possible to observe an increase in the number of certified organisations by 7% (+1623) compared to 2013. The world total is 23972 issued certificates according to the above standard. In SR, 162 certificates were distributed, which represented an increase of 3 units over the previous year. The top countries are Japan (7181), Great Britain (2261), India (2170) and China (2002) (ISO, 2014).

We identified that governmental support for information security is significant. Therefore, national information security strategies define strategic goals, recommendations and measures to meet the requirements. The Slovak national strategy forms a general framework for information security in the country by its distribution of power and competencies, priority setting and proposals towards achieving the objectives. The actual support is represented by the formation of legislation and standards. According to the National strategy for information security in SR, which was approved in 2008, information security remains multilateral. In SR, a coordinator of information security and the area of classified information is the Ministry of Finance, which is preparing a law dedicated to information security management in organisations. This law will mainly consolidate the requirements, competencies and responsibilities regarding the security of ICT. The proposal of the information security law is designed in accordance with the ICT development; it reflects changes in the public administration and self-governing bodies and takes the guidelines and recommendations of the European Union into account. Currently, the National Security Authority of the Slovak Republic submitted an action plan to the Slovak Government. The action plan includes controls, activities and authorities responsible for their implementation, which should reduce the risk of cyber attacks. The proposed controls create conditions for an integrated, coordinated and effective system for the protection of Slovak cyberspace. The whole process should be concluded by the year 2020. Preparation and presentation of the information and cyber security law proposal commences in 2016. The fact that the protection of cyberspace is not explicitly and comprehensively regulated in the Slovak law is considered to be the most serious problem in this area in SR.

Technological progress is the important external factor not only in Slovakia. Outdated enterprises' hardware and software provide opportunities for new threats, and thus increase the security risk. Monitoring possible third-party service delivery failure and communication failure is under the responsibility of inspection team. Any failure does not immediately introduce a security incident, but creates space for the risk and the likelihood of its existence.

Security incidents that arise in the internal environment occur mainly due to lack of education and training. Managers and other employees must be educated in the issue and must be instructed in a secure ICT usage. Targeted training should be a standard component of security controls in the enterprise. According to Eurostat (2011), the highest share of trainings focused on information security is carried out in Cyprus (77%) and Finland (74%). Hochmann (2011) claims that training contributes to building security awareness and helps to prevent faults. Training in information security is appropriate, desirable and currently evolving (Bishop, 2000). If enterprises are not sufficiently aware of the need for information security, it is necessary to create legal requirements as this aspect is often the only motive of enterprises to deal with information security. According to Hochmann (2011), a problem arises within affected organisations that primarily try to fulfil obligations (e.g. development of a security project, guidelines) with the objective of avoiding penalties. The quality of these documents and the real effort to increase the level of information security usually remains of secondary importance. After demanding elaboration of information security documents enterprises rarely undergo the information systems audit and update the documents regularly. Information security management and risk management should be seen as the essential and continuous process of providing competitive advantage in the current business environment. The ICT has a significant impact on increasing competitiveness of the agricultural enterprises and the enterprises engaged in agritourism (Havlíček et al., 2009).

They have the competitive advantage and offer the possibility to make themselves visible in the market, strengthen their market position and attract new customers. Maumbe (2010) and Vaněk (2011), also point to the ICT as a powerful tool of the competitiveness in agriculture and rural development as well as in developing countries.

Based on the survey conducted in the selected agricultural enterprises, we can conclude that the number of employees decreases in recent years and the management positions are being accumulated. In most of the surveyed enterprises, a separate organisational unit for the ICT governance was not created. Moreover, it is confirmed in our analysis that the absence of the separate unit has a significant impact on the creation of security incidents. Even if the ICT is available for employees, they often have to cope with only basic ICT knowledge. This means that at the lower levels of management, the low level of knowledge in the issue is observed. It is followed by the behaviour of the employees which is characterised by lax approach towards the information security (employees not paying sufficient attention to ensuring the basic data security, i.e. passwords are either not defined, or one password is shared by several workers). Nowadays, the level of completed trainings and courses aimed at increasing the level of managers' information literacy is very low.

The management of the agricultural enterprises often underestimates the information security risks and relies on the basic security controls, e.g. antivirus programs. At the same time, there is insufficient technical equipment (outdated technology). On the other hand, we confirm that the software applications are updated on a regular basis. We could not find a single enterprise without having updated its economic or antivirus software. Undoubtedly, the small and medium-sized agricultural enterprises lacked an internal directive for the ICT management and administration. According to our research, the main reasons for the shortcomings is the missing financial resources.

Conclusion

After the evaluation of the survey, a downward trend of security incidents compared to the previous period can be observed. 20% of respondents admitted that security incidents are considered satisfactory. Taking into account the current state of the agricultural enterprises, we conclude that it is necessary for managers to address the information security issues. The key area is human resources and the availability of skilled IT personnel. Increasing the educational level in information security is desirable. The results of external and internal factors' effects indicate that compliance of governmental support and legislation continues to be a major driving force in the information security improvement. Senior management that supports the active information security management and the existence of ICT department generates opportunities to improve the competitive advantage. The use of consistent procedures, rules, policies, regulations, guidelines, certification and other supporting tools ensures permanent and adequate level of enterprise information security and eliminates the security risk existence. However, the continuous technological progress brings rapid changes, therefore all stakeholders must continually educate in order to be able to identify new threats and incorporate controls into the implemented strategy of information security.

We were able to identify and evaluate the current state of information security in Slovak SME with respect to the agricultural enterprises and the effects of factors affecting information security risk existence by the conducted survey. It is possible to reduce or increase the occurrence of security incidents by influencing the areas linked to the factors.

Acknowledgements

The knowledge presented in the paper was obtained as a result of the Grant VEGA 1/0489/15, Increasing the efficiency of decision making by managers with the support of information systems and accounting.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Aqua Site Classification Using Neural Network Models

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Abstract

India being one of the major producers of fish contributes 5.5 percent of global fish production and ranks second in the world after China. The production of aquaculture mainly depends on the quality of land selected for aqua farming. Neural Network algorithms have been applied to classify the aquaculture sites based on 6 input variables viz., water, soil, support, infrastructure, input and risk factor. An artificial neural network (ANN) consists of huge number of interconnected elements called neurons that work together to solve a specific problem. An Artificial Neural network can be used for classification, prediction, pattern recognition etc., through a learning process. In this paper, the models were constructed using three Neural Network algorithms viz., Back Propagation Network (BPN), Radial Basis Function (RBF) and Linear Vector Quantization (LVQ). The models classify each aquaculture site into 3 classes viz., suitable, moderate and unsuitable. From the results of the three models, it has been found that Radial Basis Function model not only gives accurate results but also time taken for training the dataset is less when compared with the other two Neural Network models. The results obtained from the neural network models were validated with the results of the fuzzy model.

Keywords

Neural Networks, Aquaculture, Land Classification, Back Propagation Network, Radial Basis Function, Linear Vector Quantization.

Deepa, N. and Ganesan, K. (2016) “Aqua Site Classification Using Neural Network Models", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 51 - 58. ISSN 1804-1930, DOI 10.7160/aol.2016.080405.

Introduction

Due to protein shortage in many countries, Aquaculture development has become significant important nowadays. The quality of the aqua site chosen for the aquaculture development leads to the success of the projects (Boyd and Clay, 1998). Multiple variables were used for the identification and classification of aqua sites which leads to the success of aquaculture farming projects (McKindsey et al., 2006) A tool called DMTIOLA was developed for making decision on selection of best site for aquaculture farming using a mathematical function. The mathematical function was derived by the integration of few multi criteria decision making approaches (Mahalakshmi et al., 2012). A decision making model using Fuzzy logic was suggested for the classification of aquaculture sites based on six input parameters (Mahalakshmi and Ganesan, 2015).

The Neural Network Model consists of interconnected neurons. They exchange the activation signals based on the network topology in the form of activation function. Learning process is done by generating and adjusting weights in neural networks. Neural Network models are developed not only for parallel processing of data but can also be used for classification (Konecny et al., 2010). Neural Network algorithms were also used for prediction in the Knowledge-management (Svoboda, 2007)

A Radial Basis Function based neural network model was developed for the prediction of water temperature in the aquaculture ponds of sea cucumber in which it was shown that RBF produced high accuracy in shorter learning time (Min Sun et al., 2012). Freshness of silver carp was determined using BPN based model (Zhang et al., 2009). An Artificial Neural Network model was used to analyse biological growth state based on various water quality parameters in order to forecast the actual yield (Changhui et al., 2010). Many neural network algorithms are used in economic and statistical analyses.

In this study, three neural network models suitable for aquaculture classification were identified viz., BPN and RBF which comes under supervised Neural network models and LVQ which comes under unsupervised neural network model. The purpose of the models is to classify aqua sites into three classes viz., suitable, moderate and unsuitable (Mahalakshmi and Ganesan, 2013).

Materials and methods

Data sets

The essential parameters to be taken into account for aquaculture land suitability are the good quality water, quality of soil, salinity, pollution, threats to flood, temperature, pollution, infrastructural facilities, access to markets and necessary input (Nath et al., 2000). Twenty four variables (Hajek and Boyd, 1994; Mahalakshmi and Ganesan 2009) viz., water (ten sub-variables), Soil (five sub-variables), support (two sub-variables), infrastructure (three sub-variables), input (one sub variable) and risk factor (three sub-variables) listed in Table 1 were used for the construction of Neural Network models.

Sl No.	Main variables	Sub variables
1	**Water**	pH, Salinity, Total alkalinity, Dissolved Oxygen, Total hardness/ Total alkalinity, Free NH3-N, Total hardness, H2S, Temperature, Transparency.
2	**Soil**	Salinity, pH, Clay content, Available Phosphorus, Organic Carbon
3	**Support**	Distance to university/college, Distance to NGO
4	**Infrastructure**	Distance to processing plants, Distance to Local Markets, Distance to natural fry
5	**Input**	Animal wastes
6	**Risk factors**	Winter rain, Flood and cyclone, Pollution

Source: own processing

Table 1: Aquaculture land classification of main and sub variables.

Study area

Kallamandal located in West Godavari district of Andhra Pradesh state, India was selected as study area. This study area was selected because coastal aquaculture is considered as major commercial occupation in this area. The soil, water, support, infrastructure, input, and risk related data used in this paper were collected from 40 randomly chosen aqua farms located at Mogalthur (A) (25 sites), Kallamandal (B) (15 sites) (Mahalakshmi and Ganesan 2013). Data gathered from A was used for training the BPN, RBF neural network models and data from B was used to test the BPN, RBF models. LVQ being unsupervised neural network requires data for training only. Dataset B was used for developing LVQ model. And the results of neural network models were validated with the results of Fuzzy model (Mahalakshmi and Ganesan 2013).

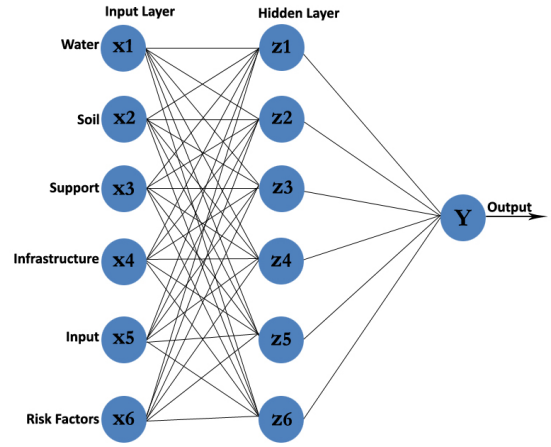
The prime set of criteria identified has been applied to DMTIOLA tool developed by Mahalakshmi. This tool has converted the data A and B to its relative closeness values using various Multi Criteria Decision Making Methods such as Rank sum weight, Analytical Hierarchical Process and TOPSIS method (Mahalakshmi and Ganesan, 2013).

Implementation

Matlab software was used to write programs for developing the three neural network models for aqua site classification. The software (http://www.mathworks.com) has many in-built mathematical functions which will be useful for coding. It is easy to code and understand.

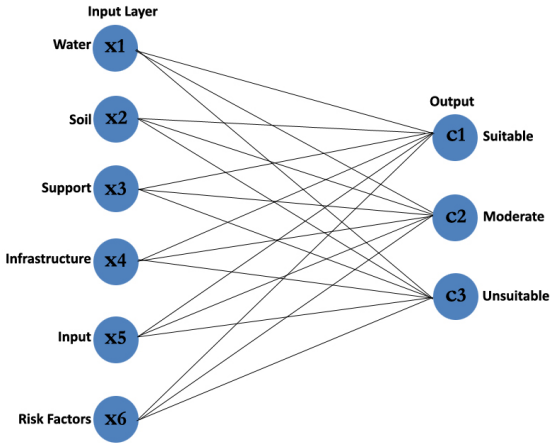
Neural Network and training algorithm

An artificial neural network is an data processing method which works similar to the human brain. It consists of huge number of interconnected elements called neurons that work together to solve a specific problem.Supervised learning is the process of providing the network with some sample inputs and outputs for training purpose whereas unsupervised learning will be provided only with input data. Supervised learning algorithms compare the calculated output with the expected response whereas unsupervised learning algorithm will group the input data into clusters by identifying some unique pattern. In this paper two supervised learning algorithms namely Back Propagation Network (BPN) algorithm, Radial Basis Function (RBF) algorithm and one unsupervised algorithm namely Linear Vector Quantization (LVQ) are used to classify the aquaculture lands. The proposed supervised neural network models for BPN and RBF is shown in Figure 1 and unsupervised Neural Network Model for LVQ is shown in Figure 2.



Source: own processing

Figure 1. Proposed supervised Neural Network Model.



Source: own processing

Figure 2. Proposed unsupervised Neural Network Model.

Back Propagation Network Model

Back Propagation Network (Arthur and Yu-Chi, 1969) is a multi-layer neural network supervised training algorithm. It uses gradient-descent based delta learning rule which minimizes total mean squared error. The BPN training algorithm is divided into 3 stages namely Feed Forward Stage, Back Propagation of errors and updation of weights and biases. Updated final weights and biases at final epoch are used while testing the algorithm to compare the calculated output with the expected response.

BPN model was developed using the following steps:

Various parameters used in the model:

X – Input vector. In our case there are 6 input parameters and 25 training input patterns available for Aqua farm classification

T – Target vector

δ_k = error at output unit Y_k. Here $k = 1$

δ_j = error at hidden unit Z_j where $j = 1$ to 6

α = Learning rate

V_{0j} = bias at hidden unit where $j = 1$ to 6

Z_j = hidden unit j

W_{0k} = bias at output unit where $k = 1$

Y_k = output unit k

V_{ij} = weights between input and hidden layer. Here $i = 1$ to 6 and $j = 1$ to 6

W_{jk} = weights between hidden and output layer where $j = 1$ to 6 and $k = 1$

1. Initialize weights between input and hidden layer V_{ij}, weights between hidden and output layer W_{0j}, bias at hidden unit V_{0j} and bias at output unit W_{0k} to random values.

2. For each training vector do the following steps

Feed Forward stage

Find output Y_k by applying bipolar activation function

$$Y_k = f(Y_{-ink}) \text{ where } k = 1 \text{ and } f(x) = \frac{1}{1+e^{-\lambda x}} \quad (1)$$

also $\lambda = 1$

where $Y_{-ink} = W_{0k} + \sum_{j=1}^{6} Z_j W_{jk}$ where $j = 1$ to 6 and $k = 1$

$$Z_j = f(Z_{-inj}) \text{ where } j = 1 \text{ to } 6 \text{ and } f(x) = \frac{1}{1+e^{-\lambda x}}$$

also $\lambda = 1$

$$Z_{-inj} = V_{0j} + \sum_{i=1}^{6} X_i V_{ij} \text{ where } j = 1 \text{ to } 6$$

3. Back propagation of errors

Error at hidden units is obtained using

$$\Delta_j = \delta_{-inj} = f(Z_{-inj}) \text{ where } j = 1 \text{ to } 6 \quad (2)$$

where $\delta_{-inj} = \sum_{k=1}^{1} \delta_k W_{jk}$ where $j = 1$ to 6 and $k = 1$.

Error term $\delta_k = (T_k - Y_k) f'(Y_{-ink})$ where $k = 1$

$$f'(Y_{-ink}) = \frac{1}{1+e^{-\lambda x}}\left(1 - \frac{1}{1+e^{-\lambda x}}\right)$$

where and $x = Y_{-ink}$

4. Updation of weights and Biases

Updation of weights between input and hidden layer are calculated using

$$V_{ij(new)} = V_{ij(old)} + \Delta V_{ij} \quad (3)$$

where $\Delta V_{ij} = \alpha \Delta_j X_i$ where $i = 1$ to 6 and $j = 1$ to 6

Updation of bias at hidden unit is obtained using

$$V_{0j(new)} = V_{0j(old)} + \Delta V_{0j} \quad (4)$$

where $\Delta V_{0j} = \alpha \Delta_j$ where $j = 1$ to 6

Updation of weights between hidden and output layer are calculated using the formula

$$W_{jk(new)} = W_{jk(old)} + \Delta W_{jk} \quad (5)$$

where $\Delta W_{jk} = \alpha \delta_k Z_j$ where $k = 1$ and $j = 1$ to 6

Updation of bias at output unit is obtained using

$$W_{0k(new)} = W_{0k(old)} + \Delta W_{0k} \quad (6)$$

where $W_{0k} = \alpha \delta_k$ where $k = 1$

5. Repeat the steps upto any specified condition to stop the iteration. The condition can be either the number of epochs or error rate.

For each testing vector we do the following steps:

By substituting the weight and bias values obtained during training process, we calculate the output Y. Then compare the output vector Y and target vector T and calculate error term using

$$E = Tk - Yk \quad (7)$$

Radial Basis Function (RBF) Model

The Radial Basis Function (Broomhead and Lowe, 1988) is a feed-forward neural network supervised training Algorithm. Radial Basis Function Networks are used in image processing applications and in many regularization networks. Radial Basis Function uses guassian function with which it differs from the Back Propagation Network algorithm. RBF networks have three network layers viz., input layer, hidden layer and output layer. Hypothetical connections are formed between input layer and hidden layer and weighted connections are formed between hidden and output layer. Updation of weights are done by RBF training algorithm. In RBF network, the Gaussian activation function is used to compute the output. We calculate the radial basis function by choosing the centres. Here all the input vectors are selected as centres to ensure sufficient sampling.

The following steps were used to develop the RBF model:

RBF Training algorithm

1. Initialize the weights between input and hidden units to some small random values
2. For each Input pattern do the following steps:
3. Each input unit (X_i, $i = 1$ to 6) sends signals to hidden unit
4. Calculate the radial basis function by choosing the centres using the equation (1). Here all the input vectors are selected as centres to ensure sufficient sampling.

$$\text{Mi(Xi)} = e \sum_{j=1}^{r} \left(\frac{1}{\sqrt{2\Pi}} e^{-\frac{1}{2}(X_{ji} - \overline{X}_{ji})^2} \right) \quad (8)$$

where $\overline{X}_{ji}$ = centre of the RBF unit for input values

$\frac{1}{2\Pi}$ is width of the RBF unit

X_{ji} = j[th] variable of input pattern

5. Calculate weight using

$$W = M' * t \quad (9)$$

where M' = Inverse of radial basis function

t = target units

6. Obtain the calculated output y using

$$y = W' * M \quad (10)$$

7. Calculate the training error using

$$E = \sum (t - y)^2 \quad (11)$$

and repeat the steps

RBF Testing algorithm

For each input pattern do the following steps:

1. Find the output vector y using Gaussian value and weights obtained during training process

$$y = W' * M \quad (12)$$

2. Compare the target vector T and output vector y and calculate testing error term using the formula given in equation (7).

Linear Vector Quantization Model – Unsupervised Neural Network

When learning is done using data without output and error calculation is not done, such network is called unsupervised network. In this, the network may react to one of many output classes on training. Target values are given for input training pattern in Linear Vector Quantization (LVQ) network. After training process, the LVQ net assigns each and every input vector to some output class. In LVQ, some input vectors are used as weights and the other input vectors are used for training

the network. Next step is to identify the winner unit by calculating the Euclidean distance. The input vector with minimum distance is identified as winner. The weights were updated based on the comparison of winner index with the target class. The iterations are repeated by decrementing the learning rate. The architecture diagram for unsupervised neural network LVQ model is shown in Figure 2.

In this neural network model, first 3 input vectors are used as the reference vectors or weight vectors and the 15 site's dataset have been taken for training the network. The following steps were used to develop LVQ model:

Parameters used in LVQ model:

Input vector X_i where i = 1, 2, …. 15

Weight vector for the j^{th} output neuron $W_j = (W_{1j}, W_{2j}\ldots\ldots W_{6j})$. Here first 3 input vectors are used as weight vectors.

C_j = output class represented by the j^{th} neuron, where j = 1 for suitable, 2 for moderate and 3 for unsuitable.

T = Target class for input X

α = Learning rate = 0.7

LVQ Training Algorithm:

1. Initialize weight vectors by assigning the first 3 input vectors to weights.
2. Until stopping condition becomes false, do the following steps from 2 to 6.
3. For each training input vector x, repeat the steps from 3 to 4
4. Find j such that $D(j)$ is minimum.
5. Calculate the Euclidean distance between the input vector and the weight vector of the j^{th} neuron using the formula

$$D(j) = \sqrt{\sum_{i=1}^{6}(X_i - W_{ij})^2} \qquad (13)$$

6. Update the weights of the j^{th} neuron using the formula:

   if $C_j = T$ then

   $W_{j\,(new)} = W_{j\,(old)} + \alpha\,(X - W_{j\,(old)})$

   (i.e. move the weight vector W towards the input vector X)

   if $C_j \neq T$ then

   $W_{j\,(new)} = W_{j\,(old)} - \alpha\,(X - W_{j\,(old)})$

   (i.e. move W away from X)
7. Reduce learning rate α
8. Test the condition used to stop the iteration: Here stopping condition is the learning rate reaching a small value.

Results and discussion

In this paper, the results of Back Propagation Network, Radial Basis Function Network models and Linear Vector Quantization model have been compared.

The two main parameters of Back Propagation network algorithm are learning rate and momentum factor. Learning rate is denoted by α which can vary from 0 to 1. The learning rate is used to control the weight adjustment during training process. It affects the rate of convergence of Back Propagation training algorithm. If the value of learning rate is high, the learning process is fast and if the value of learning rate is low, the learning process is said to be slow. Momentum factor value can be used to increase the speed of training process. BPN algorithm without momentum factor parameter has higher training time and slower convergence. Thereby momentum factor is used to accelerate the learning process. In Table 2 below, we list the results of BPN for various momentum factors and learning rate values for 5000 iterations.

Momentum Factor	Learning Rate	Error	Time
0.21	0.5	0.1382	2.1966
0.21	0.8	0.0553	1.6050
0.5	0.8	0.2443	1.5970
0.1	0.9	0.0480	1.7117

Source: own processing

Table 2: Results of Back Propagation Network with different Momentum factor and Learning rate values for 5000 iterations.

From the first two cases of Table 2 we observe that by increasing the learning rate, error and time taken for testing the data set has been reduced. In the third case, it has been observed that the increase in momentum factor leads to the increase in error rate. Finally from the 4th case, we see that an increase in learning rate and decrease in momentum factor lead to reduced error rate and time. The relationship between the target and calculated output for BPN model is shown in Figure 3. In the figure, target vectors with suitable output class (value 2.32) have been correctly classified as suitable (values 2.17, 2.19) in calculated output and the target vectors with moderate output class (value 1.01) have been incorrectly classified as unsuitable (values 1.81,

0.89) in calculated output. The Total Mean Square Error calculated by BPN algorithm is 0.7970. Time taken for testing the dataset is found to be 5.3 sec.

By applying Back propagation Network model, out of 15 testing sites, 2 sites have been found to be suitable, 5 sites have been classified as moderate and 5 sites have been found to be unsuitable with respect to the Fuzzy model results. These results were validated with fuzzy model results (Mahalakshmi and Ganesan, 2013) and the accuracy rate is found to be 80%.

From the results of RBF model, we found that out of 15 testing sites dataset, one site have been correctly classified as suitable, six sites have been accurately found to be moderate and six sites have been correctly classified as unsuitable with respect to the results of Fuzzy model. The results of RBF model are found to be 87% accurate with respect to fuzzy model results.

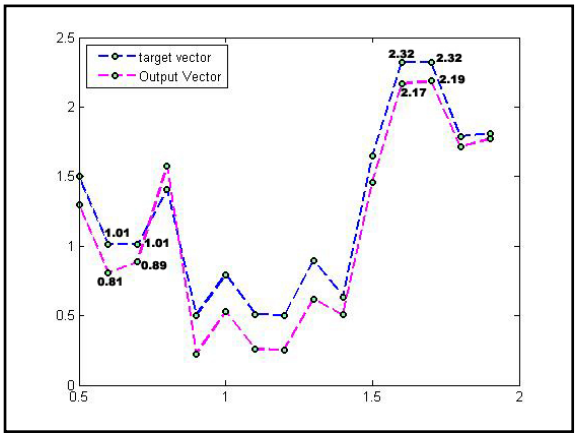
The relationship between the target and calculated output for RBF model are shown in Figure 4. In the diagram, target vector with suitable output class (value 2.32) has been erroneously classified as moderate output class (value 1.80) in calculated output and target vector with moderate output class (value 1.81) has been incorrectly classified as suitable output class (value 2.18) in calculated output. The Total Mean Square Error calculated by RBF algorithm is 0.3121. Time taken for testing the dataset is found to be 0.02 sec.

In this neural network model, first 3 input vectors from Table 1 are used as the reference vectors or weight vectors, and the 15 sites dataset (including first 3 datasets) have been taken for training the network. The learning rate is initialized to 0.7. Out of 15 dataset, 11 sites were clustered to correct output category using LVQ model thereby achieving 73% of accuracy and the results are validated with respect to the fuzzy model results.

Using the three neural network models, the test datasets have been classified and the classification results are compared with the results of Fuzzy model (Mahalakshmi & Ganesan, 2013) which is specified in the last column of Table 4. From the above comparison, the results have been validated and it has been assessed that neural network model using BPN produced 80% accurate results and RBF has produced 87% correct results whereas LVQ has given 73% correct results. Table 3 shows the results of neural network models using BPN, RBF and LVQ.

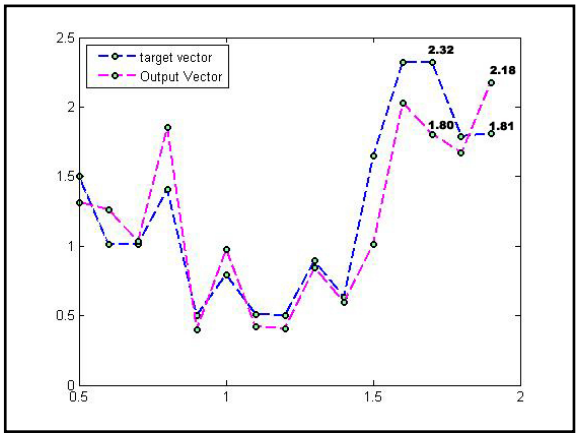
The performance of the test data sets are shown graphically with target vector and output vector plotted for BPN and RBF Network in Figure 3 and Figure 4. The LVQ algorithm provides less accurate results with reduced time compared to BPN and RBF. The time taken for LVQ algorithm is 0.0066 sec whereas BPN takes 5.3 sec and RBF takes 0.02 sec.

From the results of MATLAB programs, it has been identified that Back propagation model performance is dependent more on the parameters. It consumes more time when compared with the other two models. Radial Basis Function gives accurate results and time taken for training the dataset is also very low. Even though Linear Vector Quantization takes less time compared to BPN and RBF, it does not classify all the input dataset correctly. The results show that Radial Basis Function Network are faster



Source: own processing

Figure 3: Relationship between target and calculated output for BPN model.



Source: own processing

Figure 4: Relationship between target and calculated output for RBF model.

Land suitability Classification	Neural Network Models			Fuzzy Model Results (Mahalakshmi & Ganesan, 2013)
	BPN	RBF	LVQ	
Suitable	2/15	1/15	1/15	2/15
Moderate	5/15	6/15	4/15	7/15
Unsuitable	5/15	6/15	6/15	6/15
Accuracy	80%	87%	73%	
Time in sec	5.3	0.02	0.0066	

Source: own processing

Table 3: Results of BPN, RBF and LVQ Models.

and simpler as compared to Back Propagation Network, Linear Vector Quantization and can be used for classification problems.

Conclusion

In this paper, three artificial neural network models viz., Back propagation network, Radial Basis function network and Linear Vector Quantization have been used for aquaculture site classification. The results obtained from test datasets are compared and are validated. It has been found that the output seems to be in close correlation with the experimental results produced by fuzzy model (Mahalakshmi and Ganesan, 2013) and aquaculture experts results. The error rate, testing time of three algorithms were compared. LVQ testing time seems to be lower compared to BPN and RBF. The RBF model has classified the dataset quite faster with better accuracy. The error goal was reached by RBF in only one epoch while BPN took nearly 5000 epochs. LVQ has achieved 73% correct results within 10 epochs and the algorithm is simple to implement when compared to BPN and RBF. An important point to be noted is that BPN selects number of hidden layers by trial and error method while RBF has used only one hidden layer with growing number of neurons. The results of BPN concluded that the learning rate and momentum factor are the parmeters which affect the performance of BPN model in aqua site classification and it was shown by varying momentum factor and learning rate. It has been concluded that RBF model is suitable for classification problems which consumes less time with higher accuracy compared to BPN and LVQ models.

Acknowledgements

The authors would like to thank TIFAC-CORE in Automotive Infotronics, VIT University, Vellore, Tamil Nadu, India for providing necessary hardware and software support. This work forms part of the R&D activities of TIFAC-CORE funded by the Department of Science and Technology, Government of India.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Future Market of Pizza: Which Attributes Do They Matter?

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Abstract

Pizza is eaten all over the world because of its simplicity and taste. Given its importance in the Italian diet, this paper provides a qualitative insight into fresh pizza consumption for the first time. This study deals with the perception of pizza attributes in Italy focusing on the main drivers of consumer acceptance of the traditional Margherita pizza, and analyzing in addition consumers' preferences for novel types of pizza in the marketplace, such as those made with organic, low calorie or frozen ingredients. The results show how respondents firstly prefer to eat traditional pizza and mainly prefer organic ingredients leading Italian consumers to perceive them more positively than conventional ones. Furthermore, despite the frozen pizza market being fairly well-established in many countries, the study finds a strong propensity to buying fresh pizza in the traditional market. The role of low calorie pizzas appears to be limited despite consumers being quite interested in this type of product. The novelty of this paper is to fill the knowledge gap about new typologies of pizza available in the marketplace, by exploring consumer preferences for and perceptions of a traditionally made product in a traditional producer country. The study will also offer managerial-oriented implications to help pizza producers develop new strategies for better identifying the ongoing demand of pizza consumers both for traditional and new typologies.

Keywords

Pizza consumers, traditional food, product innovation, fresh pizza.

Di Vita, G., De Salvo, G., Bracco, S., Gulisano, G. and D'Amico, M. (2016) "Future Market of Pizza: Which Attributes Do They Matter", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 59 - 71. ISSN 1804-1930. DOI 10.7160/aol.2016.080406.

Introduction

In the last decades, food-consumption trends in western countries have been experiencing deep changes due to the continuous innovation of the agro-food system and the modern evolution of lifestyles and diets, including therefore the needs of consumers (Fonte, 2002; Leclercq et al., 2009).

Increasing attention has been paid to the evolution of eating patterns and consumer attitudes and behaviours to traditional food that have increasingly acquired elements of innovation and differentiation (Gracia and Albisu, 2001; Casini et al., 2015). This trend has involved several traditional products in the European market and ongoing development in types of consumption has been observed (Di Vita et al., 2013; Caracciolo et al., 2016).

The existing literature has pointed out from several perspectives the role and significance of traditional products in consumer behaviour (Guerrero et al., 2010; Di Vita et al., 2014; Vanhonacker, et al., 2010). A traditional food product can be defined as follows: "a product frequently consumed or associated with specific celebrations and/or seasons, normally transmitted from one generation to another, made accurately in a specific way according to gastronomic heritage... distinguished and known because of its sensory properties and associated with a certain local area, region or country" (Guerrero et al., 2009).

Traditional foods represent the basic constituent of Italian gastronomic culture, since Italy is the leading country in the EU for the number of PDO and PGI designations and its cuisine is rich in several and differentiated typologies of dishes and food recipes. Moreover, among them, a very important role in the Italian food pattern is played by cereals and pizza (Leclercq et al., 2009) which form the food pyramid base of the Mediterranean diet.

From this point of view, pizza can be argued as a traditional Italian product. In fact, despite

the consumption of pizza being widespread almost all over the planet, and representing one of the "most popular family foods" (Singh and Goyal, 2011a), with relatively high rates of pizza consumption also observed in non-Mediterranean countries (Myrland et al., 2000), Italy is considered the birthplace of the Margherita pizza, since the modern pizza was made for the first time in Naples (Statistic brain, 2015) and as such it can reasonably be considered an Italian product.

Moskowitz (2001) argues that pizza is a very "complex product" since in the marketplace it includes different typologies and varieties as well as a plurality of toppings such as meats, vegetables, fish and other condiments (Singh and Goyal, 2011a). In Italy, the Margherita represents the most widespread pizza being commonly made of tomato, sliced mozzarella, salt, and extra-virgin olive oil, wheat flour type '0', brewer's yeast and natural drinking water, and it consists of flatbread topped with tomato sauce and mozzarella baked in an oven.

Despite the prominent role of pizza in the food habits of many countries, there is relatively little analysis of it by the international scientific community. Food science literature reports few studies based on the analysis of the sensorial aspects of pizza (Moskowitz, 2001; Fedoroff et al., 2003) and its role in the dietary habits of households (Myrland et al., 2009) or associated with other food ingredients such as tomato and cheese pizza (Lucier et al., 2000). Another strand of literature has focused on the health effects of pizza, by analysing its role in cancer insurgency or prevention (Gallus et al., 2006) or to improve its nutritional properties (Combet et al., 2014). Simultaneously a series of studies have been directed towards agro-industrial aspects taking into account the production technologies able to enhance the antioxidant properties of pizza raw materials such as whole-wheat (Moore et al., 2009) and tomatoes (Singh and Goyal, 2011a). Furthermore some aspects of frozen pizza demand have been studied in the consumer marketing literature in the context of price sensitivity by measuring brand penetration and household purchases (Albuquerque et al., 2009), or estimating the price sensitivities of households in online and offline shopping (Chu et al., 2008), or exploring the interaction effects of income as well as social and consumption context on price sensitivity (Wakefield and Inman, 2003).

Furthermore, with the exception of two studies regarding the intention to buy organic pizza and an econometric approach to the exploration of the main determinants of pizza consumption (Dean et al., 2008; Di Vita et al., 2016), the existing literature presents a significant paucity of studies on the preferences and attitudes of pizza consumers, primarily with respect to the purchase intention of pizza eaters. However, no specific study has been carried out on consumer preferences for fresh 'margherita pizza' characterized as fresh, handmade and prepared (cooked) in restaurant pizzerias, as well as for novel typologies of pizza. In fact, alongside the traditional pizza, the food markets now offer different forms of commercial or industrial pizzas such as frozen and chilled pizzas, available at large retail stores, or semi-finished pizza delivered to pizza chains (i.e. Domino's and Pizza Hut). In recent years, energy-reduced pizzas or low-calorie pizzas with soy or whole wheat flour have also been gaining importance, as well as organic pizzas, made with organic food ingredients.

The question this paper explores is the extent to which consumers' behaviour towards traditional food has been progressively modifying. In particular, this study aims at investigating if in local markets there exists a more or less noticeable propensity towards traditional pizza consumption or conversely there exists a potential demand for new typologies of pizza.

This paper deals with the quality perception of pizza in Italy and focuses on the main drivers of consumers' acceptance of Margherita pizza, analysing in addition consumers' preferences for novel types of pizza available in the marketplace such as those made with raw materials from organic farming, or low in calories or frozen.

This paper is organized into four different steps as follows: the first one presents the current scenario of pizza consumption in Italy; the second section describes the methodological approach of the paper to reporting sampling methods and data collection modalities; the third part of the study focuses on the main outcomes of the univariate statistical analysis and shows the results of the conjoint analysis carried out on respondents' perception of quality by taking into account the main attributes of pizza. The last part of the paper discusses the main implications and concludes the study.

Market and consumption of pizza in Italy

The market of pizza in Italy is very well-established: in 2014 3 billion pizzas were eaten, an average of 7.6 kilograms of pizza per person per year. This data places Italy as the second largest consumer in the world, after the United States of America

whose consumption amount to 13 kg of pizza per person (Il sole 24ore, 2014) is eaten. In Italy, the turnover generated by the whole sector, including non-traditional pizza restaurants and industrial production, amounts to €16.63 billion.

But despite the favourable trend of consumption, consumers' expectations and tastes are quickly becoming oriented towards the consumption of food outside the home whose growth has favoured the spread of catering companies with an increase in fast-food restaurants, snack bars, and workplace canteens leading to an increase in the market demand of semi-cooked or ready-meal foods and ingredients (Kearney et al., 2001; Celnik et al., 2012). As a consequence, the pizza market is gradually evolving. Within this context, traditional pizza restaurants have had to face increasing competition from different distribution chains, such as take-away pizza and a large retail sector, whose growth is directly correlated to the development of different patterns of consumption. Furthermore, the increasing expansion of different typologies of industrial pizzas, primarily frozen and semi-finished sold through the retail channels has greatly modified pizza eating patterns thus exacerbating competition between traditional and industrial producers.

Frozen pizza has become one of the most important frozen food categories (Albuquerque and Bronnenberg, 2009) and its consumption is growing especially in the northern and central regions of Italy and this trend is slowly involving even southern regions. From 2004 to 2014, there was a significant increase in the frozen pizza market which traded volumes from 31,400 tons to 42,650 tons, an increase of 35% in the last ten years (Istituto Italiano Alimenti Surgelati, 2015). In addition, the number of consumers also eating takeaways or delivered meals (pizza) has considerably increased.

Nevertheless, the consumption of artisan pizza is well established at pizza restaurants as well as at home which benefit from takeaway pizza and pizza delivery. Currently, traditional pizza restaurants represent 40% of Italian restaurants; recent statistics showing that there are 25,300 and are slightly fewer than pizza delivery outlets which number 26,700.

As a food fact, the strong point of fresh handmade pizzas is the quality of their raw ingredients, the craftsmanship with which they are made, the expansion of the product range (eg: use of organic ingredients, energy reduced wheat, gluten free and vegan pizza), the increased efficiency of the take out service, the choice of location and the value-added services.

Traditional pizza restaurants have had a strong traditional identity that may be viewed as a repetitive and stereotypical expression throughout Italy, but nowadays Pizza restaurants are greatly modifying the way they offer their product by becoming more marketing-oriented. To be more market competitive, Pizza restaurants have had to radically change, changing their model structure to cater for entertainment, where the experience is not just consumption but tends to be more engaging, multi-sensory and gratifying even in terms of aesthetic satisfaction. Conversely, takeaway pizza and pizza delivery should improve the quality of their product and offer more value-added services.

Materials and methods

The survey was carried out in two different areas of Sicily from February to April 2014. A specific questionnaire containing closed-ended questions was administered to a casual sample of 202 consumers in the metropolitan areas of Palermo and Catania.

Some preliminary focus groups were formed to select the broad items to include in the final questionnaire as well in the conjoint card. Within the focus groups held at two different traditional pizza restaurants, a selected cluster of 16 consumers was invited to express their opinions on their attitudes to pizza (eating habits, shopping places, frequency, etc.) and the most important attributes and characteristics they consider when eating them such as colour, wheat typology, price, method of production, and so on. The focus groups discussed the Margherita pizza in order to identify the main determinants of its consumption. The choice of Margherita pizza pizza was due to the fact that this type of pizza is the most common within the Italian restaurants as well as among the frozen pizzas available in supermarkets.

The interviews were random, face-to-face, daily and they were carried at different times of the day. 60% of the sample were interviewed at large retail stores, while the remaining 40% were interviewed at pizzeria restaurant. According to a previous study (Panzone et al., 2016) arguing the best option in the choice of purchases places during a conjoint experiment, the selection of sample aimed to capture a random population of consumers (i.e. individuals responsible for household provisions) in a real shopping environment.

The demographic characteristics of the sample are reported in Table 1.

Category	Variable	N.o	%
Gender	Female	117	57.9
	Male	85	42.1
Age	18-30	110	54.5
	31-45	57	28.2
	46-60	22	10.9
	> 60	13	6.4
Education	Primary	48	23.8
	Secondary	108	53.5
	Graduate / Postgraduate	46	22.8
Income	- < 10,000 Euros	95	47.0
	- 10-20,000 Euros	85	42.1
	- 20-40,000 Euros	2	1.0
	- > 40,000 Euros	20	9.9
Respondents		202	100.0

Source: own processing

Table 1: Demographic characteristics of the sample.

Before administering the questionnaire, a conjoint experiment was conducted with the interviewees. According to the conjoint analysis approach, we assumed that the pizza descriptors could be expressed through a sequence of specific attributes and levels since the total utility that theconsumer gets fromthe product is determined by the partial utilities (part-worths) of each attribute level (Krystallis and Ness, 2005, Di Vita et al., 2013).

To reduce the number of pizza profiles evaluated by respondents and to facilitate the identification of attribute combinations that would maximise their utility to the consumer, eight different combinations of attributes and levels were presented (Table 2). The conjoint card was obtained by orthogonalizing all the attributes (including price levels) to remove collinearity. According to previous research, a fractional factorial design was applied to test attribute effects on respondents' preferences (Harrison et al., 1998; Campbell et al., 2004; Claret et al., 2012) and an orthogonalization procedure was adopted to get an orthogonal array. To limit the occurrence of investigator bias, consumers performed the conjoint card alone.

The interview was full-profile and was executed using SPSS 15.0 software for Windows which helped identify the combinations of attribute that would maximise utility to the consumer so the rule of additive linear composition was used.

Respondents were presented with eight different pizza profiles, differing in terms of price, organic ingredients, origin, wholegrain wheat and whether fresh or frozen. The final subset of combinations (choice set) which estimated the utility to consumers is presented in Table 2.

Option	Price (€)	Fresh/Frozen	Organic ingredients	Energy-Reduced wheat
1	4.0	Frozen	Yes	Yes
2	5.5	Fresh	Yes	No
3	2.5	Fresh	Yes	Yes
4	4.0	Fresh	No	No
5	2.5	Frozen	No	No
6	5.5	Frozen	No	Yes
7	2.5	Fresh	No	Yes
8	2.5	Frozen	Yes	No

Source: own processing

Table 2: Description of the choice set.

Results and discussion

The results were presented in two different sub-sections, the first reports and discusses the results derived from univariate analysis, while the second focuses on the consumer's perception of pizza attributes and presents the results of the conjoint analysis and discusses the main outcomes.

By taking into account pizza consumption behaviours and habits, all the sample declared to having eaten pizza regularly, and 99% of them reveal having eaten this product over more than two years. Nevertheless, as reported in table 3, the frequency of pizza consumption varies a lot: the majority of the sample (38.1%) declared to eating pizza regularly, at least once a week, while 32.2% declared to purchasing it occasionally at least once a month. Surprisingly, almost a third of the sample (29.7%) eat pizza 'frequently', or 2–3 times a week.

Item	Mean	Respondents
Weekly (one time a week)	38.1	77
Monthly (at least one time a month)	32.2	65
Frequently (2-3 times a week)	29.7	60
TOTAL	**100.0**	202

Source: own processing

Table 3: Frequency of pizza consumption.

With regard to pizza purchase venues (Table 4), 'takeaway pizzerias' were identified as the leading outlet by respondents (30%). This

initial result reflects analogous trends in other western countries such as the USA where takeaway pizza is the leading product on the market (Statista, 2015). Furthermore, this result is in line with current trends of meal and beverage consumption, where consumers are more inclined nowadays to have lunch out, and where takeaway or delivered meals are progressively gaining popularity, particularly in the Italian agro-food market (Censis, 2010; Di Vita et al., 2015).

Pizza restaurants are in second place (28.3%) by sample, confirming their important role in the Italian life-style, since going out to restaurants at weekends is fairly widespread among Italian families, more than 80% of Italians eating out at least once a week (Censis, 2010).

The remaining outlets are closely linked to characteristic Italian diversified food services as well as to food consumption culture in Italy. Bakeries and snack bars, each represent 16 % of outlets where pizza is produced and supplied. Finally, only 10.1% declare they buy pizza in large retail stores (hypermarkets and supermarkets).

These outcomes point to a close correlation between hand-crafted pizzas and southern consumers, thus highlighting the direct relationship between pizza-makers and their customers which induces consumers to prefer buying directly from restaurants or takeaway pizzerias, rather than purchasing pizzas in bakeries, snack bars or cafés let alone in large retail stores like supermarkets.

Item	Mean	S.D.
Takeaway Pizzeria	30.2	0.72
Pizza Restaurant	28.3	0.74
Bakery	16.0	0.70
Snack bar and cafè	15.4	0.76
Large retail	10.1	0.71
TOTAL	**100.0**	

Source: own processing

Table 4: Purchasing places of pizza preferred by sample.

In restaurant pizzerias or takeaway pizzerias the owner is often the one who produces the pizza which means that usually the owner himself establishes a fidelity relationship with his customers, compared to other outlets where operators change in quick succession according to planned daily shifts. These results confirm that a direct relationship with the producer represents an important consumer loyalty strategy, as previously reported in other studies on locally produced foods (D'Amico et al., 2014; Giampietri et al., 2016).

Respondents were asked to identify the main reasons they ate pizza. For 37.1% of respondents, 'taste' is the primary reason why almost four in ten consumers like eating pizza. This result also confirms the popular worth and appreciation of pizza in the Italian diet (Leclercq et al., 2009) also suggesting that the pizza consumption is dictated primarily by 'gastronomic passion'.

Concerning any additional motivations which encourage respondents to eat pizza (Table 5), it has emerged that 25.1% of the sample do so because of their 'nutritional properties', while 19.6% eat pizza because it's cheap.

Item	Mean	S.D.
Taste	37.1	0.7
Nutritional properties	25.2	0.7
Cheapness	19.6	1.0
Healthy food	18.1	0.9
TOTAL	**100.0**	

Source: own processing

Table 5: Motivations for pizza consumption.

These last two results, suggest firstly that pizza is perceived as suitable for a balanced diet and therefore not perceived as 'junk food' as opposed to observations in a recent study in the USA (Combet et al., 2014). This discrepancy probably depends on the different eating patterns among countries, since hand-crafted pizza is a traditional food in Italy while in the Anglo-Saxon countries most pizza is industrially made. Secondly, respondents are influenced by the cheapness of pizza; this outcome certainly represents an important marketing tool in western countries given the current economic crisis which also involves food consumption dynamics.

Furthermore, despite no studies consider pizza as nutritionally undesirable (Devine et al., 2007), a significant proportion of respondents (18.2%) surprisingly declared they ate pizza because it is 'healthy'. This perception would seem to be in line with a recent study reporting that pizza consumption is negatively correlated with cancer occurrence (Gallus et al., 2006), so the improvement in pizza composition and ingredients could therefore have had a positive impact on preventing ill-health and ensuring optimum energy intake (Combet et al., 2014). Our results are further corroborated by another study arguing that consumers perceived

pizza as a healthy and convenient food (Singh and Goyal, 2011a). This is consistent with a previous study arguing that consumers consider cereal products as good for their health (Arvola et al., 2007).

Finally, a Likert scale was proposed to consumers to test the main descriptors and quality attributes in evaluating pizza (Table 6). As widely reported in existing literature, quality cues for pizza were divided into intrinsic and extrinsic attributes (Acebrón and Dopico, 2000; Migliore et al., 2015; Campbell et al., 2004) to identify the optimum pizza quality levels.

According to previous research which identified four classes of sensory attributes for pizzas appearance, aroma, taste/flavour and texture (Moskowitz, 2001), the study aimed at identifying the main determinants in the sensory evaluation of pizza.

In our study we included some new parameters such as saltiness, crust colour, crunchiness, softness and the gumminess of the dough. Respondents were asked to identify and rank, using a seven point scale, the most important intrinsic characteristics of pizza. Consumer awareness of the sensory attributes of pizza - due to type of wheat, crust and salt (Moskowitz, 2001) - was confirmed by favourable evaluations of taste, aroma, crust colour and crunchiness, whose appreciation levels were between 6.8 and 5.9. However, a large proportion of the sample did not seem to be so well-informed about the negative effects of salt on health. Although the dissemination of many scientific studies and reports have shown how important low-salt diets are, saltiness endures as a rather well-requested attribute. By contrast, the softness and gumminess of dough are qualitative attributes scarcely or negatively appreciated.

Concerning the extrinsic attributes of pizza, local raw ingredients scored highest, confirming the importance that locally produced food has in the eye of consumers (Cranfield et al., 2012; D'Amico et al., 2014; Cembalo et al., 2013; Cosmina et al., 2016).

Somewhat less but certainly significant was the use of nationally sourced wheat, price and low environmental impact production. Nationally sourced wheat seems to reinforce current studies on southern Italian consumers who are willing to pay more for local products highlighting broad correspondence between the origin of a consumer and the food (Panzone et al., 2016, Scozzafava et al., 2014). While price, despite negatively correlating to utility, confirms its role in indicating the quality of food, since consumers use price to infer unobservable quality (Panzone, 2012).

Concerning environmental issues, earlier research pointed out that eating and nutrition behaviors are deeply influenced by environmental consciousness and context (D'Amico et al., 2016; Story et al., 2008). In this regard, our results seem to be consistent, highlighting how the availability of healthy products in nearby stores, can contribute to enhancing healthier and more sustainable eating patterns (Glanz et al., 2007).

Despite recent research pointing out the importance of packaging as an extrinsic quality attribute for fresh as well as processed produce (Ragaert et al., 2004; Koutsimanis et al., 2012), pizza packaging was perceived as a scarcely important extrinsic characteristic. This is consistent for consumers who expressed a preference for purchasing fresh pizza - the majority of the examined sample - while it could be interesting to examine the importance of this extrinsic attribute for frozen pizza's usual consumers.

In the last part of the analysis based on descriptive

Intrinsic characteristics		**Extrinsic characteristics**	
Taste	6.8	Local raw material	6.1
Aroma	6.4	National origin of wheat ??	5.8
Color of crust	6.0	Price	5.6
Crunchiness (crusty)	5.9	Low environmental impact production	5.5
Saltiness	5.3	Packaging	4.6
Softness of dough	4.8		
Gumminess of dough	1.9		

Note: 1 = less positive, 7 = more positive

Source: own processing

Table 6: Quality attributes in evaluating pizza.

statistics, consumers were asked to express their intention to pay more for organic and/or energy-reduced pizza (Table 7).

According to our results, it is reasonable to consider as positive consumers' intention to buy and pay a premium price for new typologies of pizza. The intention to buy appears quite important for both types though organic pizza records the highest average values (69.3%).

Concerning the intention to pay a premium price, the results were positively significant for prices between 10-20% higher, while consumers' willingness to pay more for a pizza considered healthier, does not exceed a 30% higher price.

Conversely, consumers appeared to be scarcely disposed to pay premium prices, of 30% and 40% respectively, for organic pizza and energy-reduced pizza.

Overall, this last result indicates that pizza consumers are also potentially willing to spend more for a healthier product which confirms the growing interest in functional and organic products (Bonanno, 2013; Zanoli et al., 2013). These outcomes are consistent with previous studies that found healthiness as a driver in the decision-making of Italians to buy agro-food produce (Di Vita et al., 2014; Wongprawmas et al., 2016; D'Amico et al., 2016, Vernau et a., 2014, Panico et al., 2014).

The second part of the analysis concerned evaluating preference by using conjoint analysis. As reported in the methodology section, consumers were presented with eight different pizza profiles ranging in price from €2.50 to €5.50, with differing freshness, presence or absence of organic ingredients, and low or normal calories. Energy-reduced pizza was presented as low-calorie pizza due to the use of whole meal wheat flour. According to Regulation CE n.1924/2006, a "food is energy-reduced only when the energy value is reduced by at least 30 %, with an indication of the characteristics which make the food reduced in its total energy value".

Subsequently consumers were then asked to rank the different pizza profiles according to preference (utility) from 1 (least preferred) to 8 (most preferred).

The results of the conjoint analysis, reported in Table 8, show that the most important attribute is the traditional typology, handmade fresh pizza showing 72.87% of utility, while price represents the second attribute to which consumers assign 12.72% of utility.

	Intention to buy	Premium price			
	(%)	10%	20%	30%	40%
ORGANIC PIZZA	**69.3**	39.1	39.1	20.3	1.5
ENERGY REDUCED PIZZA	**54.0**	54.0	32.2	13.4	0.5

Source: own processing

Table 7: Intention to buy and to pay a premium price.

Attribute	Level	Mean	
Typology		72.8	
	Fresh		17153
	Frozen		-17153
Price €		12.7	
	2:50		-0.1584
	4:00		0.3787
	5:50		-0.2203
Organic ingredient		3.3	
	yes		0.0767
	no		-0.0767
Low in calories		11.2	
	yes		-0.2624
	no		0.2624
Constant			4.5396

Source: own processing

Table 8: Conjoint analysis results.

At the same time, according to respondents' opinions, it emerges that new typologies of pizza don't seem to engage southern Italian consumers, so low-calorie pizzas is negatively correlated with quality while the sample showed a positive but limited propensity towards pizza made with organic ingredients. This corroborates official statistics and current research which show Italian consumers' increasing interest in organic food products (Di Vita et al., 2014; D'Amico et al., 2016), thus also confirming pizza consumers' increasing interest in environmentally-friendly products (Zanoli et al., 2012).

At the same time, the negative coefficient for the attribute "low in calories" - a whole grain flour pizza, confirms the limited interest of Italian consumers towards foods containing wholegrain, since Italian consumers perceive fewer differences in benefits between wholegrain and refined cereal products (Saba et al., 2010). This outcome might be explained by the fact that Italian consumers consider wholegrain foods to be less tasty compared to the corresponding white-flour alternatives (Arvola et al., 2007; Saba et al., 2010).

The processed data was called the 'ideal profile' of Italian pizza consumers and showed that a Margherita has to be fresh and hand-crafted, with a price of €4, prepared with organic ingredients and have a 'normal' calorie count. The results were also confirmed by Pearson's r and Kendall's t values which provides an indication of the model's degree of adaptation to the observed data.

Conclusion

Margherita pizza has become widespread throughout the world, because of its simplicity and taste. Given its significance in Italian diet patterns, this paper shows for the first time the qualitative profile of pizza as perceived by the Italian consumer.

The survey included a descriptive statistical and conjoint analysis to identify the main drivers of consumer interest in margherita pizza and verify consumer acceptance of new typologies of product available on the market.

Despite current research efforts to extend pizza shelf life, with new refrigeration techniques and modified atmosphere packaging (Singh and Coyal, 2011), the sample of Italian consumers we analyzed primarily prefer to eat traditional pizza. This last outcome is certainly due to the fact that pizza restaurants are very common and widespread both in small towns and in metropolitan areas. At the same time, respondents prefer mainly organic food ingredients rather than conventional ones which means that organic ingredients lead consumers to positively perceive the image of a quality product, although within a price increase not exceeding 20%.

On the basis of the first results of this survey, the appeal of low-calorie pizza appears to be limited, consumers still not being well informed and this is probably not helped by its rarity in local pizza restaurants. Wider availability could have a positive impact on consumers'.

In addition, despite the frozen pizza market being fairly well-established and it is one of the most important product among purchased frozen food (Weakfiled and Inman, 2003; Albuquerque and Bronnenberg, 2009), our study observes a strong propensity towards buying fresh pizza on the traditional market denoting how rooted the linkage is between Italian consumers and traditional pizza. The widespread availability of ready-to-serve pizza, such as frozen pizza is still of limited interest among respondents and although this kind of pizza is certainly not perceived as a high-quality food, its convenience as a quick meal is likely to see increased consumption in the future also in Italy.

Furthermore, consumers seem willing to demand healthy product nutrients with a low calorie content, since slightly more than half of the respondents declare their intention to buy energy-reduced pizza, paying an additional price up to 10 to 20% more. The acceptability of new typologies of pizza, such as organic or energy-reduced ones, will depend also on consumer awareness of any perceived health risks.

Finally, this paper also has implications for pizza restaurant owners suggesting the growing potential in diversifying the product both for themselves and for frozen pizza producers. Our study also suggests that the quality of raw materials can't be the only lever that encourages the consumption of pizza; nowadays food consumers require more added services than in the past, such as safety, environmental friendliness and nutritionally balanced food. As a consequence, the results recommend investing in both quality and healthy food consumption, since the consumption of pizza, like that for traditional food products, is not only a gastronomic experience but also an emotional experience.

Notwithstanding some limitations in this study due to the relatively small number of observations and limited geographic area of the survey,

the socio-economic and geographic connotations of the sample allow the results to be reasonably extended to the current Italian scenario. Further research could analyse consumer behaviours taking into account the influence of socio-demographic characteristics focusing especially on gender, age and income as well as aspects related to the comfort food consumption of pizza consumers. Finally, another strand of interesting investigation could verify whether differences exist between different regional identity groups of traditional Italian consumers as well as across non-traditional consumers from different European countries."

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Measurement and Analysis of Quality of Service of Mobile Networks in Afghanistan – End User Perspective

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Abstract

Enhanced Quality of Service (QoS) and satisfaction of mobile phone user are major concerns of a service provider. In order to manage network efficiently and to provide enhanced end – to – end Quality of Experience (QoE), operator is expected to measure and analyze QoS from various perspectives and at different relevant points of network. The scope of this paper is measurement and statistically analysis of QoS of mobile networks from end user perspective in Afghanistan. The study is based on primary data collected on random basis from 1,515 mobile phone users of five cellular operators. The paper furthermore proposes adequate technical solutions to mobile operators in order to address existing challenges in the area of QoS and to remain competitive in the market. Based on the result of processed data, considering geographical locations, population and telecom regulations of the government, authors recommend deployment of small cells (SCs), increasing number of regular performance tests, optimal placement of base stations, increasing number of carriers, and high order sectorization as proposed technical solutions.

Keywords

Quality of service, quality of experience, quality of service parameters, mobile network, end user, data measurement, statistical analysis, Afghanistan.

Habibi, A. M., Ulman, M., Vaněk, J. and Pavlík, J. (2016) "Measurement and Analysis of Quality of Service of Mobile Networks in Afghanistan – End User Perspective", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 73 - 84. ISSN 1804-1930, DOI 10.7160/aol.2016.080407.

Introduction

Existing heterogeneous environment of wireless networks is a complex mixture of Long – Term Evolution (LTE), LTE – Advanced (LTE – A), Wireless Fidelity (Wi-Fi), Universal Mobile Telecommunications System (UMTS), High Speed Packet Access (HSPA) and even General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE) (Damnjanovic, et al., 2011). Massive deployment of diverse access technologies improves QoS and increase end user satisfaction but raises many challenges e.g. network complexity, radio resource management, mobility management, etc. (Vondra and Becvar, 2016). On the other hand, end user demand for enhanced quality of data service and multimedia applications is dramatically growing (Olwal, 2016), which is moving researchers, standardization bodies, vendors and operators forward to introduce new techniques and propose various schemes in the area of QoS.

QoS in communication network is the capability of a service provider to provide satisfactory end – to – end service for its end user which includes voice quality of telephony service, signal strength, service availability, low call blocking and dropping probability, minimum delay, high data rates for data service, multimedia applications, etc. The International Telecommunication Union (ITU) has defined QoS as, '*totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service*' (ITU, 2008). Mobile phone user not only evaluates the performance of a cellular network but considers so called QoE i.e. the price of the service, the perceived quality of both content and the easy use of an application or of the mobile equipment. According to the European Qualinet Community, the QoE is '*the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the users*' personality and current state' (Callet, et al., 2013).

There is clear difference between QoS and QoE. While QoS deals with performance aspects

of physical system, QoE deals with end user assessment of a system. QoS has technology-oriented approach and it relies on analytic approaches and empirical or simulative measurements, but QoE requires a multi-disciplinary and multi-methodological approach for its understanding. It is crucial to remember that QoE is highly dependent on QoS, because the technical performance of a system has significant impact on some dimensions of QoE (Callet, et al., 2013).

The end user satisfaction with the service directly depends on the quality and performance of network, therefore, measurement of network performance and assessment of QoS are fundamentally important. As a basic fact, an operator that provides enhanced QoS comparing to an operator that offers poor QoS has better chance to attract new customers and keep them for longer period of time (Dobrota, et al., 2012). Hence, it is essential for operators to regularly measure QoS and subsequently deal with possible challenges and address the grievances of network user(s). The measurement and analyzing process of QoS in existing heterogeneous environment is one of the challenging tasks for service providers. But the main advantage is that it enables operators to manage network in more efficient manner.

In order to measure and analyze QoS, certain parameters should be considered. Throughput, bandwidth, delay, latency, low data rate, blocked call, dropped call, packet loss rate, packet error rate, etc. are determined to be measured and analyzed as QoS parameters.

Rural and urban areas have been equally in concern about enhanced QoS of mobile network. One of the initiatives of providing of enhanced QoS to both urban and rural areas is the Digital Agenda for Europe which sets the goal to provide fast internet access to all European citizens and to take it up to 100 Mbps download rate to at least 50% of European households by 2020 (European Commission, 2010). However, the costs of deploying a fixed broadband network outside an urban area is on average higher than the cost of deploying the network in the town or village – especially when costs per household are calculated (Mason, 2008). The digital divide and deficiency of fast Internet access in rural areas still constitute an issue in the European Union (EU) member states such as the Czech Republic (Vaněk, et al., 2010).

Enhanced QoS is not only important for operators and end users, but also has impact on the worldwide ranking of communication sector of a country. Out of 167 countries, South Korea, Denmark and Iceland are on the top because of their telecom networks provide enhanced QoS. Afghanistan is placed on 156th number of the ranking list (ITU, 2015).

Mobile communication sector of Afghanistan has had tremendous growth over the last decade. Over 89% of populated area of the country is covered by telecom service; there are 6,501 installed Base Stations (BSs), 25,080,389 people have access to mobile phones, 1,910,178 are 3G broadband subscribers, 1,856,781 are internet subscribers and around 2.4 billion USD have been invested in the sector, which has resulted in long-term economic growth in the country (ATRA, 2015). So far, approximately 3,100 kilometers of optical fibers have been laid and each operator has its own high capacity microwave backbone.

Afghanistan Telecom Regulatory Authority (ATRA) collects the QoS assessment reports monthly, quarterly and annually provided by mobile operators through post-measurement tests i.e. drive test, etc. (ATRA, 2003). Until now, no research is conducted and no study is undertaken to measure and analyze QoS from either end user or technical perspective in Afghanistan. The reports collected on QoS by ATRA are not published publicly for reference purposes. Therefore, this study is also going to serve as a baseline and reference for further research on QoS in the country. The study discovers all dimensions of QoS that mobile phone users prefer. It furthermore proposes adequate technical solutions for cellular operators in order to enhance QoS and to remain competitive in the market.

The rest of the paper is organized in the following order: In *Literature review*, necessary background and related work is provided. Research methodology and materials are discussed in *Materials and methods* section. Data measurement and statistical analysis are provided in *Results and discussion* section. The adequate solutions are stated in the *Proposed technical solutions* section. The paper is compared with similar studies in *Competitive studies* section. The final part of the paper provides conclusions based on the findings.

Literature review

There are several available studies which measure and analyze QoS of telecommunication networks i.e. regular assessment of network performance, end user survey, etc. Some of the most recent existing literatures which measure and furthermore statistically analyze QoS of mobile networks from end user perspective are described in this part. Majority of these papers provide a detailed insight

into the QoS dimensions of cellular networks and recommend operators to consider satisfaction of end user as one of the most required and competitive parameters in order to remain stable in current fastest – growing and challenging technological environment.

It is stated in (Aydin and Ozer, 2005), that satisfaction of end user from an operator is associated with wide and improved network coverage, efficient customer service, enhanced QoS, and fulfilling the expectation of mobile phone user. Studies in Hong Kong (Woo and Fock, 1999), China (Wang and Lo, 2002) and South Korea (Kim, et al., 2004) have found mutual factors i.e. wide and improved network coverage, reasonable pricing policies, enhanced QoS (both voice and data), value added services and customer support.

Both (Sukumar, 2007) and (Vasundhara et al., 2016) have discovered call rates, brand image, facilitation role of front line employees, quality of network, and sale promotion packages as key dimensions of end user satisfaction.

A study has recently been conducted in Pakistan discovered that service quality, price rate, brand image, sale promotion and network coverage have significant impact on end user satisfaction (Iqbal, 2016). While, the research which has been carried out by (Khan, 2010) found that tangibles, reliability, responsiveness, convenience, assurance, empathy, and network quality have statistical significance relationship with QoS.

Recently, a number of studies for example (Sharma, 2014) in Riyadh region of Saudi Arabia, (Shefali & Riddhi, 2014) in the Ahmedabad city of India, (Khayyat & Heshmati, 2012) in the Kurdistan region of Iraq, and (Ragupathi and Prabu, 2015) has discovered the statistical significance relationship between various factors and overall satisfaction of QoS. Easy use of mobile phone, usefulness of mobile technology, enhanced mobile/data service, level of education, occupation, location, and income status are the factors which have discovered in these papers.

The QoS of mobile networks and end user satisfaction have been studied in above mentioned papers from different dimensions. But a gap of detailed study in order to measure and analyze user experience toward network, and the most unwanted situations which mobile phone users face with is missing in the literature. Therefore, the objective of this study is measurement and statistically analysis of QoS of mobile networks from end user perspective in Afghanistan and furthermore proposing of adequate technical solutions. In total, three hypotheses are tested and the relationship between categorical variables are determined. The research is furthermore compared with three similar studies and it is proved that, the paper is on one hand deeply and thoroughly covers feelings of end users from QoS and on the other hand recommends operators to deploy the most advanced and efficient schemes in their networks in order to improve QoS and to provide enhanced end to end QoE.

Materials and methods

The survey of this research was originally conducted to study QoS and network coverage of mobile networks in Afghanistan, but primary data only related to QoS is measured and analyzed in this paper. The questionnaire (containing 15 questions) was prepared in English, Pashto and Dari Languages. All technical terms in the questionnaire were explained in such a way which were easily understandable for ordinary mobile phone users. The survey only covers end user practices, therefore, an effective evaluation method of multiple – choice questionnaire has been used.

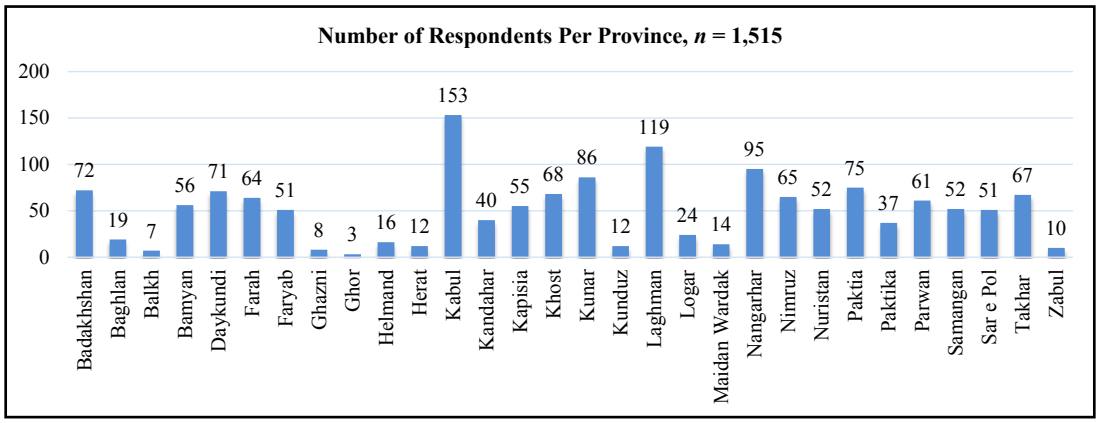
In the beginning, authors conducted a pilot survey on a small group of mobile phone users through in – person interviews in Kabul in order to test questionnaire. Based on feedbacks from the target group of respondents, necessary change has been brought in strategy as well as confirmed the final draft of survey. Authors have subsequently employed mix – mode technique in data collection from 1,515 mobile phone users during (August – December) 2015. It specifically means, that 812 respondents were collected over the internet using Google Docs from 30 provinces and 703 respondents were interviewed in – person by volunteer surveyors within 14 specific provinces.

Total number of respondents attended the survey from all 30 provinces are shown in Figure 1. The average number of respondents per province (mean) is 50.5.

Results and discussion

Data measurement

All respondents have answered about their level of education, favorite mobile operator, and the purpose of mobile phone usage. Of those respondents, 1,458 were using mobile phones for telephony service, therefore, this number is



Source: Own processing

Figure 1: Number of respondents per province.

considered as random sample size for measurement of QoS and the unwanted situations of mobile telephony. 856 were using mobile internet service, thus, it is considered as random sample size for measurement and analyzing of usage of various mobile internet technologies as well as QoS and the unwanted situations related to mobile internet.

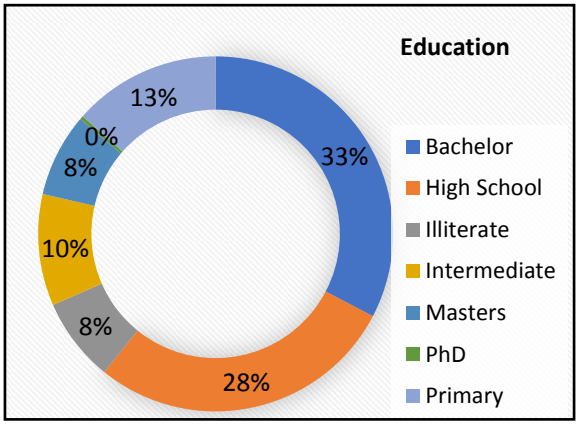


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Figure 2: Level of education of mobile users.

Education has significant role in removing of barriers on the way to access/use mobile phone (Primo, 2003). Therefore, level of education of end users has been asked in the survey in order to find the importance of level of education in access/usage of mobile service in the country. Based on the result shown in Figure 2, only 8% of mobile phone users are illiterate, while, the rest are having various levels of education.

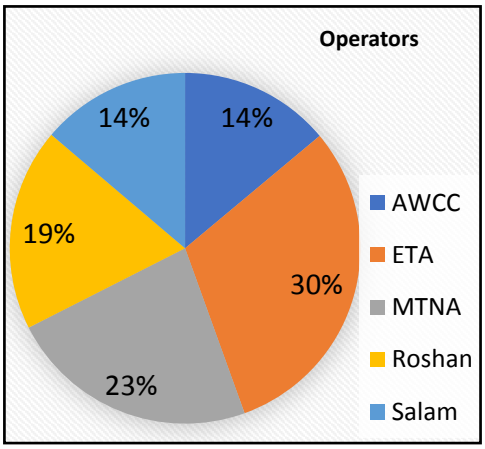

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Figure 3: Mobile GSM operators.

Afghan Wireless Communication Company (AWCC), Etisalat – Afghanistan (ETA), Mobile Telecommunications Networks – Afghanistan (MTNA), Roshan and Salam are currently five GSM operators, operating inside the country. As shown in Figure 3, end users were asked about their favorite cellular operators in order to find out the leading service provider in the market.

Mobile users use a cellular phone to send/receive messages, access to the internet, send/receive email, download apps, get directions, participate in a video call, 'Check in' or share location, and so on. In the questionnaire, all of the mentioned applications of mobile phone are divided into three categories, mobile for internet purpose, mobile for telephony purpose and mobile for both internet and telephony purposes.

The result of the survey in Figure 4 shows that 48% of end users use mobile phone only for telephony service, 48% more for both internet/

telephony purposes, and only 4% of users use mobile internet in the country.

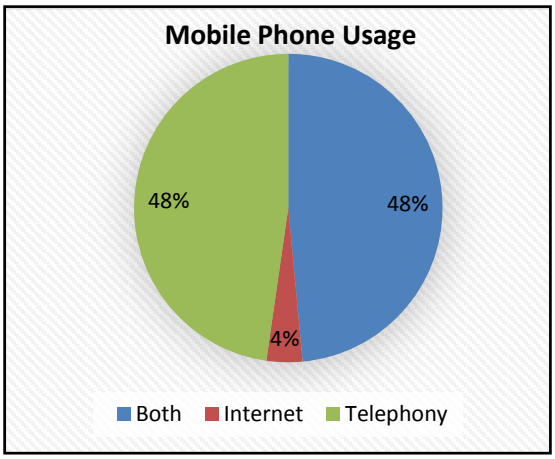

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Figure 4: Mobile phone usage.

For the time being, the most advanced mobile technology which is provided by all operators in the country is UMTS. While there are still some areas which are covered by EDGE, GPRS and in some cases the end users use one of these mobile internet technologies as Wi-Fi in their homes or small offices. The result of the survey in Figure 5 shows that roughly third out of fourth of end users use 3G (UMTS) service, 14% EDGE, 7% GPRS, and 6% use mobile internet technologies for Wi-Fi purposes.

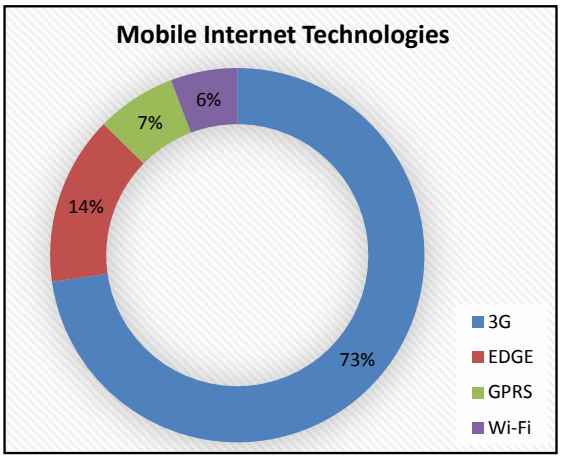

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Figure 5: Mobile internet technologies.

The end users were asked about their satisfaction from QoS of mobile telephony. The result in Figure 6 shows that roughly half of the end users (45%) are satisfied, 8% very satisfied, 16% unsatisfied, 28% neutral, and 3% are very unsatisfied.

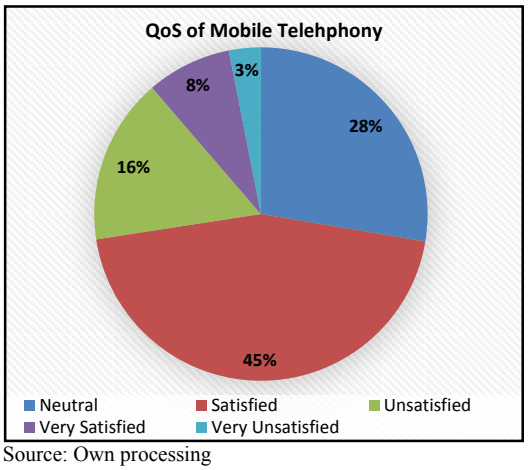

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Figure 6: Satisfaction of end users from QoS of mobile telephony.

The survey explores the events which occur during/ before telephony conversation and furthermore decrease the satisfaction of end users of mobile networks. The users were asked about the most unwanted situations they have been facing, i.e. blocked calls, dropped calls, echo, Low Signal Intensity (LSI) and noise. There are more other technical parameters and events, i.e. packet loss which effect on the quality of telephony service, but due to lack of technical expertise of end user they are not considered in this research.

The result of the survey shown in Figure 7 indicates that 32% of end users were complaining from LSI, 18% from blocked calls, 17% from dropped calls, 11% from echo, 14% from noise and 9% of end users were totally satisfied with QoS of mobile telephony and were not experiencing none of the above five mentioned phenomena during or before telephony conversations. The respondents were able to select only one option which they have mostly experienced.

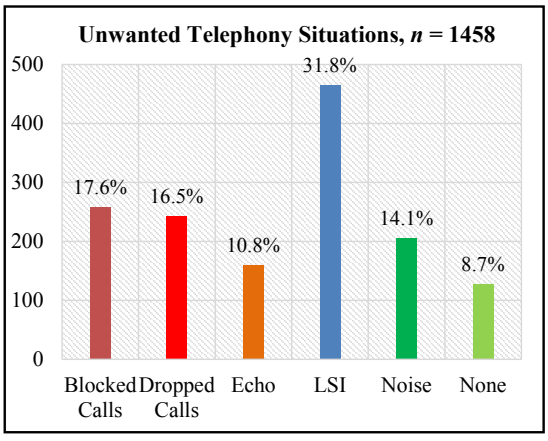

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Figure 7: Unwanted mobile telephony events.

As mentioned earlier, of those1,515 respondents, 856 were using mobile internet service, therefore, this number is going to consider as sample size for measurement and analyzing of satisfaction of end user from QoS of mobile internet as well as the events which occur while mobile internet usage. The result of the data shown in Figure – 8 declares that 22% of end users are neutral, 29% satisfied, 32% unsatisfied, 5% very satisfied, and 12% are very unsatisfied.

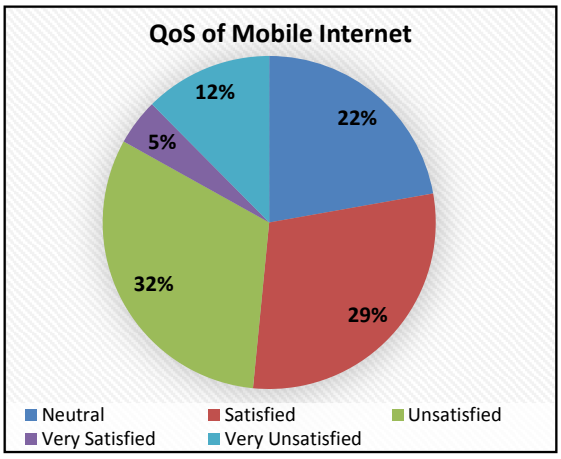

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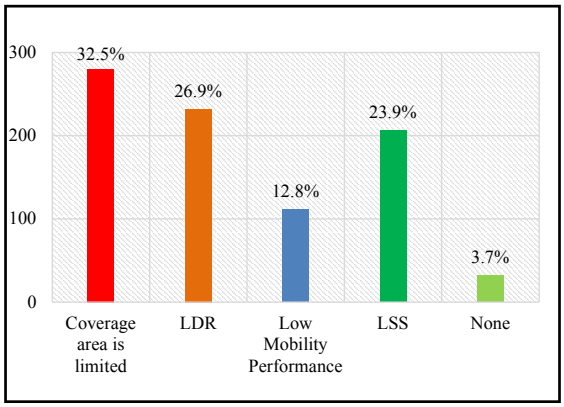
Figure 8: Satisfaction of end users from QoS of mobile internet.

The end users were further asked about the events which occur while mobile internet usage. The result in Figure 9 indicates that 33% of end users were complaining from limited coverage area of mobile internet, 27% from Low Data Rate (LDR), 13% from low mobility performance, 24% from Low Signal Strength (LSS), and 4% were not experiencing none of the above events while mobile internet usage. End users were able to select only one choice out of five for this question.



Source: Own processing

Figure 9: Unwanted mobile internet events.

Statistical analysis

There are in total six categorical variables which create three hypotheses in collected data of this survey related to the QoS of mobile networks in Afghanistan. Associations between these variables are expected to be tested, therefore, Goodness-of-Fit (*Chi-Square*) test has been chosen to deploy on each of the hypotheses in order to find dependency between them. To test dependency, hypothesis is needed to be stated, the contingency table is expected to be created, the Degrees of Freedom (DF) is to be determined, the significance level is needed to be established, the chi – square test is to be performed, and the *Distribution table* value considering DF is compared with ch-square value respectively.

Before conducting the chi – square test, it is necessary to set up significance level. Authors consider 95% significance level ($\alpha = 0.05$) for all three hypotheses. As shown in Equation 1, it is determined by multiplying of "number of rows minus one" by "number of columns minus one".

$$DF = (r - 1) * (c - 1) \quad (1)$$

r = No. of rows, c = No. of columns

In next step, the below given formula (Equation 2) is used to perform chi – square test.

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i} \quad (2)$$

k = No. of categories, = Chi-square

i = No. of parameters being estimated

O_i = Observed frequency, E_i = Expected frequency

As mentioned earlier, after obtaining the χ^2 value, it should be compared with critical value from the distribution table considering DF. The final decision is made based on this comparison. If the "chi-square value > table value", the hypothesis is rejected, otherwise, it is impossible to reject.

First hypothesis

Is there any dependency between categorical variables of 'Education level' i.e. bachelor, high school, etc. and '*Purpose of Using of Mobile Phone*' i.e. mobile for telephony/internet/both purposes of end users of cellular networks in Afghanistan?

The first step is to state the Null hypothesis (H_0) and Alternative hypothesis (H_1).

- H_0 = There is no association between '*Education Level'* and *'Purpose of Using of Mobile Phone*'.
- H_1 = There is an association between '*Education Level'* and *'Purpose of Using of Mobile Phone*'.

The Statistical Application System (SAS) software is used in order to conduct chi – square test, create contingency table and calculate DF. Based on the results obtained from SAS, the DF and χ^2 values are given below:

χ^2 = 429.9240, DF = 12

The contribution table value considering 12 DF and α = 0.05 is 21.026. As calculated, contribution table value is less than comparing to chi – square test value (429.9240 > 21.026), therefore, the null hypothesis is rejected.

To conclude, there is statistically significant evidence at α = 0.05 that H_0 is false. Thus, it can be claimed that, there is dependency between categorical variables of '*Education level*' and '*Purpose of Using of Mobile Phone*' of end users of cellular networks in Afghanistan. It specifically means that, level of education of an end user does effect on the usage of mobile phone for different usage purposes, i.e. internet, telephony, text sending/receiving, browsing, location update, and so on.

On the other hand, (Sharma, 2014) has been investigated relationship between one of the variables of first hypothesis '*Education level*' with 'satisfaction of mobile phone user' and has found that there is significant difference between both. But, (Ragupathi and Prabu, 2015) have obtained different result and stated that, there is no significant difference between above two variables.

Second hypothesis

Is there any dependency between categorical variables of 'Unwanted Situations' which occurs during/before telephony conversation i.e. blocked calls, dropped calls, etc. and '*Satisfaction of QoS of mobile telephony*' of end user of cellular networks in Afghanistan?

The H_0 and H_1 are stated as following:

- H_0 = There is no dependency between '*Unwanted Situations*' and '*Satisfaction of QoS of mobile telephony*'.
- H_1 = There is a dependency between '*Unwanted Situations*' which occur during telephony and '*Satisfaction of QoS of mobile telephony*'.

Based on the result of SAS, the value of DF and χ^2 for second hypothesis are given below:

χ^2 = 307.4957, DF = 20

The contribution table value considering 20 DF and α = 0.05 is 31.410. Based on this calculation, the contribution table value is less than the chi- square test value (307.4957 > 31.410), therefore, the null hypothesis is rejected.

It is concluded, that there is statistically significant evidence at α = 0.05 that H_0 is rejected. It can be claimed that, there is a dependency between categorical variables of '*Unwanted Situations*' which occur during/before telephony conversation and '*Satisfaction of QoS of mobile telephony*' of end user of cellular networks in Afghanistan. It specifically means that if end users experience unwanted situations during or before telephony conversations, i.e. blocked calls, dropped calls, noise and so on are going to highly decrease their satisfaction from QoS of mobile networks.

There is no study to specifically test the relationship between above mentioned variables. However, (Khan, 2010) has been found that network quality is the most dominant dimension in affecting the customers' perception of mobile phone service quality. On the other hand, (Isabona and Ekpenyong., 2015) have identified that dropped calls and blocked calls are critical in evaluation of service quality.

Third hypothesis

Is there any association between categorical variables of '*Unwanted Situations'* which occur while using mobile internet i.e. low data rate, coverage area is limited, etc. and '*Satisfaction of QoS of mobile internet*' of end user of cellular networks in Afghanistan?

The H_0 and H_1 are stated below.

- H_0 = There is no dependency between '*Unwanted Situations*' and '*Satisfaction of QoS of mobile internet*'.
- H_1 = There is a dependency between '*Unwanted Situations*' and '*Satisfaction of QoS of mobile internet*'.

The value of DF and χ^2 obtained by SAS for third hypothesis are given below.

DF = 16, χ^2 = 139.2927

The contribution table value with α = 0.05

and considering 16 of DF is 26.296, which is less than the test value (139.2927 > 26.296). Therefore, the null hypothesis is rejected.

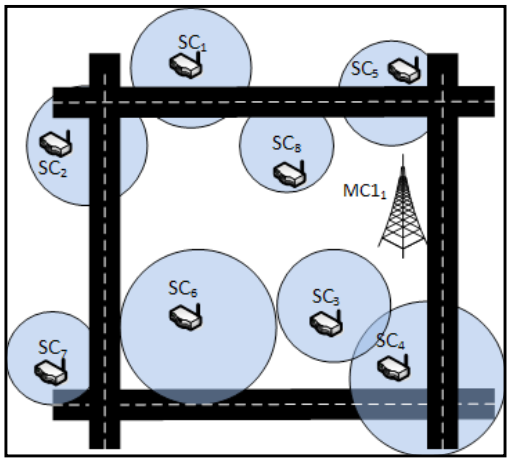
To sum up, based on the result of chi square test, the null hypothesis is rejected, and there is a statistically significant evidence at $\alpha = 0.05$ to show dependency between categorical variables of "*Unwanted Situations*' which occur during usage of mobile internet and '*Satisfaction of QoS of mobile internet*' users in Afghanistan. It specifically means that if end users experience unwanted events during usage of mobile internet i.e. limited coverage area, low data rate, low signal intensity and so on are going to highly decrease their satisfaction from QoS of mobile networks.

Refer to the available literature and alike second hypothesis, there is no study to specifically test the relationship between above mentioned variables. Meanwhile, (Isabona and Ekpenyong., 2015) have tested that poor network coverage decrease service quality which has furthermore negative impact on end user satisfaction.

Proposed technical solutions

There is a couple of schemes which increase performance of a cellular network. Each scheme has its own algorithm which has advantages and disadvantages. Some of the most recent advanced schemes which are efficient to implement are discussed in this part. It is recommended for operators to deploy each of the following schemes in its appropriate location in order to enhance QoS of their networks.

Mobile networks have shifted from being predominantly voice to primarily data. In traditional networks Macro Cells (MCs) were used to cover specific geographical areas. Later on, deployment of small cells composed with macro cells has emerged, which improves cellular coverage, capacity and applications for homes and enterprises as well as metropolitan and rural public spaces. Increased number of small cells in a given zone enhances performance and theoretically serves higher number of users, but many challenges i.e. interference, mobility management, radio resource management and so on are appeared. As shown in Figure 10, MC_1 covers a specific zone. But, later on small cells ($SC_{1, 2, 3, 4, 5, 6, 7 \text{ and } 8}$) are added to the topology in order improve network coverage and enhance QoS.

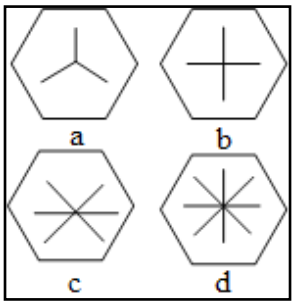


Source: Own processing

Figure 10: Deployment of small cells.

Small cells have short coverage area, therefore, it is recommended to deploy this scheme mostly in urban areas, homes, and enterprise where the density of traffic is high. Moreover, high care should be taken while selecting the position and establishing transmitting power of small base stations which have significant impact on network performance (Kelif, et al., 2013).

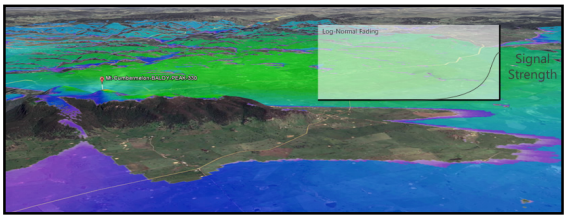
High order sectorization is the second scheme, which is recommended for operators in order to increases capacity and enhances QoS, but cell interference and number of softer – handovers are main challenges which rise with deployment of this scheme. Traditional cellular operators use macro cells with wide beam antennas for wider coverage, but high demand capacity of end users in existing and emerging networks cannot be achieved by deployment of only macro cells (Sheikh and Lempiainen, 2013). Therefore, it is required to achieve maximum practical capacity from macro cells by employing higher order sectorization and by utilizing all possible antenna solutions including smart antennas. As shown in Figure 11 (*a*), coverage area of a cell is divided into three sectors (3*120°). It is noted that cloverleaf layout is offered the lowest interference level which provides best cell and system capacity for macro cells. However, this scheme is not efficient for high density area and current demand of end user, therefore, maximum capacity utilization of macro cells is guaranteed by increasing of number of sectorization as shown in *b* (4*90°), *c* (6*60°), and *d* (8*45°) of Figure 11.



Source: Own processing

Figure 11: High order sectorization.

The placement of both macro and small base stations is a challenging task due to its interference constraints with other cells and proper coverage of a specific area where all users access to enhanced QoS. A method of optimal placement of femto cell in order to increase the QoS in dense environment where macro-cell holds many number of femto cells is discussed by (Kilaru and Gali, 2015). The proposed scheme made an assumption that the interference effect is considerably strong compared to noise. The result of the simulation has shown that the optimal placement has better throughput compare to blind placement in the topology. As shown in Figure - 12, a large area is remained uncovered due to huge amount of blackpost which is caused by wrong selection of tower location. Therefore, optimum location of base station has significant impact on enhancing of QoS.



Source: Telecoantenna, 2015

Figure 12: Optimum location of base station.

Regular post – performance measurement tests i.e. drive test for optimization purpose is a traditional scheme, which is used by all cellular operators. This scheme helps to find existing gaps in network coverage and measure QoS. But, high number of these tests will lead to spend more time, money and personnel in order to collect relevant data and furthermore analyze the problems (Isabona and Obahiagbon, 2014). Therefore, it is necessary to have optimum number of test per time period.

Increasing number of carriers (TRXs) and base station parameters i.e. transmitting power can also be useful schemes to increase QoS considering geographical location and population of the area (Haider, et al., 2009). These methods are helpful to increase the capacity of a base station, which leads to enhance QoE. As far as base station can support a limited number of TRXs, therefore, this scheme will be more efficient if it is combined with one of the mentioned proposed solutions. However, it is crucial to remember that increasing of values of parameters from defined standards rise additional challenges e.g. environmental effect and so on.

As discussed, all proposed technical schemes have its own characteristics – pros and cons. But appropriate time and place of deployment of these schemes require detailed study of geographical location, population of the area, and government regulatory policies.

Competitive studies

Three research papers are compared with this study. The first is exploratory study, performed by (Khayyat and Heshmati, 2012) which discusses mobile phone user satisfaction in the Kurdistan region of Iraq. The second is empirical research conducted by (Khan, 2010) and the third paper analyzes QoS of mobile networks in Pakistan (Iqbal, 2016).

All these papers measured and analyzed QoS and satisfaction of mobile phone users from end user perspective, but have three main drawbacks. The first one is inclusion of some unnecessary parameters and testing of unrelated hypothesis. For example, (Khayyat and Heshmati, 2012) has tested the relationship between age, gender and occupation with satisfaction of end user from QoS. These parameters and hypotheses do not have any impact on QoS of mobile networks, thus, there is no need to test. The second weak point is the exclusion of recommended solutions. Proposing of adequate solutions of author(s) is a major part of a research paper and should be highly considered. The third one is less amount of sample size. Considering geographical location as well as the population of each of area where above three studies were conducted, it would be more efficient if authors collected high number samples to address the issue more accurately.

Therefore, all existing weaknesses in current state of the art were considered and furthermore thoroughly addressed in this paper. Therefore, the strengths of this research are not only in specific measurement and detailed analysis of QoS but also inclusion of recommended technical solutions for operators and considering higher number of sample size than all competitive papers so far.

Conclusion

In this paper, authors measured and statistically analyzed QoS of mobile networks from end user perspective in Afghanistan. A survey was conducted from 1,515 mobile phone users of five cellular operators. In total three hypotheses are tested and the relationship between specific categorical variables have been determined. In order to address existing challenges in the area of QoS of mobile networks in Afghanistan, authors recommended deployment of small cells, increasing number of regular performance tests, optimal placement of base stations, increasing number of carriers, and high order sectorization as adequate technical solutions. Comparison of this research with three similar studies has shown that unlike other papers the research on one hand deeply and thoroughly covered feelings of end users from QoS and on the other hand recommended operators to deploy the most advanced and efficient schemes in their networks. In future work, authors intend to focus on measurement and analysis of QoS of mobile networks from network perspective in Afghanistan.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 20161012 "Potential of the use of Internet of Things impacting regional development and agrarian sector" (In Czech: "Potenciál využití Internet of Things s důrazem na rozvoj regionů a agrárního sektoru").

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Bolegweb Platform – Contribution to the Web Communities

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Abstract

The effective access to and reuse of geospatial information (GI) has come to be of critical value in modern knowledge based society. The standardized web services defined by Open Geospatial Consortium (OGC) are frequently used for the implementation of a spatial data infrastructure (SDI), to expose geospatial data, metadata and models on the Web. These GI are normally stored in an encoded geospatial layer, which is hidden from search engines. SDI uses a catalogue service for the web as a gateway to GI through the metadata defined by ISO standards, which are structurally diverse to OGC metadata. Therefore, a crosswalk needs to be implemented to bridge the OGC resources discovered on mainstream web with those documented by metadata in an SDI to enrich its information extent. We have to build mechanisms allowing entrepreneurs and developers access the information SDI is providing to build their apps. The paper reports a global wide and user friendly platform of OGC resources available on the web with the main goal to ensure and enhance the use of GI within a multidisciplinary context and to bridge the geospatial web from the end-user perspective, thus to open its borders to more web communities. The platform has been developed in the research project Borderless Geospatial Web (Bolegweb).

Keywords

Geospatial Web, Mainstream Web, Geospatial Information, SDI, OGC services, Discovery, Bolegweb.

Kliment, T., Cetl, V., Tuchyňa M., Kliment, M. and Bordogna, G. (2016) "Bolegweb Platform – Contribution to the Web Communities", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 85 - 95. ISSN 1804-1930. DOI 10.7160/aol.2016.080408.

Introduction

Rapid development of Spatial Data Infrastructure (SDI) in Europe triggered by INSPIRE (European Commission, 2007) and other similar initiatives make more and more geospatial information (GI) resources (data, metadata and models) available on the web. The main objective of an SDI is to enable data harmonization, sharing and reuse.. The fundamental component of an SDI which enables users to search and discover the GI resources is metadata, or data about data. Metadata are the first visible component of each SDI for users. In the frame of an SDI, the metadata are usually divided into metadata for geospatial data and metadata for geospatial services. Both are provided in a standardized way by discovery services. A very popular one is the Open Geospatial Consortium (OGC) catalogue service standard, which is implemented by many existing either commercial or open source software solutions. Geospatial data users search for GI resources within an SDI using discovery clients of a Geoportal application (i.e. INSPIRE Geoportal) (Kliment et al., 2013). All aforementioned works effectively when both producers and users are aware of an SDI, corresponding services and how to use them. On the other hand, there are many potential users who are not aware of an SDI. They usually search for GI resources through web search engines such as Google, Yahoo, Bing etc. One such community is represented by the mainstream developers, who might already be aware of data coming from an SDI world; however they need an easy recipe how to integrate the geospatial data into their applications. In addition, there are still many GI data producers making their resources available on the Web without any or incomplete and unstandardized documentation. They would need to create and publish metadata describing their GI resources in a predefined structure in order

to make them discoverable and thus shareable in an SDI. This approach would allow for distributed searches or harvesting of the metadata from different SDI nodes.

State of the art

Discovery of Geospatial Resources: Methodologies, Technologies, and Emergent Applications book (Díaz et al., 2012) presents a collection of attempts to push forward the automated discovery of GI resources. Contributions in the book from different authors provide a wide spectrum of perspectives and possible methods. For the data producers an added value would be to facilitate the production of standardized metadata embedded into data production workflows, link data with metadata, ensure that all changes in data are automatically reflected in metadata. An ability to automatically generate standardized metadata from the content of a harvested data-publishing server would significantly facilitate maintenance and management of the description of large volumes of data as reported in previous research works (Florczyk et al., 2012; Kliment et al., 2015; Kalantari et al., 2016; Giuliani et al., 2016). In addition, many research activities (Abargues et al., 2009; López-Pellicer et al., 2011; Kliment et al., 2013; Hou et al., 2016) have reported that the mainstream web provides significant number of valuable GI resources of several types (e.g. OGC services, KML data, etc.). They can be discovered using the mainstream web search engines. The benefit in comparison with SDI engines (geospatial catalogues) is that the search engine robot automatically crawls the web in order to discover available information resources. GI resources discovered with web search engines may significantly extend the information richness of an SDI, and may be used to extend a specific domain oriented SDI portal with a combination of social media, voluntary geographic information (VGI) (Poorazizi et al., 2015) etc. The importance and relevance of GI discovery can also be seen in industry through the establishment of the Spatial Data on the Web working group by the World Wide Consortium (W3C) in close cooperation with Open Geospatial Consortium (OGC). W3C and OGC are industrial standardization bodies developing open standards for the mainstream and geospatial web. The main objective is to make it easier to publish and use geospatial data on the web. Improving discovery of geospatial data on the Web is recognized as a one of the use cases that demands a combination of geospatial and non-geospatial data sources and techniques. There are two important requirements identified by the W3C and OGC cooperation: i) Crawlability - geospatial data need to be crawlable in the web, to be found and indexed by external agents; ii) Discoverability and accessibility- once geospatial data are published on the web, both humans and machines should be able to discover and access them.

This paper provides the results achieved in the research project Bolegweb, which aimed at the development of a geospatial meta-search crawler platform to collect GI resources accessible online and published on the Web using OGC services, harvest the geospatial metadata and deploy Graphic User and Application Programming Interfaces (GUI and API) facilitating access for wider web communities.

Research goal

The main objective of the project was to design, develop and implement a complex solution for the discovery of GI from OGC web services available on the Internet; generate and share geospatial metadata according to standards that might be facilitated by mainstream, SDI and Semantic web communities. The goal was composed of the following sub-objectives:

- Design and development of an OGC metasearch enhanced crawler for semi-automatic collection of OGC services end points (URLs).
- Publish the metadata describing both OGC services and the content published as geographic layers, tiles, features, coverages, observations through implementations of an SDI catalogue, and thus contribute to the information coverage provided by the current SDI's implementations at any level.
- Design and develop web graphic user and application programming interfaces providing search and access facilities.

Materials and methods

OGC Geospatial Services

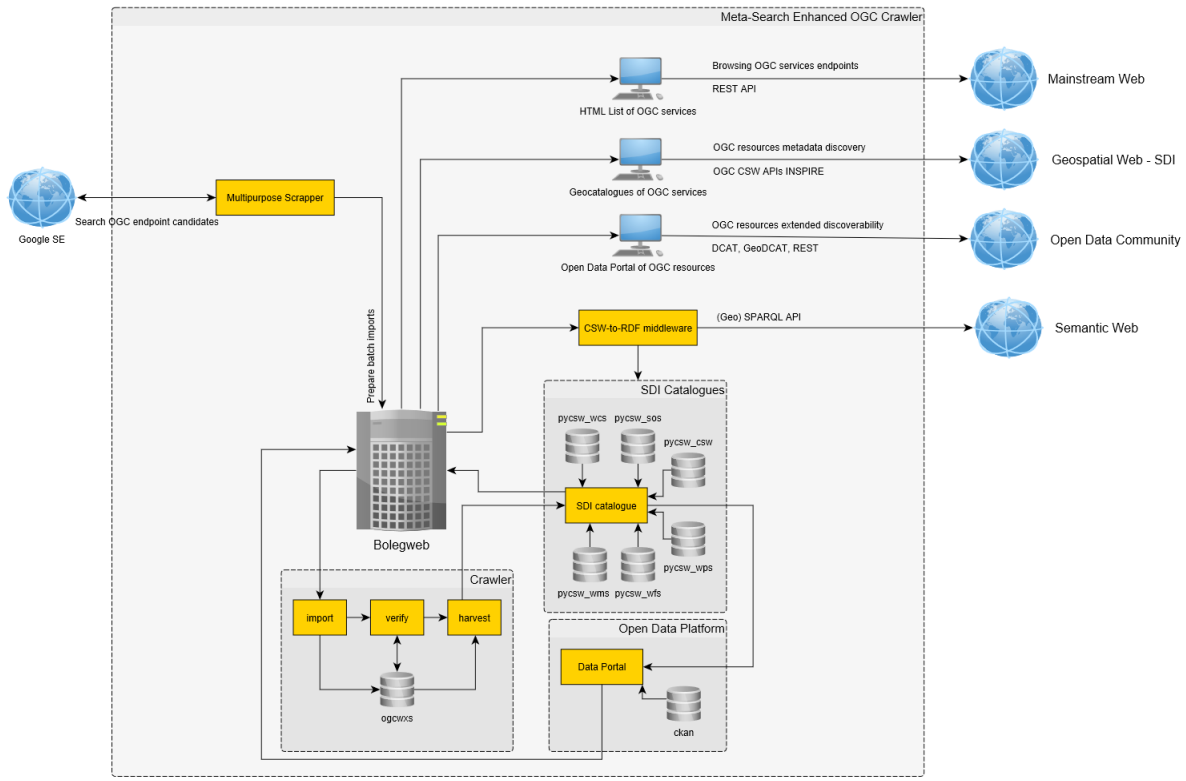
The following seven OGC services and related GI resources have been collected within the Bolegweb project:

1. Web Map Service (WMS) – is the mostly used web service operating on both raster and vector geospatial data and generates map preview with a dynamic way of layer style symbolism each associated with a legend (Blower et al., 2013).

2. Web Feature Service (WFS) – is a web service operating on vector geospatial data and provides query and transactions mechanism to access and retrieve geometric and attribute data at the feature level in real time on the Web (Peng and Zhang, 2004).
3. Web Coverage Service (WCS) – is a web service for accessing and processing of raster data, more generally: coverages (Baumann, 2010) of multidimensional gridded data, extending WMS by formats used for complex modelling and analysis, usually used to encode large datasets for meteorology, oceanography and climatology.
4. Web Processing Service (WPS) – is a web service for creating and distributing web-based functions (Michaelis and Ames, 2009) operating on raster/vector data using as inputs and producing as outputs resulting from analysis executed by the service (e.g. buffering, zonal statistics, nearest feature, shortest path, clipping, etc.).
5. Sensor Observation Service (SOS) – is a web service sharing observational and measurement data collected on a spatial feature by providing the information about observed property (what was measured), feature of interest (where was it measured), procedure (how was it measured), phenomenom time (when was it measured), the data quality and most important the result of the observation (Schleidt, 2013).
6. Catalogue Service for Web (CSW) – is a web service operating on collections of descriptive information (metadata) being created and maintained for geospatial data and services and provides access, filtering and transactions on metadata records. The service has become a major mechanism to catalogue resources and shares links to relevant GI encoded in the metadata (Li et al., 2011).
7. Web Map Tile Service (WMTS) – is a web service operating on map tiles caches of spatially referenced data using pregenerated tile images with predefined content, extent, resolution within a coordinate reference system.

System architecture

The system concept definition of the Bolegweb platform high-level architecture is represented in the architecture schema depicted in Figure 1.



Source: Own processing

Figure 1: Bolegweb system architecture overview.

The overall infrastructure of the Bolegweb system is quite complex and consists of several components. The services collection flow starts with the Google search engine where potential candidates of OGC service endpoints are collected by the Multipurpose Scrapper component using advanced search parameters (e.g. parameter inurl contains strings as "service", "request", "WMS": "inurl:service inurl:WMS inurl:request"). In the next step the results are passed to the Crawler component to process these inputs as follows: (i) Gathered OGC services' endpoints candidates and related information are imported into the crawler database (import); (ii) the Crawler's verification script checks the availability of the collected services and extracts the service type, version, basic quality parameters, server location and other information (verify); (iii) the Harvesting script queries the identified services and related resources for metadata and stores this in an SDI catalogue component (harvest).

The SDI catalogue component is represented by set of Catalogue Service for Web (CSW) interfaces implemented using pycsw, a python based implementation of the OGC's CSW server. pycsw allows for the discovery and publishing of metadata for geospatial resources, and can be deployed as a standalone server or embedded in other applications (Sibolla et al., 2014). We use pycsw as a standalone metadata management system. Individual service types have their own virtual CSW endpoint (e.g. pycsw_wms), where the metadata are harvested for both services and related content.

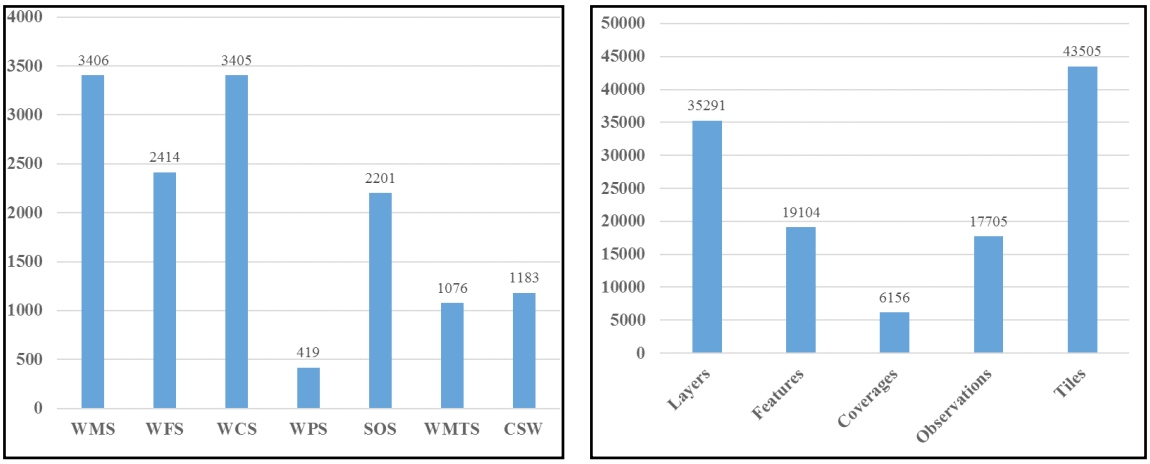
The system provides an extension over the SDI catalogues, which serves as a gateway between SDI and Semantic web communities. CSW-to-RDF middleware is implemented using the TripleGeo-CSW software developed by the GeoKnow project team; this was developed as a proof of concept working with CSWs from public authorities across Europe, which involved datasets complying with the EU INSPIRE Directive. Experience gained testifies that TripleGeo-CSW can assist stakeholders to repurpose existing CSWs with minimal overhead and readily expose spatial metadata on the Semantic Web (Athanasiou et al., 2015). The metadata collected into SDI catalogues from available OGC services are exposed via a GeoSPARQL endpoint; SPARQL queries are parsed to identify filter criteria and generate a corresponding CSW GetRecords request, which is then send to the remote CSW service via HTTP/POST. The CSW service responds with ISO/XML metadata files that are transformed to the RDF/XML form and provide RDF triples in the result set; this RDF response is then returned to the original requester.

For the development of clients' platforms various GUIs and APIs were designed and are being developed. A simple tabular representation of the data about OGC services is provided as a HTML/JavaScript client, with filtering options as well as a simple REST service interface with the same capabilities. A light JavaScript map application allows users to search for the metadata stored in the CSW and display the results. An Open Data Platform based on the data portal implementation CKAN, the world's leading out-of-the-box open-source data portal platform, was deployed. It provides tools to streamline the process of publishing, sharing, finding and using data. It has native capability to harvest several types of open resources, including SDI catalogue CSWs. We use this functionality to collect the metadata about discovered OGC resources managed by SDI catalogues communicating to CSWs and storing this into the CKAN internal data model. Metadata can be exposed to communities using mainstream REST or DCAT as well as geospatial community specific GeoDCAT standards.

Results and discussion

The collection process of OGC services endpoints has been launched in October 2013. This process has been repeated on a monthly basis. The last metasearch process was performed on August 31st and the Crawler database contains a total of 22875 records. It is important to stress that these data also characterize those URLs that do not provide direct links to OGC services, linking instead to a web page, which may after further crawling of URLs provide a link to an access point. However, the current verification step in the crawler workflow does not further investigate those URLs which do not immediately provide an XML type response with a root attribute identifying the OGC Service version. (e.g. <sos:Capabilities version="2.0.0" ….. >). In addition, some of the discovered URLs might no longer be available, or even invalid. After filtering all the potential OGC service candidates, the current database provides interesting numbers of records representing functioning services (Figure 2).

The actual figures change frequently due to the dynamic nature of the Web environment and specifically the geospatial web. Some services available today might be offline or removed tomorrow while new ones may become publicly



Source: Own processing

Figure 2: Number of functioning OGC service endpoint URLs available from the Bolegweb platform and harvested metadata for related GI resources (17 September 2016).

available. The number of available services does not necessarily provide a clear picture of GI availability on the web. Each service serves some type of GI resources as layers, features, etc. In order to understand the extent with this respect, the metadata from individual service endpoints were harvested for both service and related content (WMS Layers, WFS Features, WCS Coverages, etc.) and the results are represented by the chart in Figure 2, right part. However, the number of metadata records does not fully correspond to the number the OGC services due to various reasons as follows: i) not all versions of OGC services were harvested; ii) some of the supported services were not harvested due to exceptions raised during the harvesting requests. These facts decreased the final number of metadata records and will have to be resolved in future work by extending the functionality of pycsw and resolving the exception errors. Nevertheless, with regard to the main objective of the Bolegweb project, we were able to reach the goal of providing interfaces to the collected GI resources for wider web communities by deploying existing solutions and developing new ones where required, as described in the following section.

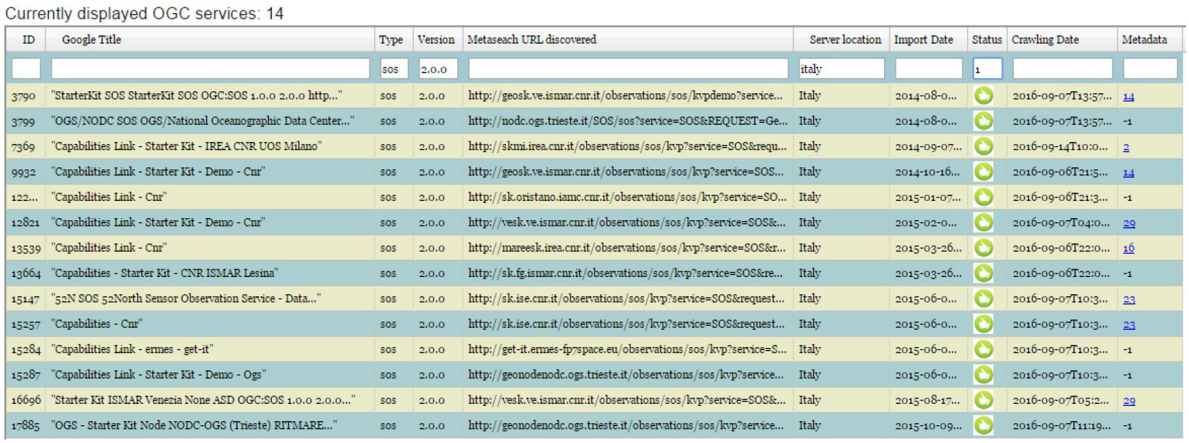
Mainstream web community

For the mainstream web community, represented by the entrepreneurs and developers having interest in discovering GI served by OGC services in an easy and straightforward manner, both GUI and API interfaces were developed. The GUI developed for the mainstream Web community and easy access to OGC services is entitled HTML List of OGC Services (Figure 3).

This simple HTML page provides a list of OGC Web Services represented in a simple tabular view based on the database implemented underneath the Bolegweb crawler component. Information such as the OGC Service type, version, location of the server, date when the service was discovered on Google SE, when its availability has been last checked and finally its status after the last check are made available. In addition, a link to metadata available as a query to the corresponding CSW is provided. A user can filter by applying free text criteria on each column. In the example represented by the Figure 3, the user filters the OGC service type SOS, restricting the version to 2.0, the country to be Italy and value 1 under status which stands for functioning service. To access the same information from the remote application code, a REST service is made available and provides the same filtering capabilities as the described GUI using the HTTP GET protocol. The same query would be represented by the following URL:

https://bolegweb.geof.unizg.hr/ogcwxs/rest/json.php?
type=SOS&
version=2.0.0&
location=Italy&
status=1

This would result in the JSON representation of the data from the database being returned, as illustrated in the following object fragment of the first result:



Currently displayed OGC services: 14

ID	Google Title	Type	Version	Metaseach URL discovered	Server location	Import Date	Status	Crawling Date	Metadata
		sos	2.0.0		italy		1		
3790	"StarterKit SOS StarterKit SOS OGC:SOS 1.0.0 2.0.0 http..."	sos	2.0.0	http://geosk.ve.ismar.cnr.it/observations/sos/kvpdemo?service...	Italy	2014-08-0...		2016-09-07T13:57...	14
3799	"OGS/NODC SOS OGS/National Oceanographic Data Center..."	sos	2.0.0	http://nodc.ogs.trieste.it/SOS/sos?service=SOS&REQUEST=Ge...	Italy	2014-08-0...		2016-09-07T13:57...	-1
7369	"Capabilities Link - Starter Kit - IREA CNR UOS Milano"	sos	2.0.0	http://skmi.irea.cnr.it/observations/sos/kvp?service=SOS&requ...	Italy	2014-09-07...		2016-09-14T10:0...	2
9932	"Capabilities Link - Starter Kit - Demo - Cnr"	sos	2.0.0	http://geosk.ve.ismar.cnr.it/observations/sos/kvp?service=SOS...	Italy	2014-10-16...		2016-09-06T21:5...	14
122...	"Capabilities Link - Cnr"	sos	2.0.0	http://sk.oristano.iamc.cnr.it/observations/sos/kvp?service=SO...	Italy	2015-01-07...		2016-09-06T21:3...	-1
12821	"Capabilities Link - Starter Kit - Demo - Cnr"	sos	2.0.0	http://vesk.ve.ismar.cnr.it/observations/sos/kvp?service=SOS&...	Italy	2015-02-0...		2016-09-07T04:0...	29
13539	"Capabilities Link - Cnr"	sos	2.0.0	http://mareesk.irea.cnr.it/observations/sos/kvp?service=SOS&r...	Italy	2015-03-26...		2016-09-06T22:0...	16
13664	"Capabilities - Starter Kit - CNR ISMAR Lesina"	sos	2.0.0	http://sk.fg.ismar.cnr.it/observations/sos/kvp?service=SOS&re...	Italy	2015-03-26...		2016-09-06T22:0...	-1
15147	"52N SOS 52North Sensor Observation Service - Data..."	sos	2.0.0	http://sk.ise.cnr.it/observations/sos/kvp?service=SOS&request...	Italy	2015-06-0...		2016-09-07T10:3...	23
15257	"Capabilities - Cnr"	sos	2.0.0	http://sk.ise.cnr.it/observations/sos/kvp?service=SOS&request...	Italy	2015-06-0...		2016-09-07T10:3...	23
15284	"Capabilities Link - ermes - get-it"	sos	2.0.0	http://get-it.ermes-fp7space.eu/observations/sos/kvp?service=S...	Italy	2015-06-0...		2016-09-07T10:3...	-1
15287	"Capabilities Link - Starter Kit - Demo - Ogs"	sos	2.0.0	http://geonodenodc.ogs.trieste.it/observations/sos/kvp?service...	Italy	2015-06-0...		2016-09-07T10:3...	-1
16696	"Starter Kit ISMAR Venezia None ASD OGC:SOS 1.0.0 2.0.0..."	sos	2.0.0	http://vesk.ve.ismar.cnr.it/observations/sos/kvp?service=SOS&...	Italy	2015-08-17...		2016-09-07T05:2...	29
17885	"OGS - Starter Kit Node NODC-OGS (Trieste) RITMARE..."	sos	2.0.0	http://geonodenodc.ogs.trieste.it/observations/sos/kvp?service...	Italy	2015-10-09...		2016-09-07T11:19...	-1

Source: https://bolegweb.geof.unizg.hr/site/products#tabs-1

Figure 3: GUI of HTML List of OGC Services with a query applied searching for online SOS services, version 2.0 running on machines in Italy.


```
{
   "id" : "3790",
   "title" : "\"StarterKit SOS StarterKit
    SOS OGC:SOS 1.0.0 2.0.0 http...\"",
   "url" :
"http:\/\/geosk.ve.ismar.cnr.it\/
observations\/sos\/kvpdemo?service
=SOS&request=GetCapabilities",
    "importDate" : "2014-08-
    05T02:15:07+02:00",
    "location" : "Italy",
    "endpoint" :
"http:\/\/geosk.ve.ismar.cnr.it\/
observations\/sos\/kvpdemo",
    "type" : "sos",
    "version" : "2.0.0",
    "status" : "1",
    "statusDate" : "2016-09-
07T13:57:44+02:00",
    "harvested" : "1",
    "harvestingDate" : "2016-09-
   10T12:13:35+02:00",
    "metadata" : "14",
    "metadataDate" : "1970-
    0101T01:00:00+01:00"
}
```


Geospatial web community - SDI

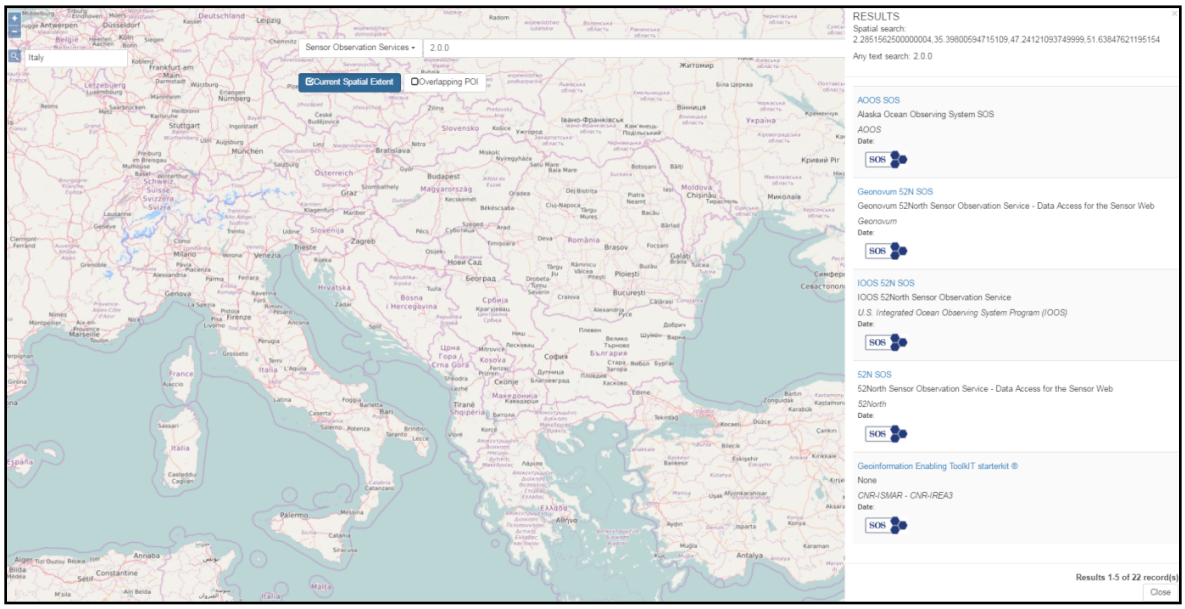
For the geospatial community, while they may also use the interfaces described in the previous section, standard SDI techniques for search of GI resources might be of preference; for these we developed a map based discovery client and deployed CSW endpoints for individual OGC Services endpoints. Ideally the user searches, displays and uses the data from within the same web application, or within a desktop GIS e.g. using the QGIS plugin MetaSearch Catalogue Client. The same query as above would be set up in the discovery map viewer as follows: i) selecting the Sensor Observation Service from the drop list; ii) selecting Italy from the place search box iii) activating the current spatial extent function and iv) typing the string 2.0.0 in a full text query box; v) triggering the search function (Figure 4).

The result list provides metadata records for SOS and related observations matching the query with links to metadata records and the service endpoint URL. The same scenario can be imitated from a third party discovery client, e.g. using the Metasearch Catalogue Client plugin in QGIS desktop and a CSW endpoint for OGC service type of interest. In our example we use SOS services CSW endpoint (Figure 5).

Semantic web community

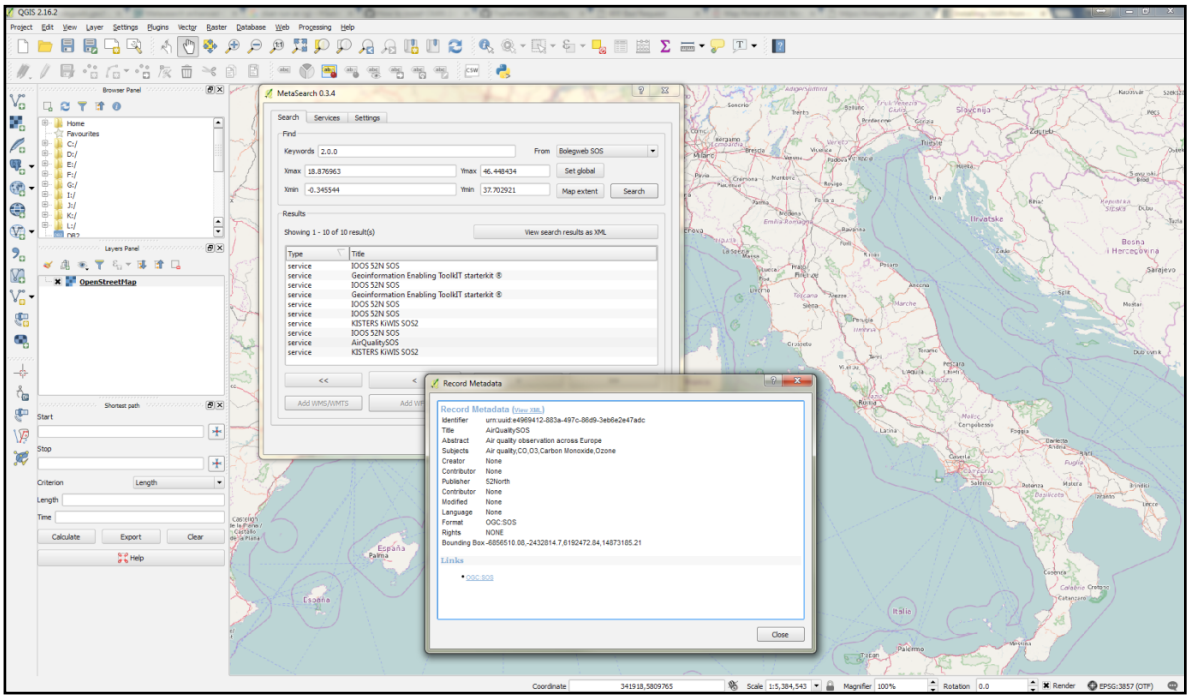
The semantic web community can reuse the GI resources collected by the Bolegweb platform using the GeoSparql endpoint deployed using the middleware software TripleGeoCSW connected to the platform's CSWs. The sample query tested in the previous section would be represented by the following SPARQL encoding:

```
PREFIX dc: <http://purl.org/dc/
elements/1.1/>
PREFIX csw: <http://www.opengis.net/cat/
csw/2.0.2>
PREFIX geo: <http://www.opengis.net/ont/
geosparql#>
PREFIX geof: <http://www.opengis.net/def/
geosparql/function/>
SELECT *
WHERE {
?s dc:format ?type .
?s csw:AnyText ?anytext .
```



Source: https://bolegweb.geof.unizg.hr/site/products#tabs-3

Figure 4: GUI of HTML List of OGC Services with applied query searching for online SOS services, version 2.0 running on machines in Italy.



Source: Own processing with a CSW endpoint used from: https://bolegweb.geof.unizg.hr/site/products#tabs-2

Figure 5: GUI of Metasearch Catalogue Client plugin of QGIS desktop GIS software connected to the CSW endpoint for SOS services with applied a free text "2.0.0" and spatial query extracted from the map extent.

```
?s geo:hasGeometry ?fWKT .
FILTER ( REGEX(?anytext , "2.0.0")
&& (?type , "OGC:SOS") &&
geof:sfWithin(?fWKT, "BOX2D(-12.65625
33.23868752757414,32.2998046875
49.98655213050617)"^^geo:wktLiteral))
}
```

This query results in an RDF representation of metadata records matching the filter parameters as shown in the following fragment for a single record:

```
<rdf:Description
rdf:about="http://geosk.ve.ismar.cnr.it/
observations/sos/kvp">
```

```
    <foaf:primaryTopicOf rdf:resource="ur
n:uuid:urn:uuid:9a8744ff-74bc-457a-862c-
aef6cfbd1d63"/>
    <dct:language rdf:datatype="http://
purl.org/dc/terms/ISO639-2"/>
    <dct:title xml:lang="">Geoinformation
Enabling ToolkIT starterkit &#174;</
dct:title>
    <dct:description xml:lang="">National
Data Buoy Center SOS</dct:description>
    <rdf:type rdf:resource="http://www.
w3.org/ns/dcat#Dataset"/>
    <dcat:landingPage rdf:resource="http://
geosk.ve.ismar.cnr.it/observations/sos/
kvp"/>
    <dct:identifier rdf:datatype="http://
www.w3.org/2001/XMLSchema#string"/>
    <dct:subject/>
    <dcat:keyword xml:lang="">ASD1</
dcat:keyword>
    <dcat:keyword xml:lang="">ASD1</
dcat:keyword>
    <dct:spatial>
      <dct:Location>
        <locn:geometry
rdf:datatype="http://www.openlinksw.com/
schemas/virtrdf#Geometry">BOX2D(12.0
12.0,45.0 45.44)</locn:geometry>
      </dct:Location>
    </dct:spatial>
    <dct:provenance>
      <dct:ProvenanceStatement>
        <rdfs:label xml:lang=""/>
      </dct:ProvenanceStatement>
    </dct:provenance>
    <dcat:distribution>
      <dcat:Distribution>
        <dct:rights>
          <dct:RightsStatements>
            <rdfs:label/>
          </dct:RightsStatements>
        </dct:rights>
        <dct:accessRights>
          <dct:RightsStatement>
            <rdfs:label/>
          </dct:RightsStatement>
        </dct:accessRights>
      </dcat:Distribution>
    </dcat:distribution>
    <dct:rightsHolder>
      <foaf:Organisation>
        <foaf:name xml:lang="">National
Data Buoy Center</foaf:name>
        <foaf:mbox rdf:resource="mailto:"/>
      </foaf:Organisation>
    </dct:rightsHolder>
    <prov:qualifiedAttribution>
      <prov:Attribution>
        <prov:agent>
          <vcard:Kind>
            <vcard:organization-name
xml:lang="">National Data Buoy Center</
vcard:organization-name>
            <vcard:hasEmail
rdf:resource="mailto:"/>
          </vcard:Kind>
        </prov:agent>
        <dct:type rdf:resource="http://
inspire.ec.europa.eu/codelist/
ResponsiblePartyRole/resourceProvider"/>
      </prov:Attribution>
    </prov:qualifiedAttribution>
    <dcat:contactPoint>
      <vcard:Kind>
        <vcard:organization-name
xml:lang="">National Data Buoy Center</
vcard:organization-name>
        <vcard:hasEmail
rdf:resource="mailto:"/>
      </vcard:Kind>
    </dcat:contactPoint>
    <prov:qualifiedAttribution>
      <prov:Attribution>
        <prov:agent>
          <vcard:Kind>
            <vcard:organization-name
xml:lang="">National Data Buoy Center</
vcard:organization-name>
            <vcard:hasEmail
rdf:resource="mailto:"/>
          </vcard:Kind>
        </prov:agent>
        <dct:type rdf:resource="http://
inspire.ec.europa.eu/codelist/
ResponsiblePartyRole/pointOfContact"/>
      </prov:Attribution>
    </prov:qualifiedAttribution>
    <dct:conformsTo>
      <dct:Standard>
        <dct:title xml:lang="en"/>
        <dct:issued rdf:datatype="http://
www.w3.org/2001/XMLSchema#date"/>
      </dct:Standard>
    </dct:conformsTo>
  </rdf:Description>
```

Conclusion

The availability of GI resources on the Web is increasing on a daily basis. This progress can be clearly seen on many geoportals around the world (e.g. on INSPIRE geoportal). This is mainly driven through overall SDI developments. On the other hand, also the number of interested

users is increasing at a similar pace. It brings us new ideas and new added value applications. However, for a non GIS expert it is not easy to understand how to search, find and efficiently use GI resources provided by OGC services. The most convenient way for non GIS users to search for something on the web is through either mainstream or semantic search engines. The outcome will be that most of the GI resources published in standardized SDI environments will not be discovered. This fact triggered many researchers to try and find better solutions of how to identify and utilize available spatial services. This paper described the idea and products of the Bolegweb platform aimed at addressing this issue. It provides various products to web communities, foremost a tabular view of the services available online deployed using OGC standards like Web Feature / Map / Tile / Observation Service, etc. Results reported in the paper already provide a solid basis of information about available GI resources on the global scale. On the Bolegweb project web page it is possible to get information about currently available OGC Web Services that have been discovered from the Google Search Engine together with their geographic distribution and basic statistics. It is possible to use other components of the platform as described in the paper and filter results by different attributes (e.g. title, type of service, version, server location etc.). In order to provide an intuitive and user friendly GUI, a pilot version of a discovery map portal of OGC resources metadata is provided. Simple full text and spatial queries are supported by defining the location of the point of interest and the map extent. This pilot is operational but still in the development phase, and is foreseen to provide more advanced functionalities in the near future. The contribution to other web communities is also supported by REST, SPARQL and CKAN interfaces, which have been deployed on the top of the Bolegweb platform GI resources. A likely outcome of the OGC/W3C Spatial Data on the Web working group is the definition of how to wrap those services in software that automatically creates human and machine readable Web pages for each of the information items behind the service. This would mean that not just the service itself, but also the data provided by the service would be discoverable, thus enabling tools such as the Metasearch Enhanced OGC Crawler to provide a much richer information coverage and user experience. The Bolegweb project ended in October 2016; and same system components are still in the development and pilot phase; however, they are functional and publicly available. The major future plans are to further develop the geospatial map portal of OGC resources with visualization, download and processing functionalities, with the main goal to reuse available OGC Services capabilities as much as possible.

Acknowledgements

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 291823 Marie Curie FP7-PEOPLE-2011-COFUND (The new International Fellowship Mobility Programme for Experienced Researchers in Croatia - NEWFELPRO). This article has been written as a part of a project "Borderless Geospatial Web (Bolegweb) which has received funding through NEWFELPRO project under grant agreement n° 3.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Sources of Microbrewery Competitiveness in the Czech Republic

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Abstract

This article aims to determine the reasons for the number of microbreweries increasing in the Czech Republic. The analysis compares various (micro)brewing industry indicators in selected traditional beer-drinking countries. The research questions are focused on relations among number of microbreweries and demographic aspects, market concentration aspects and some other beer market indicators. Furthermore, there were made simulation – for which conditions will be in the Czech Republic 400, 500 and 1 000 microbreweries. Statistically significant dependency on the number of microbreweries are beer market concentration (Gini index), the percentage of the total population made up of the 25 – 39 years age group, and the share of domestic beer consumption in cans. Since the beginning of Economic crisis the number of Czech microbreweries has been increasing exponentially and the results suggest that the microbrewery boom will have been continuing.

Keywords

Microbrewery, craft brewery, demography, market concentration, Plato, beer.

Maier, T. (2016) “Sources of Microbrewery Competitiveness in the Czech Republic", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 97 - 110. ISSN 1804-1930. DOI 10.7160/aol.2016.080409.

Introduction

The production of fermented drinks made from cereals began soon after cereal cultivation. The beer hopping process is much younger. The cultivation of hop began around A.D. 859 (Behre, 1998). Thanks to the low amount of alcohol, the beer (or rather fermented drink made from cereals) became a social drink. Beer consumption has a powerful cultural role in many societies (Carroll, Swaminathan, 2000; Kirkby, 2003; McAllister, 2003, 2006), and in the Czech Republic especially it is a very important social phenomenon and very often pubs in small villages are the the sole centre of social life. In the Czech lands, a different technique is historically used for beer production. The decoction technique is much better suited for the Czech type of beer as during its production a number of agents are produced which positively affect the sensory value of the beer (Kryl et al., 2012). The first commercial breweries emerged at the turn of the 12th and 13th century (Strizencova, 2014). The microbreweries segment is historically a phenomenon of a postindustrial era. Before this era, all breweries had many technological limits and they had very limited opportunities to grow.

The Czech brewing industry has a number of peculiarities when compared to other well developed beer-producing countries. The first difference compared to the other main beer-producing countries is a remarkably high level of (main) product homogeneity. In 1994, 97.2 % of beer produced was pilsner and 2.8 % was dark lager (CBAMA) in Czech breweries. Porter (1980) has identified three generic strategies available to firms: low cost, differentiation, and focus. Because of the homogenous market, there were perfect condition for using second strategy for differentiation in the Czech Republic that in the first half of 90´s. Moreover, there was no production of any top fermented beer. Porter (in frame of “focus”) means that the firm should develop the ability to serve a particular target customer group very well (often at the expense of other potential customer groups) and this is strategy, which the microbreweries use mainly for younger consumers (demographic aspects). The only strategy which is not usable for microbreweries is the low cost strategy. Consider the American beer brewing industry - its market was virtually stagnant before the microbrewery movement. Specialty brewers tapped new beer business, bringing in new customers for as much as half of their markets (Backus, 1999). The number of breweries fell sharply during the communist era. Maye (2012) came to the conclusion that if a particular town has one

brewery then the inhabitants will not experience much variety. Especially at the beginning of communist era, many smaller breweries were closed and during the whole communist era the market was managed by the state on the basis of regionalism.

The Czech beer market has been changing very slowly, with dark beer making up 2.62 % of total production and top fermented beer making up 0.23% of total production within industrial breweries (CBAMA) in the Czech Republic in 2015. The USA saw a very similar situation in the past. In 1970s there were no specialty brewers. In 2003, specialty brewers commanded a 3.3% share of domestic beer production and a 2.9% share of total U.S. consumption (Tremblay, 2005).

As such, the Czech beer market is generally characterized by a high level of product homogeneity, but on for microbreweries the situation is different with the products of microbreweries characterized by considerably high product heterogeneity[1]. It is very difficult to quantify the market share of microbreweries, because in the Czech Republic it is not obligatory for the breweries to publish beer production volumes. But if we take a microbrewery to mean a brewery with annual production of less than 10 000 hl, then according to the Customs Office (responsible for excise tax collection) we can deduce that the market share of microbreweries on domestic consumption was approximately 1.7 % in 2015. In 1994, 16 microbreweries were operating, and as such the market share of microbreweries was unimportant. Figure 1 shows the Czech microbreweries market share over 10 years (2006 – 2015). In 2009, the microbrewery market share has started to accelerate. The average chain index value for the above mentioned period is 113.9 %, which means it is very progressive sector, especially since domestic consumption of beer decreased over the 2006 – 2015 period. The index 2015/2006 is 790 %, so it means that in 2015 was the market share of microbreweries by 690 % higher than in 2006.

It is possible to make a comparison on the basis of the number of microbreweries per 1 mil. inhabitants indicator between various (selected) states. The results are given in Table 1. In 2014, the Czech Republic was in second position, with Switzerland in first position. In the Czech case, however, we can see a high acceleration in this indicator in the 2011 – 2014 period. All the values in the Table 1 are rather indicative however, because there are various definitions and various conditions pertinent to each of above mentioned states.

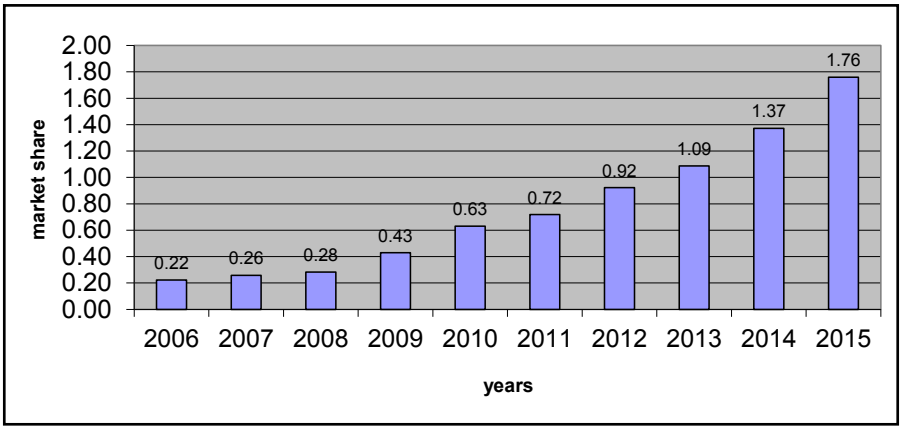
	2011	2012	2013	2014
USA	6.2	7.5	9.0	11.2
Czech Republic	11.4	13.6	18.2	22.0
Austria	11.4	10.8	12.8	12.8
Germany	8.1	8.2	6.9	8.4
United Kingdom	13.9	19.4	22.3	21.9
Switzerland	38.2	40.1	44.3	53.7
Spain	1.5	2.5	4.4	6.8
Italy	5.5	6.7	8.1	9.6
Ireland	-	3.2	5.0	6.9

Sources: Brewers Association, World Bank, Swiss Customs Administration and Brewers of Europe

Table 1: Number of microbreweries per 1 mil. inhabitants in selected states.

In the United States the term "craft brewery" is more frequently used, while the term "microbrewery" is more frequently used in the EU. In the United

[1] The product heterogeneity means that the production units (microbreweries) produce various kinds of beers (like ale, stout porter, weitzen etc.) instead of one kind (like lager).



Source: Customs Administration of the Czech Republic

Figure 1: Czech microbreweries market share development in 2006 – 2015 (%).

States, according to US Brewers Association, the category "craft brewery" consists of four groups:

1. Microbrewery: A brewery that produces less than 15,000 barrels (17,600 hectoliters) of beer per year with 75 percent or more of its beer sold off-site.
2. Brewpub: A restaurant-brewery that sells 25 percent or more of its beer on site. The beer is brewed primarily for sale in the restaurant and bar.
3. Contract Brewing Company: A business that hires another brewery to produce its beer. It can also be a brewery that hires another brewery to produce additional beer.
4. Regional Craft Brewery: An independent regional brewery with a majority of volume in "traditional" or "innovative" beer(s). (Brewers Association)

Wells (2016) noted in regard to this problem that the conflation of brewpubs and microbreweries reflects some ambiguities in the data and the definitions of these activities. Brewpubs are businesses that brew and sell their beer on the premises; microbreweries on the other hand are small-scale brewers (and scale here is open to some debate) that may sell on the premises but may also distribute their product to other retailers, sometimes over long distances. Both categories are sometimes also known as craft brewers or artisanal brewers. Bower & Cox (2012) and Sandberg (2010) add one aspect that is of interest is that beer can be made at almost any scale, from the household level through to huge multinational combines running vast centralised production complexes.

The fuzziest definition is that of "regional craft brewery"; this category can also cover big breweries like the Boston Beer Company. According to its Annual Report, this company produced 6 677 466 hl in the 2015 fiscal year, which represents one third of total annual beer production in the Czech Republic. In 1980s, the Boston Beer Company entered the sector like any typical small microbrewery, and boosted by the large US market it has grown very strongly. But for the category "craft brewery", the number of regional craft breweries is not so important; in the USA a total of 4225 craft breweries were operating in 2015, including 178 regional craft breweries (Brewers Association), representing 4.2 % of the total.

In the EU, the regional craft breweries typical for the US are almost non-existent, there being two reasons for this situation. In EU states, beer never changed into such an homogenous product as it did in the USA in the second half of 20th century. The second reason is that the national markets in EU are much smaller, such that regional craft breweries do not have such good conditions for growing, being more limited.

The most intensive microbrewery state in the whole world is Switzerland; according to Swiss Customs Administration, in 2014 there were 53.7 microbreweries operating per million inhabitants. This is more than 2.4 times the figure in the Czech Republic, which is in second position. According data from the Swiss Federal Customs Administration FCA, in Switzerland in 2014 there were 483 breweries and one year later there were 623 breweries. It can be supposed that these 140 new breweries over the course of 2015 are mainly (or only) microbreweries. The reasons for this situation can be historical, as Switzerland is a traditional beer-drinking country, and also that the purchasing power of Swiss consumers is one of the highest in the world. Meanwhile, Switzerland does not have a progressive excise tax system for beer. In Switzerland, compared to the Czech Republic, there are only three excise tax brackets which depend on ° Plato, while in the Czech Republic the amount of tax depends on each additional ° Plato. Let's give an example. A brewery with annual production of less than 10,000 hl pays excise tax of 8 EUR for 12 – 12.99° Plato in the Czech Republic, while in Switzerland it would pay 26.3 EUR. Both these values are calculated per 1 hl of beer. The excise taxes are additional costs for brewers, so it represents a restriction for them. On the other hand, taxes on alcohol contribute to the state's exchequer (Castiglione et al., 2011). Ellis, V. and Bosworth, G. (2015) indicate that the number of microbreweries in the UK has more than doubled since the start of the millennium. Compared to the United Kingdom, there has been more expansion in the Czech Republic.

The Czech excise beer tax is shown in Table 2. The progressive beer excise tax system was established in 1995 and was inspired by the German tax system. This system helps smaller producers to stay or to enter the market. In 1995, only approximately 20 microbreweries were operating in the Czech Republic, and as such the lobby comprised mainly smaller industrial breweries.

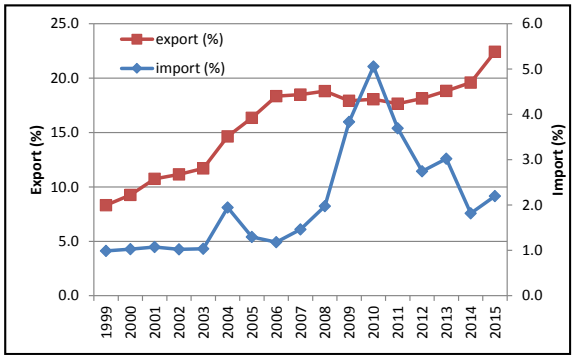
Another particular of the Czech beer market is that it is almost closed to imports. Czech consumers are very conservative and they do not usually prefer foreign brands. The figure 2 shows the share

Year	Basic rate (EUR)	Reduced rate (EUR) for annual production up to				
		10,000	50,000	100,000	150,000	200,000
2009	0.907	0.453	0.544	0.635	0.725	0.816
2010 and further years	1.209	0.605	0.725	0.846	0.967	1.088

Note: Exchange rate of 31/12/2009
Source: Act No. 353/2003 of the Legal Code

Table 2: Beer excise tax rates in the Czech Republic.

of Czech beer import and export based on data from the Czech Statistical Office for the period 1999 – 2015. In the observed period we can see that export grew over almost the whole time, although in the economic crisis period tone can detect stagnation or very slight decrease. 2015 shows historically the highest export, with more than 20% of domestic production exported for the first time the Czech history.



Source: Czech Statistical Office, Customs Administration of the Czech Republic

Figure 2: Share of Czech beer import and export.

Import was very low compared to export, and lower than 2 % of domestic beer consumption until 2008. Then it started to increase, but the main reason here was a sudden change in consumer habits, with consumers starting to demand beer in plastic bottles, a technology which in 2009 was only used in one small Czech brewery, Nová Paka. As such, the large brewery companies imported beer in plastic bottles. Later, the breweries built their own technology for plastic bottles such that in 2014 import was once again less than 2 % of domestic consumption.

If we compare these indicators with the other selected EU countries (Table 3), we can see that all other states have higher values of import, the lowest being in Austria (6.9 %) and the highest in Ireland (49.8 %), but this value is decreasing.

A Relatively large change in terms of export is indicated in Slovakia from 2010 compared to the previous year. The export value went from 0.5 % to 8.7 %. The reason for this is the above mentioned plastic bottles. In 2010, Heineken International (3rd position on the Czech beer market, leader in Slovakia) started with heavy exports of beer in plastic bottles from Slovakia to the Czech Republic, because in Slovakia this company had plastic beer bottle technology.

Another strong specific indicator compared to other well developed beer-drinking states is the Czech Republic's highest consumption per capita in the whole world. Within the Czechoslovak federation (before 1993) the Czech Republic reached the top global position in 1970, but in the past Czechoslovakia had a lower consumption than Western Germany. This has changed with the independence of the Czech Republic. But beer consumption volume is not mainly determined in accordance with particular states, but rather by habits within particular regions. The region with the highest beer consumption per capita is Bavaria excepting its southwest part, Bohemia except Prague and the western part of Austria. It can be supposed that in this region the per capita beer consumption may be around 170 liters. The per capita beer consumption for selected states is shown in Table 4.

In the Table 4 it is possible to detect the strong influence of the economic crisis on the Czech beer sector. Year-on-year (2010/2009) the per capita consumption decreased by 10 %, while in all the other states the affect of beer crisis was not so strong. Generally, we can make the statement that in all traditional beer-drinking states, per capita beer consumption has been decreasing.

From the above discussed, we can deduce that the microbrewery boom in the Czech Republic is a society-wide phenomenon, and thus we need to find the reasons behind this boom and in particular to find the sources of Czech microbrewery competitiveness. The aims of the paper are:

1. To quantify the number of all microbreweries over the period 1991 - 2015. Because there are no official statistics in the Czech Republic for this indicator

	2009	2010	2011	2012	2013	2014
Germany import	7.3	8.5	8.8	8.4	7.3	7.7
Germany export	14.3	15.8	16.7	16.6	16.0	16.2
Belgium import	10.3	11.0	12.8	14.1	12.7	13.7
Belgium export	56.8	58.5	59.7	62.3	61.1	61.6
Austria import	6.9	6.9	7.4	7.5	6.9	7.4
Austria export	7.7	8.0	8.0	7.9	9.1	9.9
Slovakia import	22.4	25.3	25.7	26.7	29.9	31.2
Slovakia export	0.5	8.7	4.3	5.3	10.1	6.5
United Kingdom import	16.5	17.6	18.7	20.5	20.7	19.5
United Kingdom export	10.5	10.2	9.9	13.9	15.6	12.7
Ireland import				34.3	29.2	29.8
Ireland Export				42.9	49.8	38.5

Sources: Brewers of Europe

Table 3: Share of import and export for selected EU countries.

State/Year	2009	2010	2011	2012	2013	2014
Czech Republic	159	143	142	147	144	144
Germany	110	107	107	108	107	107
Austria	107	106	108	108	106	104
Ireland	91	90	86	86	79	81
Belgium	81	78	78	74	72	72
United Kingdom	71	69	67	67	66	68
USA	-	78	77	78	76	76

Source: Statista, Inc., Brewers of Europe

Table 4: Per capita beer consumption (l).

and this variable is required to undertake the research further (aim), it is necessary first of all to quantify (or estimate) these values.

2. To determine main external reasons for microbrewery foundation.

In particular, the paper addresses following research questions:

i. Is there any statistically significant relationship between number of microbreweries and selected demographical aspects? It can be supposed that the total population value can influence the number of microbreweries; and furthermore certain selected age bracket may also influence it. Microbreweries usually focus their production on (non-conservative) consumers, and thus this aspect may be a very important source of Czech microbrewery competitiveness.

ii. Is there any statistical relationship between number of microbreweries and annual per capita consumption of beer? A negative dependency can be supposed; this is typical for Belgium. Belgium is typical beer country, but the per capita consumption is half compering to the Czech Republic (Table 4), because typical beer for Belgium – Belgian abbey – is high-strength beer. Microbreweries usually brew special and high-strength beers, meaning that consumers drink smaller volumes of beer. Beer produced by microbreweries usually has higher added value and the Czech Republic has been the state with highest beer consumption per capita for many years.

iii. Is there any statistically significant relationship between number of microbreweries and beer market concentration? It can be supposed that the beer market operates in two ways; there is ever increasing market concentration in industrial breweries segment and this usually brings homogenization of the market, while on the other hand microbreweries bring heterogeneity. It can be supposed that generally high beer market concentration may be another source of Czech microbrewery competitiveness.

iv. Is there any statistically significant relationship between number of microbreweries and various

beer market indicators (packaging, ° Plato). Increasing demand for stronger beer (higher degrees Plato) can have a positive impact on microbreweries competitiveness. The segment of microbreweries in the Czech Republic is still very tiny if it is measured by amount of produced bee (Figure 1). In last 10 years, the market share of microbreweries has increased 8 times, it can be supposed that the market indicator can be tightly linked with some other beer market indicators – variables. The problem is that there are not available data for the amount of top fermented beer – ale. In the Czech Republic many of microbreweries brew top fermented beer and some of them produce only top fermented beers.

v. Can models be produced to simulate the market? And using these equations, can one determine the conditions which will result in 400, 500 and 1000 microbreweries? Some Czech beer experts have the opinions, that in the nearby future can be in the Czech Republic 1000 (micro)breweries, similar situation was in in the end of 19th century.

Materials and methods

The aims and research questions are addressed using the derived econometric model. The model specification is based on the neoclassical consumer theory and new industrial organization theory. Thus, the model explains the the number of microbreweries based on the three groups of variables, namely: demographic aspects, market concentration aspects and six selected market indicators (see relation (7)).

The variable specification is as follows. Two variables were chosen in regard to the demographic aspects of the first research question:

- Total population in the Czech Republic.
- Population within the age range 25 – 39 years. We can suppose that these consumers are the most important consumers for microbreweries. Young consumers (younger than 25 years) do not normally earn so much and as such they don't usually buy more expensive beer from microbreweries, and old consumers (older than 39) can be more conservative. Microbreweries very often produce less traditional kinds of beer (such as ales etc.), and as such conservative consumers do not normally frequent such institutions.

Four indicators were chosen for market concentration as explanatory variable:

i. Herfindal-Hirshman index (*HHI*).

HHI is defined as the sum of the squared market shares of all the firms in the industry (Tremblay, V. J. et al., 2005). This indicator is very often used by various national and supranational authorities for solving mergers, acquisition etc.

The formula for its calculation is

$$HHI = \sum_{1}^{i} y_i^2 , \quad (1)$$

where

$i = 1, 2, \ldots, n$,

y_i states for the market share of i^{th} company (%),

n means number of operators in the sector.

ii. Concentration Coefficient *CC3*

The formula for its calculation is

$$CC3 = \sum_{1}^{j} y_j , \quad (2)$$

where

$j = \langle 3 \rangle$

y_j states for the market share of j^{th} company (%),

so this indicator describes market share of three biggest companies,

iii. Concentration Coefficient *CC5*

The formula for its calculation is

$$CC5 = \sum_{1}^{k} y_k , \quad (3)$$

where

$k = \langle 5 \rangle$

y_k states for the market share of k^{th} company (%),

so this indicator describes market share of three biggest companies,

iv. Gini Coefficient *GC*

The Gini Coefficient is calculated on the basis of a Lorenz Curve. This curve describes cumulative percentages of market shares dependency (in ascending order) and cumulative percentages, if every operator has the same market share. The border of ideal equality is an ideal situation where all the operators in the sector have the same market share. As such, the Gini coefficient is the surface between the border of ideal equity and the Lorenz Curve. If we have the general form

of the Lorenz Curve

$$y_1 = a^{bx}. \quad (4)$$

So the surface between the Lorenz Curve and axis y in the interval ⟨0 %; 100 %⟩ is

$$B = \int_0^{100} ae^{bx} = \frac{a}{b}\left(e^{100b} - 1\right). \quad (5)$$

And finally the formula for Gini Coefficient is

$$GC = \frac{5000 + 100a - \frac{a}{b}\left(e^{100b} - 1\right)}{5000}. \quad (6)$$

Data in the form of time series is used for the modelling, with the data in annual sequences (1995 – 2015), meaning a total of 21 observations, see Table 5.

Thus the model is in this general form

$$y = f(x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, x_{15}), \quad (7)$$

And the declaration of variables is

y number of operating microbreweries

x_2 population of 25 – 39 years age range (mil. inhabitants)

x_3 total population (mil. inhabitants)

x_4 beer consumption per capita (l/year)

x_5 *HHI*

x_6 *CC3* (%)

x_7 *CC5* (%)

x_8 *GI*

x_9 x_2/x_3

x_{10} proportion of domestic beer consumption in party barrels (%)

x_{11} proportion of domestic beer consumption in glasses (%)

x_{12} proportion of domestic beer consumption in plastic bottles (%)

x_{13} proportion of domestic beer consumption in cans (%)

x_{14} proportion of domestic beer consumption of beer 11 – 12.99 ° Plato

x_{15} proportion of domestic beer consumption in barrels (KEGs) and tanks (%)

We can suppose with a high level of probability that some variables from the economic model are not

year	y	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
1995	20	2.07	10.33	157	733	34.58	48.43	0.74	0.20	0.00	52.32	0.00	0.92	30.39	45.89
1996	21	2.06	10.32	157	770	38.16	52.00	0.77	0.20	0.00	53.61	0.00	1.20	30.43	44.16
1997	23	2.06	10.31	161	861	43.19	57.03	0.77	0.20	0.00	50.45	0.00	1.37	31.10	46.75
1998	24	2.07	10.30	161	2374	58.55	68.10	0.69	0.20	0.00	48.98	0.00	1.63	29.98	48.09
1999	27	2.12	10.29	160	2222	58.39	68.32	0.72	0.21	0.00	47.67	0.00	1.79	29.24	50.54
2000	28	2.12	10.29	160	2176	58.03	67.89	0.69	0.21	0.06	45.67	0.00	1.89	29.27	50.32
2001	33	2.25	10.27	157	2428	60.83	70.04	0.69	0.22	0.01	44.90	0.00	1.92	28.06	53.16
2002	38	2.28	10.21	160	2588	62.45	71.24	0.80	0.22	0.02	43.54	0.48	1.94	28.45	54.01
2003	39	2.33	10.20	162	2662	63.49	72.19	0.80	0.23	0.02	43.29	0.27	2.02	28.08	54.39
2004	45	2.37	10.21	161	2616	63.37	71.96	0.80	0.23	0.02	43.72	0.34	2.16	28.14	53.76
2005	49	2.40	10.22	164	2645	63.74	72.36	0.80	0.23	0.03	44.10	0.29	2.26	27.86	53.33
2006	59	2.42	10.25	159	2723	64.72	73.29	0.78	0.24	0.02	44.89	0.05	2.60	29.15	52.44
2007	68	2.44	10.29	159	2760	65.09	73.78	0.76	0.24	0.01	45.87	0.14	2.61	29.82	51.37
2008	74	2.48	10.38	157	2790	72.06	81.15	0.78	0.24	0.03	46.58	0.05	2.78	31.10	50.57
2009	79	2.52	10.47	151	2710	71.48	79.85	0.75	0.24	0.11	53.56	1.31	3.01	32.61	49.39
2010	96	2.53	10.51	144	2420	68.84	77.48	0.79	0.24	0.12	46.00	2.80	3.14	36.76	47.94
2011	120	2.53	10.53	143	2400	70.93	80.71	0.80	0.24	0.12	44.31	5.78	3.63	37.71	46.14
2012	143	2.49	10.51	149	2410	69.86	79.76	0.88	0.24	0.10	41.98	10.25	4.19	38.05	43.48
2013	192	2.46	10.52	147	2450	65.25	74.34	0.89	0.23	0.08	41.91	11.24	3.86	38.86	42.91
2014	232	2.42	10.51	147	2475	67.73	76.98	0.90	0.23	0.08	40.96	12.35	4.41	41.49	42.20
2015	289	2.39	10.55	145	2352	69.84	80.08	0.91	0.23	0.08	40.86	11.99	5.62	43.24	41.45

Sources: Czech Statistical Office, Czech Beer and Malt Association, Customs Administration of the Czech Republic

Table 5: Data set used for the estimation.

statistically significant, including multicollinearity etc. This aspect is discussed and dealt with in the next chapter.

The regression dependency is calculated for linear function and power function and the Gretl SW was used for the estimation.

Results and discussion

The only microbrewery which survived the communist era and was founded before 1991 is Microbrewery U Fleků in Prague. This brewery is historically an old brewing privilege holder. This law was introduced by King Wenceslas II. (1278 – 1305), and their old brewing privilege has never been officially canceled.

Figure 3 shows the evolution of microbreweries in the Czech Republic since 1991. In order to create the graph, various information (mainly from the internet) was used. In the Czech Republic, there is no official database of microbreweries which is managed by any state authority.

The very first microbrewery in the Czech Republic was Meloun (named after founder Milan Meloun), which opened in 1991. It was a family business. Production ceased in 1998, because of the sudden death of Meloun (personal interview with his granddaughter). He was the only one who was involved in beer distribution and nobody else in the family knew the distribution channels. This microbrewery was not a typical microbrewery, because more than half of production was consumed beyond its own restaurant.

The oldest microbrewery which has survived to the present (except U Fleků) is Pivovarský dvůr Chýně near Prague, which was founded in 1992. In Figure 3, we can see that the number of breweries operating has grown exponentially.

Many of the 15 explanatory variables are redundant, so they should be reduced. The highest pair correlation was detected between the variables x_6 ($CC3$ (%)) and x_7 ($CC5$ (%)). For linear dependency, the correlation is 0.9955, for power function the value is 0.9948. As such we should choose only one variable for describing market concentration. The situation is very similar for the variables which describe the types of packages.

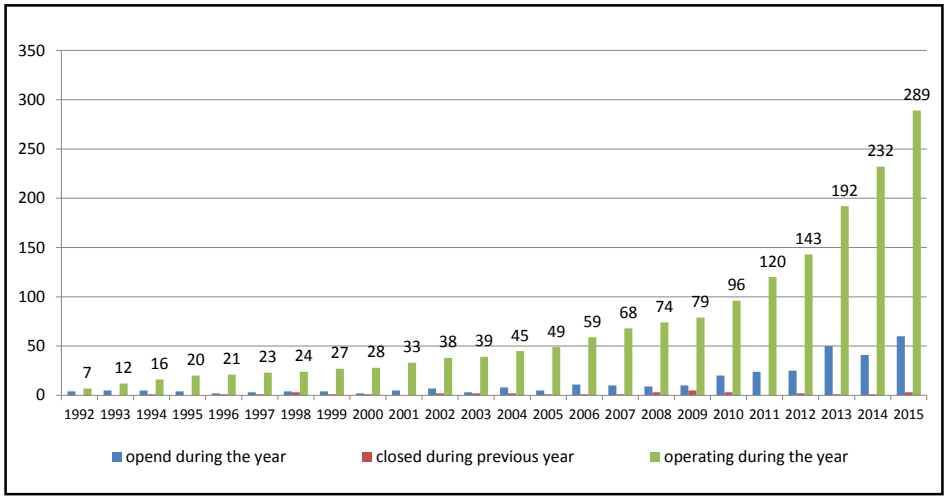
So by the gradual eliminations of (redundant) explanatory variables we estimated the two models. The criteria for elimination is a statistical significance of every particular variable and multicollinearity. Model 1 is a linear model and Model 2 is a model in nonlinear (power) form.

Econometric verification

- We can exclude the problem with autocorrelation for both regressions because the DW-values are in the range $\langle 1.40823^2; 2\rangle$, or more specifically we can say that there is not a statistically significant autorrelation.

- According to the White and Breusch–Pagan tests, heteroscedasticity was not detected for linear regression nor for power regression.
- According to the Jarque-Bera test the residuas have normal distribution.

A very strong relationship between all the chosen phenomena is confirmed. Thus according to both models the number of operating companies depends



Source: Own calculations, http://pivni.info/, http://pivovary.info/, http://www.pividky.cz/ and http://www.minipivo.cz/

Figure 3: Microbrewery evolution in the Czech Republic.

	Coefficient	Std. Error	t-ratio	p-value	
const	-1.217	81.2976	-0.0150	0.98823	
x_8	254.26	84.9976	2.9914	0.00820	***
x_9	-1219.51	280.075	-4.3542	0.00043	***
x_{13}	59.6018	5.25418	11.3437	<0.00001	***

Mean dependent var	80.90476	S.D. dependent var	75.02593
Sum squared resid	3845.814	S.E. of regression	15.04076
R-squared	0.965839	Adjusted R-squared	0.959810
F(3, 17)	160.2126	P-value(F)	1.16e-12
Log-likelihood	-84.50500	Akaike criterion	177.0100
Schwarz criterion	181.1881	Hannan-Quinn	177.9168
rho	-0.054036	Durbin-Watson	1.979351
p-value White	0.090682	p-value Jargue – Bera	0.01309

Source: Own calculation in Gretl

Model 1 (linear): OLS, using observations 1995-2015 (T = 21).

	Coefficient	Std. Error	t-ratio	p-value	
const	13.2349	1.92937	6.8597	<0.00001	
x_6	-1.94305	0.286841	-6.7740	<0.00001	***
x_9	2.09279	0.703408	2.9752	0.00849	***
x_{13}	2.21634	0.113257	19.5691	<0.00001	***

Mean dependent var	4.053994	S.D. dependent var	0.817689
Sum squared resid	0.251542	S.E. of regression	0.121641
R-squared	0.981189	Adjusted R-squared	0.977870
F(3, 17)	295.5808	P-value(F)	7.32e-15
Log-likelihood	16.66129	Akaike criterion	-25.32258
Schwarz criterion	-21.14449	Hannan-Quinn	-24.41583
rho	-0.063016	Durbin-Watson	1.982014
p-value White	0.141034	p-value Jargue – Bera	0.57705

Source: Own calculation in Gretl

Model 2 (power): OLS, using observations 1995-2015 (T = 21).

on

i. Market concentration;
ii. Proportion of 25 – 39 year olds in the total Czech population;
iii. Proportion of domestic beer consumption in cans (%).

So the analytical forms of the equations are:

Linear:

$$y = -1.217 + 254.26x_8 - 1219.51x_9 + 59.6018x_{13} + u \quad (8)$$

Power:

$$y = 559556.6205x_6^{-1.94305}x_9^{2.09279}x_{13}^{2.21634} + u \quad (9)$$

In this form, a comparison of both results is not possible, instead one has to count the values of elasticities for the linear equation. The elasticities for both models are clearly given in Table 6.

	Linear dependency		Power dependency	
	variable	elasticity	variable	elasticity
Market concentration	x_8	2.47	x_6	-1.94
Population rate	x_9	-3.38	x_9	2.09
Consumption in cans	x_{13}	1.93	x_{13}	2.22

Source: Own calculation

Table 6: Values of elasticities for linear and power dependency.

The results show that all the values of elasticities (in absolute value) are considerably high. The primary assumptions are valid for both equations only for the variable x_{13}, i.e. the rate of beer consumed in cans. A particularly surprising result is that the market concentration indicator (x_6) has negative elasticity for the power function,

and an economic interpretation of this is that if the market concentration (indicator *CC3*) increases by 1 %, then the number of microbreweries decreases by 1.94 %. The reason for this value may be the decrease in market concentration since 2008. In this year, the three most powerful companies controlled 72.06 % of the Czech beer market, while two years later this figure was only 68 % and the number of microbreweries had increased by 30 %. But we should highlight that two different variables were used for the market concentration indicator; *GC* was used for linear dependency, and *CC3* was used for power dependency (according to the statistical characteristics and verification of both models).

The condition for the primary assumption about demography was met only for a power function, where the influence is positive. For a linear function, the condition is negative. The demography indicator is the proportion of 25 – 39 years old in the total Czech population. The influence is ambiguous; while the number of microbreweries increased in the whole period (1995 – 2015), the value of the demographic indicator increased in the period 1995 – 2010, but decreased from 2011. The maximum rate was in 2011 at 24.1 %.

The only assumption which is in agreement with the results is beer consumption in cans (x_{13}). The elasticities are pretty similar for both equations, for a linear function it is 1.93 % and for a power function it is 2.22 %.

We can do a simulation for both regressions. The endogenous variable (number of microbreweries) does not influence exogenous variables. The microbreweries do not produce beer in cans, the microbreweries cannot influence the population rate and because they had in the year 2015 total market share 1.7 % (289 companies), so they cannot influence the beer market concentration. The results are given in the Table 7.

The simulations were calculated for 400, 500 and 1000 microbreweries, ceteris paribus. Some results are not in line with assumptions according to the previous analysis. The problem may be that the microbrewery sector in the Czech Republic is very young and the microbrewery boom (wave) is very strong, such that it is very difficult to do any simulation in these conditions.

The simulation results for market concentration for linear dependency do not make any sense, as the market concentration (*GC*) can't be higher than 1. The population rate (for 1 000 microbreweries) does not make any sense either, because it is a negative number.

The only acceptable results of the simulation are population rate for the power function, and share of beer consumed in cans for both functions.

Conclusion

Development of the Czech microbrewery sector is very similar to that in western states, except with a 10 – 15 years delay because of the communist regime. While the first microbrewery in USA was opened in 1976, in the Czech Republic (specifically in Czechoslovakia) the first microbrewery was opened in 1991. To understand the microbrewery boom in the Czech Republic one must go back to the situation after the Second World War, specifically the situation in 1948, when the communists carried out their coup d'état. The number of Czech breweries at the time was very similar to that in neighbouring Bavaria. Both beer markets were heterogeneous (there was no homogenous beer product) and both markets were fragmented, with very low market concentration. But subsequent to 1948, a forced concentration process was started, mainly involving small industrial breweries with annual production of less than 10 000 hl, which were closed by the communists. Product homogenization processes also took place. Development in Bavaria from 1948 was completely different; product homogeneity was kept at a similar level and the HH index is still very low. The HH index is no more than 800 points for the whole of Germany (Adams, 2006). This is also very important for the successful

	linear				power			
	variable	no. of microbreweries (y)			variable	no. of microbreweries (y)		
indicator		400	500	1000		400	500	1000
Market concentration	x_8	1.35	1.74	3.71	x_6	60.18	53.65	37.55
Population rate	x_9	0.14	0.05	-0.36	x_9	0.26	0.29	0.40
Consumption in cans	x_{13}	7.48	9.16	17.55	x_{13}	6.40	7.08	9.68

Source: Own calculation of the basis of equations

Table 7: Results of the simulations.

microbrewery boom in the Czech Republic. Over the period 1991 – 2015, the Czech Republic started slowly but surely to return to the previous situation and tradition which had been interrupted in the 1948 – 1989 period.

The answers to the all five research questions are mostly difficult and mostly ambiguous. The statistical significance between beer market concentration and number of microbreweries was strongly proven. But the direction of influence is very ambiguous; on the basis of both above mentioned models it is not possible to make unequivocal results. The reason for this may be that with the economic crisis (2008/2009) the fall in the market share of the Czech beer market's leading company was of greatest importance. The market share of this company decreased from 49 % to 43 %. A fairly similar process was characteristic of almost all major Czech brewing companies. While before 2008 the number of microbreweries had increased fairly slowly, since 2009 the number of microbreweries has been growing exponentially. Danson et al. (2015) came to the conclusion in the UK context that, while there are particular challenges to starting a microbrewery, barriers to entry are lower than for many other sectors. In terms of the food and beverage industry, different conditions can be seen for example in sugar beet processing. New processors have no chance of penetrating the EU market (Rezbová et al., 2014). We can suppose that conditions in the Czech Republic may be similar to those for microbreweries like in UK. The microbrewery boom in the 21st century in the Czech Republic is more a question of the demand side than the supply side. Technical efficiency in the food processing industry did not change significantly within the period from 2000 to 2007 (Čechura, 2009).

Similarly controversial is the influence of demographic aspects – the proportion of the population 25 – 39 years of age. It can be supposed that this generation have enough money for more expensive beer from microbreweries compared to younger consumers, and on the other hand this generation is not as conservative as older generations. In the above mentioned part of this text we state that in general Czech beer consumers are very conservative. For a linear dependency the influence is negative, while for power function it is positive. Similarly to the case of market share concentration, there is a critical point in this case too. The proportion of above mentioned generation in the whole population grew until 2010, but since 2011 the proportion of this generation has been decreasing. We can make the statement that before reaching this demographical peak (a similar period to the growth of beer market concentration) this variable had influenced the number of microbreweries in an unequivocally positive manner. Since reaching this peak, the microbrewery boom has become a society-wide phenomenon.

The influence of per capita beer consumption for both models is not statistically significant. As in the case of the above mentioned variables, per capita beer consumption until 2008 was extremely stabile. In the period 1995 – 2008 the differences between annual values and mean value (159.55) was no higher than 2.5 % (this was the value in 2005). With the economic crisis, a beer consumption decrease was identified. The average value for the period 2009 -2015 is 8.2 % lower than the period 1995 – 2008.

There is not more statistical data on the production volume of various kinds of beer, because the beer microbreweries very often focus on is not mainstream beer. It would be very interesting to analyze the relationship between the microbrewery boom and the production of non-filtrated beer, ales etc. According to the available data, there is no relation between beer original gravity and number of microbreweries; for describing beer original gravity, the proportion of 11 – 12.99 ° Plato beer compared to total production was used. The only statistically significant variable which influenced the number of microbreweries is the share of beer sold in metal cans. This is related to market change, with consumers visiting ordinary pubs and restaurants less, and considering more deeply the decision about which restaurant (or brewpub) to visit, and they buy more beer in cans. The same development was seen in the US market.

Furthmore, it is indisputable that a very significant source of the Czech microbrewery boom and competitiveness is the economic crisis and the limited ability of industrial breweries to respond to consumer demand adequately and in time. Negative aspects can also be seen, however. Operations which offer only in-house brewed beers and ales can fall victim to the same market trap of limited variety of offerings that has troubled the large brewers (Murray and O'Neill 2012).

Acknowledgements

The findings presented in this paper have arisen from research enabled by the grant of the Internal Grant Agency provided by the Faculty of Economics and Management,

Czech University of Life Sciences in Prague – no. 20151049.

This article is dedicated to Milan Meloun (1951 - 1998), who founded the first microbrewery in the Czech Republic after the communist era.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Influence of Qualitative Factors on Quantitative Determinants in the Czech Meat Industry Economy

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Abstract

The meat industry is one of the key sectors within the food industry in the Czech Republic. Development, especially in the pork production, is unfavourable. Negative foreign trade balance and low self-sufficiency is reported. Czech market products compete with foreign imports of meat and economic performance of enterprises plays an important role in this field. Article aims to identify qualitative factors limiting the competitiveness of the meat industry and to identify groups of enterprises with key position. The size of a company was confirmed as an only factor limiting the competitiveness. Statistically significant differences among the three performance indicators (out of the four analysed) were demonstrated. The larger the enterprise, the greater values of indicators are. Form of company ownership, drawing subsidies and region of the company cannot be confirmed as factors influencing the economic performance and competitiveness.

Keywords

Meat industry, competitiveness, economic performance, cluster analysis, food processing industry, economy of enterprises.

Náglová, Z. and Horáková, T. (2016) "Influence of Qualitative Factors on Quantitative Determinants in the Czech Meat Industry Economy ", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 111 - 123. ISSN 1804-1930. DOI 10.7160/aol.2016.080410.

Introduction

The meat industry belongs to food processing industry, which is one of the most important sectors in the whole EU as well as in Member States with high importance for economic and environmental development but also for social welfare (Bigliardi and Galati, 2013). Food processing industry plays an important role as an employer, but it is also important for its economic outcomes. It is the base for the competitiveness of the agricultural market in each EU country. Its important role arises from the processing of agricultural raw materials and the food supply for population (Menrad, 2004).

Economic research focuses more on the area of the Czech food industry as a complex rather than on its individual processing fields. For example, Putićová and Mezera (2008) dealt with this issue. They analysed the development of the food processing industry and the trends in economic indicators in comparison with the entire manufacturing industry. The authors stated that the entire manufacturing industry is developing dynamically. However, the importance of the food industry decreases over the time. Differentiated and fluctuating trends are seen in individual production fields (in number of employees, sales, value added), on the other hand the labour productivity grew for the period 2000-2006. According to Mejstříková et al. (2011), the food industry is a major area of the agrarian sector and its financial-economic results affect the development of agriculture and other related subjects. The authors analyzed the positives and negatives of economic performance in food processing business. The results show an intersectoral heterogeneity of profitability. Čechura and Hockmann (2010) also analysed the Czech market. They identified the uneven development of the food processing industry. Results indicate serious problems including problems in the capital market. According to research of Hockmann et al. (2013) the key determinants of competitiveness in the food industry are: changing consumer preferences towards higher quality and nutritionally valuable

foods and the changing purchasing power of the population on one hand; progressive trade liberalization creating new competitive environment accompanied by structural changes in the food industry on the other hand. The meat industry is among the key sectors of the food industry both in the EU and the Czech Republic.

The study Food Drink Europe (2015) summarizes the basic economic performance of the food industry in the EU. The meat industry represents 14% of the food and drink industries of the EU which makes it the second highest number of enterprises after the bakery industry (54% of enterprises). The sector employs 21% of employees in the food industry (the second highest number of people). It contributes by 15% (which is the fourth highest part) to the value added of food industry and has a turnover of 20% (the highest portion). However, labour productivity is very low, it is below average of food and beverage industry, ie. 33 000 EUR/ person (the second lowest labour productivity).

A publication Panorama of Food Industry (MoA, 2015) is dedicated to the problems of the food processing industry in the Czech Republic. According to this publication, the meat industry reached 22.9% of total revenues from the sales of own products and services of food industry in 2014. In this field there is the fourth highest number of companies (i.e. 23.8%), which employ 24.4% of the entire food industry. The food industry contributed with 17.4% to the value added of food processing industry in 2014, ie. the third highest part. Problematic area of the meat industry is a long-term decline in the number of employees in this field (in 2014 the company employed 21 051 persons); as well as low labour productivity (484 000 CZK) and a low average wage per month of employees. In the long term the lack of competitiveness in the pork production is reported, especially the negative foreign trade balance. Decrease in the number of pigs and sows as well as low self-sufficiency, especially in pig and poultry meat are among the greatest challenges of livestock production in the Czech Republic. The declining self-sufficiency is involved in increasing pork imports that compete with domestic supply and thus influence the profitability of the sector. According to the above stated data the situation of meat processors does not develop very favourably. For this reason, the economic performance of enterprises plays an increasingly important role in this field, and identifies competitive position of those companies on the Czech market.

This article aims to identify qualitative factors limiting the competitiveness of the meat industry enterprises measured by their economic performance. Partial goals are to find statistically significant differences in the selected indicators and in qualitative factors; to perform cluster analysis and to identify groups of companies with similar characteristics on the market. To find a group of companies that can be considered as endangered or their position is crucial and to identify factors affecting their market position will be found as a synthesis of partial goals in this article.

Materials and methods

Data and variables

The primary source for a database of enterprises of the meat industry was a database of companies and institutions Albertina, managed by Bisnode company. This database provides individual data from financial statements (balance sheet and profit and loss statement) of businesses. The selection of companies was carried out according to the CZ-NACE businesses (ie. the classification of economic activities). This means that companies engaged in the production field 10.1 Processing and preserving of meat and meat products (just as the predominant activity) were selected. A total of 233 enterprises were subject to evaluation in 2014.

Accounting data as added value, production consumption, revenues from sales of own products and services, assets, EBIT and additional indicator of the number of employees (all data for 2014) from the Database Albertina were used for a purpose of this article. Four financial evaluation indicators, respectively economic analysis were set based on this data. The indicators reflect internal and external business environment and can be considered to be the basic representatives of company competitiveness measured by their performance. Evaluation of competitiveness based on financial indicators was done, for example by authors Liargovas and Skandalis (2010), Habib (2006), Meric et al. (2011). This includes the following quantitative indicators:

- Labour Productivity: a representative of business performance that reflects the economic level of enterprise and efficiency of employee utilization (Kislingerová et al., 2008). Labour productivity was determined as the converted value added per employee.
- Revenues: It is an item of profit and loss statement - Revenues from sale

of own products. The indicator was ranked as a representative of a production created by a company.

- Production Consumption: an indicator representing the key cost item of the operating area of the company. It is a unit profit and loss statement- Production consumption, which includes the cost of materials, services and energy.
- Return on assets (ROA) is calculated as the ratio of profit before interest and taxes, and the total amount of assets. As an indicator for measuring competitiveness was ROA used for example by Tangen (2003) and Berman et al. (1999).

Qualitative factors limiting companies' performance

Latruffe (2010) specifies determinants of competitiveness of the agricultural and agri-food sector and divides them into two groups. The first are the determinants controllable by the company, ie. size and other structural characteristics (legal form, intensity of factor use; indebtedness; specialization of business), social capital (age of the entrepreneurs, education, gender, etc.). Determinants, that are not controllable by the company, ie. equipped by factors (sources of labour, land and capital) and conditions of demand; government restrictions in the agricultural sector; public expenses for research and infrastructure; location of activities.

Determinants forming the competitiveness of the agri-food sector have been set with respect to the data availability. Meat industry businesses were divided and analysed according to selected qualitative characteristics, ie. according to their size, form of ownership, using grants and regions. These are the factors that have been identified as factors limiting the competitiveness of meat companies measured by financial and economic indicators.

Businesses were classified into four groups according to the size, ie. the micro, small, medium and large businesses. The primary criterion for classification was the number of employees. Micro-enterprise is an enterprise which employs 0-9 employees; small enterprise employs 10-49 employees, medium companies are with 50-249 employees, and large enterprise has more than 250 employees. Czech Statistical Office commonly use this criterion. Widely used is also criterion based on the Recommendation 2003/361/ES) which use also turnover and annual balance sheet. The authors are aware of possible different results when choosing this indicator in point of view to the definition of size of company. Information about the number of employees was obtained from the database of companies and institutions Albertina. In case of missing data for some enterprises, the information was searched at justice.cz in a section of annual reports. Overall 102 micro enterprises, 82 small companies, 34 medium and 15 large enterprises were analysed.

According to the forms of companies' ownership, the meat industry is divided into the following categories: individual ownership (in this category there are firms owned by one person); family ownership (incorporated businesses with owners of the same name); other ownership (company owned by various people) and foreign ownership (enterprises with owners of foreign origin with an ownership greater than 50%). Information about the ownership of individual firms was obtained from the Arachné database, managed by the company Bisnode, which focuses on ownership in companies. Their own classification of property into the above groups was carried out based on the data. A total of 67 individually owned companies, 69 family owned enterprises, 91 enterprises of other ownership and 6 foreign companies were analyzed.

The penultimate qualitative criterion was subsidy drawing. Meat industry businesses are part of the processing industry and therefore they have the opportunity to benefit from the Rural Development Programme support. i.e. 1. 3. 1 Adding value to agricultural and food products (valid for RDP 2007-2013). Based on this factor, the enterprises have been divided into three groups, i.e. companies which benefited from a subsidy (enterprises that applied for a grant in 2012-2014, were supported and their applications for aid have been paid); businesses that did not draw subsidies (businesses did not apply for the support within that time period) and businesses that applied for a grant, but did not receive it, thus were not supported. Information on drawn subsidies of the meat industry enterprises was obtained from the Registry of grant recipients, managed by the Ministry of Agriculture. In the evaluation there were 40 supported companies, 167 businesses that did not receive subsidies and 26 companies that have failed in obtaining a grant and were not supported.

The last factor which was monitored by meat businesses was a region in which the business is located. Criterion of location (country, region), have been used by for example Bakucs et al. (2010).

Frequencies of enterprises in individual regions will be shown in the tables of basic descriptive characteristics.

Qualitative variables with greater than 75% statistically significant effect on quantitative indicators were evaluated as a factor affecting competitiveness.

Database Albertina provides accounting data for 316 companies in manufacturing sector 10.1 Processing and preserving of meat and meat products in a time period from 2010 to 2015. Data for 2015 are not complete; it is only listed for minimum companies therefore the year 2014 was evaluated. Data was gathered from 233 companies that year. Thus the article analyses 73.7% of companies with available accounting data.

Statistical analysis

At first, the basic descriptive characteristics - some measures of location and variability, such as mean, 95% lower and upper confidence interval of mean, median and standard deviation - were calculated for individual enterprises of Processing and preserving of meat and meat products (CZ-NACE 10.1) industry. Furthermore, the relative and absolute frequencies were evaluated, i.e. frequency tables for various economic indicators based on qualitative factors were made (Brase and Brase, 2016).

Then, statistical differences of the impact of factor (the individual categories of mentioned qualitative variables) per average levels of monitored economic indicators were observed using one-way analysis of variance (one-way ANOVA). The ANOVA is a standard used tool (Rossi and Mirtchev, 2016). The null hypothesis is that the average values of the given economic indicator are the same for all observed groups classified by the given factor. An alternative hypothesis is that at least one of the monitored groups differs with its average from other average values. Analysis of variance is based on the F test. Output of F test is p-value, which is compared with the significance level $\alpha = 0.05$. If $p < \alpha$, then we reject the null hypothesis (Baguley, 2012). Within ANOVA there is sometimes performed so-called multiple comparison using a post-hoc tests (Cardinal and Aitken, 2013) however, it is not covered in the paper.

Furthermore, cluster analysis was used, specifically Hierarchical Cluster Analysis, tracking the similarity of enterprises' behaviour on the basis of monitored economic indicators as authors (Santis et al., 2016) use it. The paper uses Ward's method as a Cluster Method with chosen measure Squared Euclidean Distance (Rasmussen, 1992). The output of cluster analysis is a graphical representation of clusters using dendrogram (Bennani and Benabdeslem, 2006).

Results and discussion

The results are organized according the examined qualitative factors that have been identified as possible factors affecting competitiveness (defined by selected quantitative indicators) of the meat industry enterprises. Basic descriptive statistics are always listed (mean, 95% lower and upper confidence interval of mean, median, standard deviation), including statistical significance of influence of qualitative variables on financial-economic indicator (p-value).

Size of business

Size of the company was the first examined factor, respectively its impact on the performance indicators shown in Table 1. Average labour productivity is the lowest in micro enterprises, highest in large enterprises. The larger the enterprise, the greater is its average labour productivity. However, the productivity grows more slowly with increasing size (in the case of medium and large enterprises it is very similar). Wide range of values (minimum and maximum) is evident for micro and small enterprises, which is primarily due to the nature of enterprises, i.e. family firms with a small number of employees, which increase the value of this indicator. Testing statistically significant differences in this indicator by size category proved to be significant (p-value).

Average revenues of micro and small enterprises are at closely comparable level. In the case of micro enterprises they are even slightly higher. On the other hand, the difference between revenues of medium and large enterprises is significant (large companies have in average higher revenues by more than 1 mil. CZK). Values of indicators differ significantly across the size categories. In connection with this indicator, a linear development of pivotal cost indicator was proved, ie. production consumption has shown where its value differ significantly among other companies. However, there is no reduction in the consumption of materials, energy and services as the business grows.

Micro and small enterprises reported a negative ROA in 2014 due to the negative profit. Profitability of medium and large enterprises is low, while large firms reported higher profitability. However,

Economic indicator	Size of business	N	Mean	95% Lower Confidence Interval for Mean	95% Upper Confidence Interval for Mean	Median	Std. Deviation	P-value ANOVA
Labour productivity	Micro	102	165.62	104.66	226.59	0	308.84	0.000029*
	Small	82	286.83	241.46	332.21	247.54	206.51	
	Medium	34	370.03	312.89	427.17	337.75	163.75	
	Large	15	378.62	275.48	481.76	317.02	186.24	
Revenues	Micro	102	65 853.35	-29 368.73	161 075.42	787.00	482 350.69	<0.000001*
	Small	82	62 978.88	43 601.12	82 356.64	30 099.75	88 191.32	
	Medium	34	355 068.12	265 299.36	444 836.88	273 751.00	257 278.64	
	Large	15	1 442 223.07	799 576.48	2 084 869.66	1 495 991.00	1 160 469.50	
Production consumption	Micro	102	56 041.90	-21 547.74	133 631.53	1 635.00	393 032.95	<0.000001*
	Small	82	59 813.47	41 977.43	77 649.51	33 727.75	81 174.71	
	Medium	34	313 091.75	229 436.49	396 747.01	219 945.50	239 757.26	
	Large	15	1 359 331.97	841 204.89	1 877 459.05	1 383 939.00	935 616.38	
ROA	Micro	102	-0.14	-0.36	0.08	0	1.11	0.620629
	Small	82	-0.02	-0.09	0.05	0.02	0.32	
	Medium	34	0.01	-0.03	0.05	0.04	0.12	
	Large	15	0.02	-0.01	0.06	0.03	0.06	

Note: * Statistically significance of influence of company size on economic indicators (testing on level of significance α=0.05). All indicators are in thousands CZK, ROA in CZK.
Source: own processing

Table 1: Descriptive statistics and one-way ANOVA for factor „Size of business“, year 2014.

the values of this indicator do not differ significantly in individual size categories of meat enterprises.

The size of the business can be considered as a factor limiting the competitiveness of enterprises of the meat industry. Statistically significant differences among the three performance indicators (out of the four analyzed) were demonstrated. Whereby it was confirmed that larger businesses show a better performance characteristics as confirmed for example by Carroll et al. (2009), Zhu et al. (2008), Latruffe et al. (2004). Therefore it can be agreed with the statement that large firms achieve economies of scale and can benefit from preferential access to the market of inputs and outputs (Hall and LeVeen, 1978). On the contrary, an inverse relationship between the size of the business and its productivity was proved by Munroe (2001) or O'Neill and Matthews (2001). According to Buckwell and Davidova (1993) the explanation for this relationship is that small businesses are not affected by the need to control labour or organizational problems and the family workforce is highly motivated to benefit from their own business.

Business ownership

Effect of ownership on the economic results of meat enterprises is documented in Table 2. Individual business or small family firms may be associated with certain traditions and craft activities, so there is an obvious lower labour productivity than in foreign-owned enterprises of the meat industry. On the other hand, the age of the owner may be the reason for the low productivity. Older owners may not be willing or able to accept the possibility of technological innovation (Lambarraa, 2009). On the other hand, older owners can use their experience and knowledge for more efficient use of inputs (Munroe, 2001; Mathijs et al., 2001). This indicator is not statistically different among the categories of enterprise.

Statistically significant differences were confirmed for the indicators of revenues and production consumption. Family businesses report the lowest revenues; foreign-owned businesses report the highest. The average return on assets was negative for individually owned and other enterprises in 2014. The highest ROA was in family businesses, which is confirmed by the results of Buckwell and Davidova (1993) who claim that family businesses are very motivated to prosper. Indicator is not statistically significantly different according to business ownership. Similar results ie. no effect on the return on assets, respectively return on sales, in the food business are confirmed by Schiefer and Hartmann (2008).

According to the results foreign-owned enterprises may be the best performing group, because they have the highest values of the evaluated indicators. The position of other categories of enterprises is not clear, which was confirmed by the authors Davidova and Gorton (2004), whose results indicate no clear superiority of performance either in family

Economic indicator	Business ownership	N	Mean	95% Lower Confidence Interval for Mean	95% Upper Confidence Interval for Mean	Median	Std. Deviation	P-value ANOVA
Labour productivity	Individual	67	216.42	165.48	267.36	217.33	208.83	0.193638
	Other	91	236.18	192.22	280.14	232.15	209.88	
	Family	69	298.5	214.83	382.17	245.48	348.3	
	Foreign	6	359.29	9.14	709.43	393.35	333.65	
Revenues	Individual	67	127 227.46	44 469.53	209 985.40	8 844.00	339 284.27	0.027145*
	Other	91	285 386.48	124 200.16	446 572.81	43 948.00	769 584.35	
	Family	69	107 057.36	43 224.83	170 889.88	19 208.00	265 718.38	
	Foreign	6	654 189.50	-319 125.31	1 627 504.31	148 915.00	927 464.99	
Production consumption	Individual	67	126 481.99	47 088.15	205 875.84	12 633.00	325 492.45	0.027686*
	Other	91	246 350.36	111 731.71	380 969.01	40 480.00	642 736.97	
	Family	69	105 019.53	43 532.47	166 506.58	18 729.00	255 954.79	
	Foreign	6	617 976.92	-319 890.10	1 555 843.93	111 727.00	893 687.03	
ROA	Individual	67	-0.19	-0.52	0.13	0	1.35	0.353767
	Other	91	-0.05	-0.11	0.01	0.01	0.29	
	Family	69	0.04	-0.02	0.1	0.03	0.25	
	Foreign	6	0.03	-0.06	0.12	0.05	0.09	

Note: * Statistically significance of influence of company size on economic indicators (testing on level of significance α=0.05). All indicators are in thousands CZK, ROA in CZK.

Source: own processing

Table 2: Descriptive statistics and one-way ANOVA for factor „Business ownership“, year 2014.

businesses or other types of businesses.

Form of company ownership according to testing the significance of differences cannot be considered as a factor limiting the competitiveness of enterprises of the meat industry.

Subsidies

In Table 3 there is a difference in performance indicators when dividing enterprises according to the use of grant resources. The lowest labour productivity is reported by firms that did not apply for support. Average labour productivity of businesses that have been supported is higher than labour productivity of firms that did not receive support (ie. eventually they had to finance the investment by themselves). However, the labour productivity does not differ significantly which was confirmed by testing statistically significant difference by p-value. The impact of subsidies can be assessed as positive since supported businesses have higher labour productivity. Similarly, it is confirmed in the Czech agri-food by Špička and Krause (2013), Medonos et al. (2012).

Supported businesses also have the highest revenues. However, in case of production consumption they do not achieve economies of scale and value of this indicator is also the highest. Both revenues and the production consumption differ significantly among categories. The positive impact of the subsidy was confirmed for example by Bernini and Pellegrini (2011), Del Monte and Papagni (2003) or Skuras et al. (2006), the negative impact by Criscuolo et al. (2009) and Harris and Trainor (2005). Supported enterprises showed a positive return on assets in 2014. Enterprises that drawn subsidy or were not supported had a negative ROA. It was not confirmed that this is a statistically significant difference.

According to the results it cannot be confirmed that subsidies are among factors that would significantly contribute to increasing the competitiveness of firms on the market (as measured by performance indicators).

Region

Another possible factor determining the competitiveness of companies can be explained by their locational characteristics. Therefore the last tested factor was a region, respectively location of meat enterprise and its effect on performance. Thus it is a factor over which the companies have no control. Location of enterprises may be associated with a different climate and soil quality in the case of primary production enterprises. In the case of processing enterprises, it may be more of a market infrastructure. Basic descriptive characteristics are apparent in Table 4. Statistically significant effect of the region on individual performance indicators was not a single case. Location of the enterprise cannot be considered as a factor that would affect the competitiveness of the meat industry.

Economic indicator	Subsidies	N	Mean	95% Lower Confidence Interval for Mean	95% Upper Confidence Interval for Mean	Median	Std. Deviation	P-value ANOVA
Labour productivity	**Supported**	**40**	302.34	239.83	364.85	286.94	195.46	0.246421
	Not drawing	**167**	234.24	192.57	275.92	201.27	272.79	
	Not supported	**26**	291.84	175.9	407.78	246.59	280.87	
Revenues	**Supported**	**40**	552 317.64	260 927.25	843 708.02	208 619.00	911 120.22	0.000017*
	Not drawing	**167**	102 974.06	39 541.44	166 406.68	7 419.00	415 188.25	
	Not supported	**26**	249 269.78	67 246.16	431 293.40	55 186.00	440 970.37	
Production consumption	**Supported**	**40**	500 765.44	244 356.97	757 173.91	185 920.00	801 738.69	0.000007*
	Not drawing	**167**	95 266.63	41 917.19	148 616.08	7 797.00	349 190.42	
	Not supported	**26**	226 395.58	65 279.41	387 511.75	51 951.00	390 319.98	
ROA	**Supported**	**40**	0.02	-0.01	0.05	0.03	0.08	0.728902
	Not drawing	**167**	-0.09	-0.22	0.05	0	0.89	
	Not supported	**26**	-0.06	-0.12	0.01	0.01	0.16	

Note: * Statistically significance of influence of company size on economic indicators (testing on level of significance α=0.05). All indicators are in thousands CZK, ROA in CZK.

Source: own processing

Table 3: Descriptive statistics and one-way ANOVA for factor „Subsidies“, year 2014.

Economic indicator	Region	N	Mean	95% Lower Confidence Interval for Mean	95% Upper Confidence Interval for Mean	Median	Std. Deviation	P-value ANOVA
Labour productivity	Jihočeský	13	174.17	69.48	278.87	187.27	164.78	0.410302
	Jihomoravský	35	231.98	140.31	323.65	210.71	266.85	
	Karlovarský	5	61.28	-46.57	169.13	0	86.86	
	Královehradecký	14	186.24	86.09	286.39	189.51	173.45	
	Liberecký	7	205.93	0.43	411.42	193.33	222.19	
	Moravskoslezský	23	271.78	135.83	407.74	232.7	314.4	
	Olomoucký	5	196	-38	430.01	191.74	188.46	
	Pardubický	14	296.07	182.57	409.56	255.76	196.57	
	Plzeňský	10	309.62	122.24	496.99	332.47	261.93	
	Praha	20	386.03	151.99	620.07	222.9	500.07	
	Středočeský	30	241.02	160.87	321.18	245.35	214.66	
	Ústecký	12	169.08	66.98	271.18	181.82	160.69	
	Vysočina	19	307.69	208.9	406.49	291	204.98	
	Zlínský	26	255.59	175.02	336.17	237.84	199.48	
Revenues	Jihočeský	13	424,958.17	-457,665.92	1,307,582.26	7,134.5	1,389,150.45	0.61708
	Jihomoravský	35	97,295.61	29,680.49	164,910.74	6,640	196,834.81	
	Karlovarský	5	31,333.4	-5,609.32	68,276.12	26,103	29,752.59	
	Královehradecký	14	108,493.25	119.24	216,867.26	13,252.5	187,698.71	
	Liberecký	7	70,592.29	-12,030.85	153,215.43	48,215	89,337.21	
	Moravskoslezský	23	106,896.13	34,120.74	179,671.52	16,741	168,293.09	
	Olomoucký	5	205,299.8	-103,781.62	514,381.22	78,141	248,925.17	
	Pardubický	14	184,567.21	-60,314.4	429,448.83	64,467	424,123.49	
	Plzeňský	10	455,324.45	-150,988.67	1,061,637.57	34,106.75	847,567.3	
	Praha	20	171,577.05	30,405.2	312,748.9	22,134.25	301,639.96	
	Středočeský	30	191,129.7	33,106.79	349,152.61	28,542.25	423,193.13	
	Ústecký	12	56,677.5	-13,239.88	126,594.88	20,384.5	110,042.04	
	Vysočina	19	420,495.63	-133,735.25	974,726.52	26,917	1,149,893.41	
	Zlínský	26	245,741.56	61,181.49	430,301.62	50,240.5	456,935.06	

Note: * Statistically significance of influence of company size on economic indicators (testing on level of significance α=0.05). All indicators are in thousands CZK, ROA in CZK.

Source: own processing

Table 4: Descriptive statistics and one-way ANOVA for factor „Region“.

Economic indicator	Region	N	Mean	95% Lower Confidence Interval for Mean	95% Upper Confidence Interval for Mean	Median	Std. Deviation	P-value ANOVA
Production consumption	Jihočeský	13	348,246.33	-369,264.65	1,065,757.32	9,779.25	1,129,281.11	0.629967
	Jihomoravský	35	91,456.44	28,035.67	154,877.22	14,697	184,624.61	
	Karlovarský	5	28,587.4	-4,976.1	62,150.9	23,329	27,031.07	
	Královehradecký	14	101,771.18	-737.25	204,279.61	9,698	177,539.8	
	Liberecký	7	62,682.71	-4,691.69	130,057.12	41,613	72,849.34	
	Moravskoslezský	23	118,401	34,907.05	201,894.95	14,911	193,079.76	
	Olomoucký	5	296,308.2	-207,044.9	799,661.3	64,556	405,385.92	
	Pardubický	14	172,116.04	-60,906.58	405,138.65	51,620.5	403,584.26	
	Plzeňský	10	428,197.2	-154,053.69	1,010,448.09	29,998.25	813,930.62	
	Praha	20	147,164.1	23,353.61	270,974.59	13,259.75	264,544.19	
	Středočeský	30	165,583.68	29,857.4	301,309.96	24,062	363,481.65	
	Ústecký	12	57,139.54	-8,047.79	122,326.87	18,863	102,597.48	
	Vysočina	19	358,944.55	-109,449.82	827,338.92	23,397	971,803.66	
	Zlínský	26	226,954.5	59,201.72	394,707.28	50,536	415,323.48	
ROA	Jihočeský	13	-0.04	-0.23	0.14	0.02	0.29	0.731963
	Jihomoravský	35	-0.03	-0.1	0.05	0.02	0.23	
	Karlovarský	5	-0.14	-0.82	0.55	0	0.55	
	Královehradecký	14	0	-0.07	0.06	-0.02	0.11	
	Liberecký	7	0.02	-0.07	0.1	0.02	0.09	
	Moravskoslezský	23	0.03	-0.04	0.11	0.01	0.18	
	Olomoucký	5	-0.02	-0.18	0.14	0.01	0.13	
	Pardubický	14	-0.01	-0.17	0.14	-0.01	0.28	
	Plzeňský	10	-0.01	-0.04	0.03	0	0.05	
	Praha	20	-0.55	-1.7	0.6	0.03	2.46	
	Středočeský	30	-0.08	-0.25	0.08	0.03	0.45	
	Ústecký	12	-0.04	-0.17	0.09	0.01	0.21	
	Vysočina	19	0.04	-0.03	0.12	0.02	0.16	
	Zlínský	26	-0.01	-0.04	0.03	0	0.08	

Note: * Statistically significance of influence of company size on economic indicators (testing on level of significance α=0.05). All indicators are in thousands CZK, ROA in CZK.
Source: own processing

Table 4: Descriptive statistics and one-way ANOVA for factor „Region“ (Continuation).

Cluster analysis

Another objective was to find a group of meat industry companies that perform similar market behaviour and thus to identify groups of companies that can be considered endangered, or they have a key position on the market. Enterprises have been classified into four clusters. Because of the extent there is no dendrogram in the article but only a verbal description. More detailed results of the cluster analysis are therefore available on request from the authors of the article.

There were 7 companies grouped in the first cluster. There were only large enterprises. Five of them have drawn subsidies and those were mainly from the group with other ownership (company owned by various people). According to previous analysis we can suggests a strong position of this group on a market, which also pose a potential threat for other groups with regard to the fact that large companies have shown the best performance characteristics. It was also shown that companies which have drawn subsidy achieve higher sales than unsupported businesses.

The second cluster includes only two large companies whose economical results have surpassed other businesses. Companies have a corporate owner and because of their economical results they are key players on the market.

The third cluster includes 25 companies. These are mainly enterprises with other ownership (56%), which are medium size (60% of enterprises) and 44% of them did not draw subsidies. Medium-sized businesses get closer to large enterprises with their results. Size is a factor limiting the competitiveness on the Czech market and that is why this group has the potential to develop its opportunity to compete with the previous two clusters.

The last largest cluster is a group of 199 enterprises made up by 36% of businesses owned by various persons, and 32% of family businesses. These are mainly small and micro enterprises (total 89% of enterprises), which did not apply for support (77% of enterprises). Micro and small enterprises performed the lowest values of indicators as well as the unsupported businesses. The position of these enterprises on the Czech market may be endangered to a certain level. Since these are small sized businesses, we can assume that their philosophy (ideas about visions and goals) is totally different than in the case of large enterprises. Small businesses can face their production to local customers and compete with other local processors. Especially because of the form of sales and the access to specific markets they have the advantage that large companies are missing and might not even be interested in these markets (preference of sold amount).

Conclusion

The main aim of the article was to identify qualitative factors that limit the competitiveness of enterprises of the meat industry on the Czech market. Size of the company, ownership, use of support and region were considered. It was confirmed that better performance characteristics are shown by large enterprises. Differences among the companies were significantly different so the size of a company can be stated as a factor limiting competitiveness. Foreign -owned enterprises can be evaluated as the most powerful according to the business ownership. These differences were statistically significantly different only in indicators of revenues and production consumption. Therefore competitiveness is not determined by the form of ownership. It was confirmed that the enterprises which were supported by grants tend to have improved performance indicators. Statistically significant differences were confirmed only for revenues and production consumption. Therefore it cannot be confirmed that subsidies are among factors that would contribute to increase the competitiveness of enterprises, as well as a location of company (statistically significant differences in indicators did not show in any single case).

Four groups of companies that exhibit similar characteristics operating on the Czech market were identified according to cluster analysis. Two key groups of players on the market were identified from these clusters. This is a group of large companies that exhibit superior performance characteristics and are a potential threat for other groups on the market. The potential for the development or being a competition to these groups have businesses of the third cluster (consisting primarily of medium-sized companies that exhibit values very close to large enterprises). The largest group is the cluster formed by micro and small enterprises which did not apply for support. Their position on the market can be influenced by other clusters to some degree. However, these companies might have different goals than large businesses and focus more on local consumers.

Where were used various approaches to analyse economic situation in meat industry. It is hard to compare the same problematic as in this paper. Mijic et al. (2014) used wide portfolio of financial analysis indicators to evaluate meat industry. They indicated the low return on investment, profitability, liquidity, and high debt of the companies in the meat industry in Serbia. The companies in the meat-processing industry had better performance than livestock producers and this difference is statistically significant. With these authors we can compare ROA, which was 11.08% in 2012, in our sample of processing companies was much lower (depends on company´s type). Martin et al. (2015) used to evaluate the economic and financial health of the meat industry companies, by financial ratios Price to earnings ratio, profit margin, debt to equity, and return on equity. The ratios were compared to the ratios of the top 15 industries. For three of the four key financial ratios that were tested, meat industry firms on average performed significantly weaker than the top 15 industries. Debt to equity ratio showed the meat firms to be about the same as the top 15 industries. Financially and economically, the meat firms were not as strong as the average firm in the top 15 industries.

Wijnands et al. (2007) dealt with competitiveness of sub-sectors food industry. The EU is a leading exporter of meat, net exporter for pork and poultry and net importer for beef. The trade balance in meat for the EU developed negatively, he surplus decreased. The EU has a negative trade balance for beef. Author recommended to focus on the production of fresh products for the demanding European customer. The competitiveness of the EU meat industry is weak. Third countries like Brazil and Argentina have competitive advantages (large and reliable livestock supplies, low costs of labour and feed combined with economies of scale). The need

for consolidation will be a key issue in the meat industry mergers to achieve economies of scale. Only bigger companies with an adequate scale can exploit the opportunity to cater for the various preferences for meat cuts between countries.

Banterle and Carraresi (2006) applied cluster analysis to highlight groups of countries with similar features in meat industry. The competitiveness was presented by RCA and NEI indexes. Good competitive performance in the meat sector was observed in Italy, Spain, Ireland and Austria, all were found to be specialised in the sector and export oriented. Germany and France showed positive competitive performance, but a high level of intra - industry trade and low specialisation. Denmark was characterized by negative dynamics of competitiveness even though there were high exports in the sector; a similar trend is observed in Belgium and the Netherlands. The rest of the countries show weak competitiveness for the analysed sector. The type of exported product varies greatly also. Italy and Spain export dried or smoked swine meat, whereas Germany and Denmark export mainly sausages and preserved meat. Krystallis and Arvanitoyannis (2006) used also cluster analysis to analyse meat industry in Greece, but to define consumer types in relation to meat quality perceptions.

Acknowledgement

This article was created with the support of the Internal Grant Agency of the Faculty of Economics and Management of the Czech University of Life Sciences Prague. Grant title: The competitiveness of enterprises of the food industry on the Czech market. Registration number: 20161006.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

The Demand of Services for Information Technology Industry in Indonesia

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Abstract

This research has a goal for analyzing determinant demand of telecommunication services either mobile phone or internet in Indonesia. This research uses secondary data of publication result from the Indonesian Central Bureau of Statistics in 2012-2013 period for 34 provinces in Indonesia. The demand for mobile phone is considered as the function of Gross Domestic Product (GDP) per capita and the region for dummy while the demand of internet service is the function of mobile phone service request, GDP per capita, proportion of educated society, proportion of the employment, and the region as a dummy. This research also modifies the model by placing the region as a moderating variable on GDP per capita. Furthermore, it is also done by using reduced form (mediation) to estimate the indirect effect on mobile phone ownership towards internet service request. The result of research showed that the demand for mobile phone and internet in Indonesia was influenced by income factor (GDP per capita). Yet In Indonesia, there are still imbalances in adapting the information technology (internet) between the area of Java-Bali and the outside of those areas. The result of research also showed that the demand for the telephone was able to be mediation of internet use. However, some regions (Maluku and Papua) have not optimally exploited mobile phone to access the internet compared to other regions.

Keywords

Mobile phone, internet services, income, territory, multiple linear regression model.

Rafiy, M., Ernawati, Adam, P. and Rostin (2016) “The Demand of Services for Information Technology Industry in Indonesia", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 125 - 132. ISSN 1804-1930. DOI 10.7160/aol.2016.080411.

Introduction

The development of information technology today begins to eliminate barriers among countries. How it could be, information on certain parts will soon be accessible in other parts of world. The flow of information will be unstoppable, and has become a new power in mobilizing public opinions. Today the war is no longer in physical scale, but has entered the part of the war of ideas. Information technology is just like a double-edged sword, on one side it supports the progress of a nation through time efficiency and information cost, but on the other hand it can be a means of controlling public opinion through harmful opinions which distract the order that have been made in politics, economics, social, and other fields. Unsurprisingly, there is also an idea which states that anyone who controls the information will rule the world. For this reason , every country strives to increase the availability of telecommunication infrastructures, not only to serve as parts of developmental needs but also to meet market demands. The European Union for example has had a strategy ‘Digital Agenda 2020’. The Agenda strives to maximise the social and economic potential of ICT, especially the potential of the Internet, a key medium of economic and social activity in all domains (education, commerce, work, communication, culture etc.). The strategic objective is to bring basic broadband connection to all European citizens by 2013 and to ensure that by 2020 all Europeans have access to much faster Internet (above 30 Mbps) while at least 50% of European households should have access to Internet (Vaněk et al., 2011)

In Indonesia, the development of information technology industry has strived by the government, especially from supply side. The policy of telecommunication has been pushed into the perfect competition so that

telecommunication service providers can compete fairly, as intended by price competition. Expected through price competition, the demand for telecommunications can continue to increase, so that it can give more benefits to the society. Another benefit which can be obtained via telecommunication industry is inter-regional connectivity in Indonesia consisted of thousands of islands separated by oceans. However, due to the large coverage area of Indonesia, the telecommunication developments seem to be unequal. Based on the data of communication and information (Kominfo, 2011) showed that based on territorial aspect, the highest telendensity value is Jakarta and Banten, the value reached 169.3 while the lowest teledensity occurred in the area of West Java and Central Java and Yogyakarta with telendesity value of 36.9. This showed that every 100 people in West Java, Central Java and Yogyakarta there were 37 people using mobile phones. While the figures for the Jakarta-Banten telendensity of 169.3 indicated that each contained 170 people as mobile phone users. This implies that the residents of Jakarta, Banten use two or more mobile phones. The telendensity of Kalimantan, Sumatra and Sulawesi-Maluku-Papua was 83.67, 70.85 and 56.75 respectively. While regional telendensity of Java-Bali and Nusa Tenggara was 56.5.

Thus it is necessary to make many efforts to improve the telecommunication industry from the demand aspects among regions in Indonesia. On the demand aspect of the development of information technology industry, either mobile phones or internet access of households in Indonesia is presented as Table 1.

Years	Household Mobile Phone Users (%)	Household Accessing Internet (%)	Household accessing internet through Mobile Phone (%)
2005	19.88	3.34	n.a.
2006	24.60	4.22	n.a.
2007	37.59	5.58	n.a.
2008	51.99	8.47	33.43
2009	61.84	11.59	n.a.
2010	72.00	22.40	53.51
2011	78.96	25.90	55.35
2012	83.52	30.66	62.58
2013	86.09	32.22	68.76

Sources: Statistics of Indonesia, BPS (2014b)

Table 1: Percentage of Household Phone Users and Internet Users in Indonesia from 2005 to 2013.

Table 1 shows that the number of households using mobile phones continued to increase up to 86.09 per cent in 2013. However, from the aspect of internet usage was still low, only about 33 percent. Whereas the majority of households accessed the internet (2009-2013) through telephones. This indicates that the phone ownership has not been used optimally by the community.

Several factors which can affect the optimal use of the phone including for the purpose of Internet data access were educational level of the telephone users and employment status. internet access was influenced by someone's education because accessing these data required knowledge which was more complicated than using a regular phone. Internet users are also strongly associated with a person's job, either as students, office workers, or other professional workers. The demand for the service was potentially higher than other groups, such as children and housewives. Some other factors that could affect demand for telecommunication services industry can be viewed from the aspect of micro and macro. Some studies related to the demand for telecommunication services of micro aspects were reviewed by (Omotayo and Joachim, 2008; Wang and Lo, 2002; and Olatokun and Nwonne, 2012). This research generally correlated with the decision of provider's service election that was associated with the factor of quality of service and satisfaction. Several other studies examined the demand for telecommunication services from the macro aspects (Gruber and Verboven, 2001; Ahn and Lee, 1999; and Jha and Majumdar, 1999) by placing the variable gross domestic products (GDP) per capita as a variable affecting the demand.

Studies on the use of telephone and internet in Indonesia were carried out by Utomo, et al (2013) on the public of capital city of Jakarta, which incorporated the element of demographics as a determinant of telephone and internet use. This study investigated the determinants of telecommunication services from the micro level. The study examined the determinants of demand for telecommunication services to the macro scale of all provinces in Indonesia with the involvement of the regional location remained unconsiderable, whereas the position of Indonesia which is divided into several areas with different imbalances in economic development that is more inclined to the Java-Bali obviously a little more influences developmental differences of telecommunication industry between Java-Bali and non Java-Bali. This study examined how aspects of the area, population status (school and work) as well as aspects

of the economy (GDP per capita) affected the demand for telecommunication services in Indonesia.

Review of literature

The demand for services and goods have multiple determinants. As the standard of existing theories, the demand is influenced by the price of the goods themselves, the price of other goods, tastes, income, and population. Price is the major determinant of the demand for goods and services. In essence, the lower the price of an item, the more demand for goods. Conversely, the higher the price of an item, the less demand for goods. The price of other goods also affects the purchase, depending on the nature of the relationship between the two items, whether as a substitution, complementary, and no interconnection. Although goods / services are not interconnected, but still influence demand if factors constant revenue because the increase in price will reduce purchasing power. Consumers will face a more limited budgeting problem so that they must choose certain types of goods. The selection will sacrifice other options that reduce the demand for goods and services. Patterns of relatedness are indicated with an income elasticity with the request indicating the characteristic of the goods of which is essential goods, luxury, or inferior. The income elasticity, $e>1$ indicates the goods/services of a luxury item; while $0<e<1$ is of basic goods; while $e<0$ indicates the type of inferior goods. Garbacz and Thompson (2007) found that income elasticities of fixed main lines was 0.291, while income elasticities of mobile was 0.933. But when model incorporates the instruments for residental landline and mobile monthly prices, income elasticities of mobile was 1.260 or indicate as luxury goods.

The demand for services in the telecommunication industry is influenced by several factors. Herrmann et al. (2007) stated that the price factor had a vital role, especially in the telecommunication market particularly in mobile phone service providers. Several studies related to the demand for telecommunication services from micro aspects generally reviewed purchasing decisions with customer satisfaction and loyalty. Omotayo and Joachim (2008) found a strong relationship between customer service and customer retention in the telecommunication industry in Nigeria. Park and Ohm (2014) found that satisfaction and with and perveived usefulness of mobile map services were the most significant antecedent of users' attitude toward services and behavioural intention to use them. Then Olatokun and Nwonne (2012) found that the quality of service and availability affected more on the electoral process of the use of telecommunication provider service compared to promotion factor and brand image. The demand for cellular phone services in Malaysia was also reviewed by Rahman et al. (2010) from micro aspects which found that the quality of service and price significantly and positively impact on the demand for mobile phone services. In contrast to these studies, Adikari (2013) conducted a study about a telephone request to the students in Sri Lanka by using the variable of availability of facilities / features of the phone and income as a determinant, the research showed that the income level significantly and positively impact on the demand for mobile phones, whilst the facilities / features provided no effect. Other studies that incorporated demographic aspects in the use of the phone studied the use of the phone at the same time as the use of the internet in Jakarta conducted by Utomo, et al. (2013) using variables gender, age, education level and employment status (working, student, work, and not in the labor force). Regression of all these variables showed that the variables of age, education level and employment status affected the ownership of the phone, but not for gender. While the Internet access via mobile phones showed that all variables were significant except for a group of junior secondary school. Result of a study conducted by Varallyai and Herdon (2010) showed that demands for telecommunication, particularly the use of internet, decrease along with age increase. In 2008 about 73 percent of a population ageing 16 – 24 years in European countries used the internet, 51 percent by 25- 43 years of age, and only, and only 7 percent by those ageing 66-74 years accessed the internet. While the demographic aspects in the use of the Internet was also seen in the study of Taylor et al. (2003) researching the determinants of Internet use on a variety of purposes, the results showed that the demographic factors and socio-economic (location, gender, education level, marital status, combined with family income and employment status) influenced the internet access for the purpose of working in Central Queensland resident. While people using the internet for online shopping purposes were only influenced by factors of age and level of education. Hsiao and Chen (2014) found that users' gender, age, occupation and income have significant effects on the contract with voice and 3G internet, and the monthly 3G internet fee.

Furthermore, Kalmus et al. (2011) examined aspects of Internet requests from the aspect of personal traits, socio-demographic variables and habitual indicators as well as lifestyle of Estonian population at the age of 15-74 showed that the motive for someone to access the internet was the use of Social media and entertainment (SME), and work and information (WI). The analysis showed that the use for the purposes of WI could be well predicted by frequency of use of the Internet for work/school/home, education level, age, gender, language and income level, as it happed to the lifestyle of participating in the public sector. As the SME needs, income and gender factors had no effect. Usage for SME in addition to do at work / school was also done at home and other places. Al-Hammadani and Heshmati (2011), his work in Iraq included elements of the location / region in addition to demographic factors (such as gender, age, educational level and occupation), cost factor, and the intended use of the internet. The results showed that all of these factors had a significant effect, except for the location (area).

Furthermore, several studies evaluating the demand for telecommunication from macro side were namely Gruber and Verboven (2001); Ahn and Lee (1999); and Jha and Majumdar (1999). These three studies using GDP per capita as one of the variables affected the GCC demand for telecommunication services. Gruber and Verboven (2001) found that countries with a higher GDP per capita and larger fixed networks tended to have the higher rate of adoption of mobile services. These results were also in line with the research of Ahn and Lee (1999) which found that the probability of subscribing to mobile phone services was positively correlated with GDP per capita and the number of fixed lines per person. Abu and Tsuji (2010) conducted a study of panel data from 51 countries from 1997 to 2007 period. The results showed that in the group of developed countries, the use / ownership of the phone was influenced by per capita income, the cost of mobile phones, network infrastructure, fixed network, and fixed telephone costs and technology; while in the group of developing countries, telephone installation was affected by the cost of mobile phones, market size, infrastructure, technology, and technological innovation. Mocnik and Sirec (2010) found that the strongest positive and most significant impact on internet use was ICT infrastructure and poeple capabilities, followed by income distribution, and investment and international trade.

Material and methods

The study uses secondary data from the Indonesian Central Bureau of Statistics's publication period of 2012 -2013 in 34 provinces in Indonesia. In order to know the factors that affect the demand for telecommunication services, then we analyze them using the multiple linear regression model which has been also used by Abu and Tsuji (2010) and Al Hammadani and Heshmati (2011). We stated this model in equation (1a), where the demand for mobile phones is a function of GDP per capita and region. The layout of the region as well as the estimated dummy variables is to determine differences in the demand for mobile phones based on the region, which is divided into Java-Bali and non Java-Bali-Bali, based on development inequality of Java-Bali and non Java-Bali-Bali. The are seven provinces in Java and Bali, including: DKI Jakarta, D.I. Yogyakarta, West Java, Central Java, East Java, Banten, and Bali. The other 27 propinces are outside of these regions. Development in Java and Bali occurs rapidly, creating agap between these and ather regions, including the availability of telecommunication inffrastructures. Sujarwoto and Tampubollon (2016) use region variable to estimate spatial inequality and the internet divide in Indonesia. Furthemore, the model of the relationship between the demand for mobile phones (DFMP), GDP per capita (*GDPC*), and region (REGI) are as follows

$$DFMP = \beta_0 + \beta_1 GDPC + \beta_2 REGI + \varepsilon_1 \quad (1a)$$

where β_i (i = 0, 1, 2) are regression parameters, ε_1 is error term, and *GDPC* is the natural logarithm of GDP per capita. Furthermore, *REGI* is a dummy variable with *REGI(x)* = 1 if *x* = a province in the Java-Bali region and *REGI(x)* = 0 if *x* = is not a province in Java-Bali region.

Model (1a) may be further modified by introducing the region as moderating variable on GDP per capita. This is done on the basis of telecommunication infrastructure is more developed in Java and Bali, and still limited for outside of the region; so although GDP per capita in a province is high, but if it is located outside Java and Bali; it will affect the demand for mobile phones. Reformulation of model (1a) becomes:

$$DFMP = \beta_0 + \beta_1 GDPC + \beta_2 REGI + \beta_3 GDPC.REGI + \varepsilon_2 \quad (1b)$$

where β_i (i = 0,1,2,3) are regression parameters, ε_2 is error term, and GDPC.REGI is interaction

factor between GDP per capita (*GDPC*) and region (*REGI*).

As demand for internet services (*DFIS*) as model (2a) is a function of the demand for mobile phones (*DFMP*), GDP per capita (*GDPC*), proportion of the population enrolling in school (*PPES*), the proportion of the working population (*WORK*), and the location of the provinces (regions) as dummy variables (*REGI*).

$$DFIS = \alpha_0 + \alpha_1 DFMP + \alpha_2 GDPC + \alpha_3 PPES + \alpha_4 WORK + \alpha_5 REGI + \varepsilon_3 \quad (2a)$$

where α_j (j = 1,2,3,4,5) are regression parameters, ε_3 is error term, and *DFMP* is a percentage of household telephone users. The demand for internet service is also applicable for interactional factors between GDP per capita and region in model (2b), as follows

$$DFIS = \alpha_0 + \alpha_1 DFMP + \alpha_2 GDPC + \alpha_3 PPES + \alpha_4 WORK + \alpha_5 REGI + \alpha_6 GDPC.REGI + \varepsilon_4 \quad (2b)$$

where ε_4 is error term, α_j (j = 1,2,3,4,5,6) are regression parameters,. Furthermore, the estimate of the full model on mobile phones variables resulting in reduced form as Model (2c)

$$DFIS = \alpha_0 + \alpha_1 (\beta_0 + \beta_1 GDPC + \beta_2 REGI + \varepsilon_1) + \alpha_2 GDPC + \alpha_3 PPES + \alpha 4 WORK + \alpha_5 REGI + \alpha_6 GDPC.REGI + \varepsilon_5 \quad (2c)$$

where ε_5 is error term, The significance of the indirect effect GDP per capita and region via mobile phone demand in the demand for internet use Sobel Test.

Results and discussion

The development of the demand for telecommunication services in Indonesia

Table 2 presents the demand for telecommunication services by households in Indonesia. Table 2 shows that areas with the highest proportion in the control of the mobile phone is Sumatra region with the proportion of 88.35 percent. This also applies to rural RT, and not for an urban neighborhood dominated by Kalimantan with the proportion of 96.32 percent. Based on BPS data in 2014, the province with the household had a mobile phone with the highest proportion over 95 percent was Kepulauan Riau (Sumatra), DKI Jakarta (Java-Bali region), and East Kalimantan (Kalimantan), While the lowest one was Papua (Maluku and Papua region), which has not even reached 50 percent. While the Java-Bali region as the center of the Indonesian economy only ranks as the third after the Sumatra and Kalimantan.

In the aspect of the ownership of the number of active mobile phones, it seems that thehouseholds in Maluku and Papua had a higher mobile phone number other areas. But this seems to have more limited features and not used optimally for example for data access needs. Table 2 shows that on average, the highest proportion of households with access to the Internet is located in Java and Bali, while Maluku and Papua is the second lowest, after the Nusa Tenggara region. Based on BPS data in 2014, the provinces with the highest percentage of Internet usage were Jakarta (located in the Java-Bali region), and DIY (Java-Bali region) and Riau (Sumatra region).

The determinant of demand for telecommunication services

Table 3 presents a model of the demand for telecommunication services in Indonesia. Model (1) and (2) are equal to the demand of telephone service. On models (1a) shows that the GDP per capita affects the demand for mobile phone services, which was in line with research of Gruber and Verboven (2001); Ahn and Lee (1999); and Jha and Majumdar (1999); and Abu and Tsuji (2010) for the case of developed

Territory	Mastering Mobile Phone (%)			Average Active Phone (unit)	Internet (%)		
	Urban	Rural	Average		Urban	Rural	Average
Sumatera	94.89	83.93	88.35	2.11	46.56	16.01	28.42
Java-Bali	90.75	77.69	86.65	2.27	48.85	20.93	40.16
Nusa Tenggara	86.21	59.59	66.43	1.74	36.65	6.79	14.64
Kalimantan	96.32	83.47	88.31	2.26	50.44	14.94	29.36
Sulawesi	92.49	76.86	81.62	2.04	47.16	14.11	24.39
Maluku and Papua	94.75	49.50	63.10	2.34	42.67	7.38	18.45

Sources: BPS 2014b, processed

Table 2: Households Mastering Mobile Phone and Internet Access by Region in Indonesia during 2012.

Variable	Model 1a	Model 1b	Model 2a	Model 2b	Model 2c
C	9.792	-18.452	-68.643**	-72.167**	-63.933
DFMP			0.481***	0.463***	
GDPC	16.735**	23.353***	10.178**	11.913*	18.223**
PPES			0.1	0.066	0.1
WORK			0.58	0.554	0.58
REGI	0.908	69.091	9.482***	25.296	9.918
R	0.481	0.521	0.859	0.86	
R^2	0.232	0.271	0.737	0.739	
Adj R^2	0.18	0.196	0.689	0.679	
F-statistic	0.019	0.025	0	0	

Note: *1% significant level, **5% significant level, and ***10% significant level

Sources: Own processing

Table 3: Estimation results of the model.

countries. While the position of the area showed no significant difference in the use of mobile phones in Indonesia. After having the interaction between the region and the GDP per capita as Model (1b), it appears that despite the negative sign, the position of the area is not a significant factor that will increase the influence of GDP on the demand of mobile phones.

Further, fitting model of internet demand (2a), (2b), and (2c) seems that for the entire internet demand model presented, it appears that education and employment status variables had no significant effect. The results of this study are not consistent with Utomo's reserch, et al, (2013); Cerno and Amaral (2005) and Taylor et al. (2003). In the Model (2a) as an initial model of Internet service demand showed that the use of any mobile phone and GDP per capita effected on households Internet use in Indonesia. The results of this study confirmed the findings of Cerno and Amaral (2005), and Utomo et al (2013) showing that using a phone positively affected Internet access at home.

The results also showed that households using internet in Java-Bali region were higher than the outside of that region. This finding was not in line with Al-Hammadani and Heshmati (2011) for the case of Iraq. Furthermore, when the region was positioned as a moderating factor of GDP capita (Model 2b), it showed no significant result. The final model of the internet demand of households in Indonesia (Model 2c) which is a full model of (2a) appears that the effect of GDP per capita for internet usage is increasing due to the mediation of the use of mobile phones. The biggest effect of GDP per capita for internet usage in Model 3 was 10.178 and increased to 18.223 (Model 2c). This indicates that mobile phone ownership may be mediated the use of the internet for households in Indonesia.

The use of mobile phones in the media showed the increasing growth of features provided by the telecommunication industry, even the feature had been well understood not only the urban population, but also rural population. BPS data (2014b) on the Indonesian communication statistics showed that in 2012 there were 62.58 per cent households accessing Internet through mobile phones; and this number increased to 68.76 percent in 2013. However, the results of research Utomo et al. (2013) confirmed that the use of media in the phone to access the internet was not significant, yet the majority frequency on adolescents in Jakarta was with higher levels of education. The use of Internet access for this group covered the whole purposes studied, which were email, social networks, religious websites, news, job searching, capital markets, economic trends, work related projects, studies, and other general information. In the case of Spain, as well as research Cerno and Amaral (2005) that there was about 25.2 percent of the Spanish population accessed the internet, and the majority of them accessed over the phone that was equal to 74.6 percent

Conclusion

Indonesian territory is separated by oceans and consists of various islands requiring connectivity among regions. This connectivity can be done via telephone and internet media. The development of telephone and internet usage in Indonesia is increasing from year to year. This increase is influenced by the income (GDP per capita). In addition to the revenue factor, internet usage is also influenced by the region. So it seems

that in Indonesia still lies an inequality adaptation in information technology between Java-Bali and out of Java-Bali. This condition will certainly affect the economy of the regions concerned. Therefore, efforts should be to improve the supply side. The results also show that the demand for the phone is able to mediate the use of internet. In Indonesia, in 2012 there were 62.58 percent households accessing Internet through mobile phones; and this number increased to 68.76 percent in 2013. However, there are still regions (Maluku and Papua) which have not been optimally used telephones to access the Internet compared to other areas.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Evaluation of Market Relations in Soft Milling Wheat Agri-food Chain

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Abstract

This paper deals with the assessment of price transmission in partial chains of soft milling wheat on example of the Czech Republic. The price transmission examination is accompanied by an international comparison of analyzed topic. The analysis is carried out for the chain of smooth flour, white baked goods and consumer bread. In all cases, the relation of the farm-gate price – wholesale price – consumer price is examined. The aim of the article is to address the question of whether all of the partial product chains of soft milling wheat can be considered identical in terms of the formation of the price and its transmission to other levels. The analysis itself is based upon variables in the form of time series containing monthly data for the period of January 1999 – October 2011, the time series contain 154 observations. Subsequently, the possibility of the results generalization was verified based on the results of the price transmission in period of January 2012 – December 2015. Price transmission is modeled with the utilization of the Vector Error Correction Model and co-integration analysis. The research showed certain congruent features of the analyzed chains, which can be further generalized. However, significant differences were also established, which constitute the uniqueness of each chain. One-way relations were established on some market levels, while mutual relations were established on others. Overall, the relations in the analyzed agri-food chains can be considered long-term, inelastic and demand-driven. Price transmissions in the chains do occur, individual changes in partial prices are followed by the relevant reaction.

Keywords

Agri-food chain, farm-gate price, wholesale price, consumer price, soft milling wheat, price transmission, co-integration analysis, VECM.

Rumánková, L. (2016) “Evaluation of Market Relations in Soft Milling Wheat Agri-food Chain", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 133 - 141. ISSN 1804-1930. DOI 10.7160/aol.2016.080412.

Introduction

The economic crisis has influenced the efficiency as well as competitiveness of all subjects in national economies all around the world. The prices play the key role in relationships between farmers, retail and consumers. The issue of the agricultural and foodstuffs market together with the issue of the purchasing power of consumers, primarily in relation to essential goods and their willingness, is among the principal topics of recent years. In connection with the accession of the Czech Republic to the European Union as well as with the economic crisis, the position of farmers in individual sectors has changed as compared to their previous situation. Producers, as well as processors and consumers, are forced to react to such changes.

Putičová, Mezera (2011) analyzed competitiveness of the Czech food industry. Among other things, their study shows that sector competitiveness is not critical. Further, the authors emphasize the fact that food producers currently face the basic problems in the output sphere mainly in the domestic market. Kita et al (2012) states that relations between food producers and retailers are connected with the economic situation of farmers characterized by the share of agriculture in GDP and the situation of retailers in negotiating with their suppliers. In relation to the consumers’ behavior, Šrédl, Soukup (2011) state that in connection to the current economic crisis, there is increased interest in the private assortment brands due to the price-quality ratio as a good alternative to the branded products. Syrovátka (2006) states that a significant role in the decision-making of consumers is held by their income level. Demand relationships can thus be measured with the utilization of income elasticity of consumer demand. Luňáček and Feldbabel (2011) further emphasize

the importance of price elasticity of demand, which shows the "willingness" of consumers to purchase individual goods and on the basis of which vendors can make decisions in setting the price of food products. Kim (2012) adds that end consumers are, in relation to the other segments of the chain, disadvantaged because of asymmetrical information. It can be assumed that the most advantageous position within agri-food chains is had by merchants, primarily large retail chains, upon whom both agricultural producers as well as consumers are dependent. However, the situation and market relations in individual chains differ, and thus a detailed analysis is desirable in this regard.

The agri-food chain is generally made up of interconnected segments within the production chain. The agri-food chain generally covers agricultural producers including suppliers of inputs into the agricultural chain, processors of agricultural raw materials, merchants as well as end consumers. As stated by Pánková (2010), the production chain might be considered as a highly complicated system with complex relationships to analyze. Also, similarly, Palát et al (2012) states that numerous factors of the external environment affect agricultural production. On the basis of the econometric analysis of supply, demand as well as price trends, the relations between the individual segments can be examined, quantified and economically described and conclusions can be made regarding the market structure of the given agri-food market.

This paper focuses on wheat that belongs to the most significant agricultural crops grown in the Czech Republic. Studies analyzing this crop vary in terms of the purpose for which the wheat is utilized. Some authors analyze the chain of soft milling wheat, while others focus on its utilization in the feed industry. In the Czech Republic, approximately 40% of the total production is utilized for foodstuffs utilization. Gallová (2009) analyzed the chain of wheat for feed purposes. The quantification of the price transmission relationship in the paper is based on the assumption of a simultaneous relationship between the price of wheat producers and the prices of processors of feed-stuff mixtures for chicken, pigs and cattle. Blažková, Syrovátka (2012) analyzed price transmission in the chain of soft milling wheat on the basis of monthly data within the period of January 2000 – October 2009. The assessment of price transmission along the wheat commodity chain confirmed the existence of market power especially on the retail stage and low impact of price changes of farm prices on final consumer food prices.

The first studies dealing with econometric analysis of agri-food chains were focused on US markets, and subsequently also expanded to other territories. In recent years, more and more studies also deal with the examination of market relations in central Europe. In terms of studies focusing on plant production, primarily wheat markets, we can mention the following as examples. Palaskas, Crowe (1996) analyzed the seasonality of wheat prices in selected EU states. In their research, Thompson, Herrmann (1999) focused on structural breaks and elasticity of price transmission of wheat prices in Germany. Von Cramon-Taubadel, Loy (1999) addressed symmetry and asymmetry in price transmission on a theoretical level, and application then established asymmetry in price transmissions on markets of the main global exporters. On the basis of comprehensive analysis of selected US markets, Peltzman (2000) showed that price transmission can generally be considered being asymmetrical. Mohsin et al (2006) focused on the analysis of the wheat market in Pakistan on the basis of time series of production, consumption and farm-gate prices, wholesale prices, and the global price of wheat. Brümmer et al (2009), with the utilization of MS-VECM, analyzed price transmissions in the relationship of soft milling wheat and wheat flour in Ukraine. Bakucs et al (2012), with the utilization of MS-VECM, analyzed price transmissions at the level of farm-gate prices of wheat in Hungary and Germany.

The objective of this article is to identify and assess the relationships among the individual segments of the chain of soft milling wheat in the Czech Republic. The analysis itself is divided up into three partial chains, specifically the following:

- soft milling wheat (FP) – smooth wheat flour 00 extra (WP1) – smooth wheat flour (CP1)
- soft milling wheat (FP) – smooth wheat flour (WP2) – white wheat baked goods (CP2)
- soft milling wheat (FP) – wheat bread flour (WP3) – caraway consumer bread (CP3)

The price transmission in agri-food chains might be considered as an important factor in relationships among the farmers and processors as well in relation to the consumers. These days, the farmers and consumers are usually assumed to be price takers while the processors and retail as the institutions which may determine the price level. Thus, this relationship in the selected agri-food chains will be verified in this paper. The analysis itself attempts to answer the following working

question: "*Is it possible to determine the differences in the nature of vertical price transmission among the selected cereals agri-food chains which means that the price transmission in every agri-food chain is unique; or can we consider the nature of selected price transmissions as identical?*".

Materials and methods

The price transmission is analyzed using Vector Error Correction Model (VECM) and co-integration analysis. VECM and co-integration analysis are introduced e.g. in Engle, Granger (1987), Johansen (1991), Chatfield (2004), Kočenda, Černý (2007), Kirchgässner, Wolters (2008) or Juselius (2009). The vertical price transmission in crop agri-food chains was analyzed e.g. in Gallová (2009), Pánková (2010), Reynolds (2010) or Fischer, Hartmann et al. (2010).

The analysis of price transmissions on partial markets within the chain of soft milling wheat is processed in the following steps:

1. *Unit Root Tests:* ADF (Augmented Dickey-Fuller Test) and PP (Phillips-Perron Test) tests were employed to detect stationary or non-stationary character of individual time series.
2. *Model Derivation:* An appropriate form of the time series model was selected according to the results of information criterions, unit root tests and co-integration analysis. In the case of stationary time series VAR (Vector Autoregressive Model) was derived while VECM (Vector Error Correction Model) was selected in the case of non-stationary time series. Co-integration analysis was used to detect and describe the long-run relationship between analyzed time series or agri-food markets, in case of data integration of order 1 or 2, i.e. I(1) or I(2).

   VAR model is defined in the following form

$$\Delta X_t = \eta + \sum_{s=1}^{p} C_s \Delta X_{t-s} + U_t,$$

   where $C_s = 0$ for $s > p$, X_t is a k x 1 vector of variables supposed to be integrated of order 0, (I(0)), $u_1, \ldots, u_t$ are nid $(0,\sum)$.

   VECM model according to Johansen approach was derived as follows:

$$\Delta X_t = \eta + \Pi X_{t-1} + \sum_{s=1}^{p} C_s \Delta X_{t-s} + U_t ,$$

   where $C_s = 0$ for $s > p$, X_t is a k x 1 vector of variables supposed being integrated of order 1, (I(1)), $u_1, \ldots, u_t$ are nid $(0,\sum)$ and is a matrix of the long-term relationship.
3. *Residual Analysis:* Several additional tests were employed to verify the quality of estimated models. Among others autocorrelation of residuals, normality of their distribution or model volatility were examined.
4. *Transmission Elasticity:* Coefficients of price transmission elasticity were quantified to define sensitivity of prices at individual agri-food markets.

The analysis of price transmission in agri-food chains of soft milling wheat in the Czech Republic is processed based on the time series containing monthly data for the period of January 1999 – October 2011. In view of the analyzed levels of price transmissions, time series of average monthly farm-gate prices of soft milling wheat in CZK/t, time series of average wholesale prices of mill and bakery goods in CZK/t (specifically, the time series of smooth wheat flour 00 extra, smooth bakery wheat flour and wheat bread flour are included) were included in the analysis, as well as time series of average consumer prices of mill and bakery goods in CZK/kg (specifically the time series of smooth wheat flour, white wheat baked goods and caraway consumer bread).

The analyzed time series contain 154 observations. The data set was provided by the Ministry of Agriculture of the Czech Republic and the Czech Statistical Office. The calculations were done in econometric software RATS and GRETL.

Finally, the results of the price transmission in soft milling wheat agri-food chain detected in analyzed period were verified based on the price transmission analysis in period of January 2012 – December 2015.

Results and discussion

The examination of the price transmission in the Czech soft milling wheat chain was conducted in three different partial agri-food chains. It can be stated that the time series of farm-gate price, wholesale prices and also consumer prices were affected by the financial crisis. The beginning of the global financial crisis was detected in the development of the prices and some consequences of this influence can be still observed. The time series were also examined

to detect their variability. As the values of coefficient of variation show the biggest variation might be considered in case of farm-gate price of soft milling wheat and consumer price of white wheat baked goods. Variation coefficient reaches the value of 0.25 in these cases. Variability of other examined time series is not as significant as the variability in the time series of FP and CP2. The values of coefficient of variation equals approximately 0.15. The problem of time series variability is connected to the topic of prices volatility. As Hassouneh et al (2015) states the prices development is commonly analyzed while the examination of prices volatility is not as frequent.

The analysis of price transmission in selected agri-food chains was based on the time series of farm-gate price, wholesale prices and consumer prices. As first, the significant time delay in each time series was selected according to AIC and SBC criterions. Even in some cases the information criterions provided different results as the most significant were selected 6 lags for all time series. Subsequently, ADF and PP tests were employed to detect unit root in analyzed time series. The unit root tests proved that all analyzed time series are non-stationary and integrated of order 1, i.e. I(1). The problems of ADF utilization and quality of its results in case of bread wheat prices are discussed by Bubáková (2013).

Then, co-integration analyses examined the long-run relationship between analyzed prices. Finally, based on previous results the Vector Error Correction Model was considered as a suitable tool to describe the relations in analyzed agri-food chains. The residual analysis provides acceptable results concerning the quality of the quantified relationships. The evaluation of the values of coefficient of elasticity were used to explain the relations in analyzed agri-food chains.

Table 1 compares the main features of estimated Vector Error Correction Models. As it is obvious among others the seasonality in analyzed relations were detected. Derived models proved seasonal character of some periods; nevertheless, the significant seasonal character could not be considered generally. Table 1 also contains the values of Adjusted coefficients of determination. It is obvious that most estimated relations are significant. Low values of the Adjusted coefficient of determination in relations WP1-CP1, WP2-CP2 and WP3-CP3 show possible problems with quantification and explanation of relationships between wholesale price and consumer price in the agri food of soft milling wheat.

Co-integration analysis discovered one co-integrating vector in all analyzed relations. Thus, the long-run relationships between the selected time series were examined based on estimated VECM models. The analysis has proven the long-run relationship in all analyzed partial chains. This result corresponds with the statement of Arnade, Vocke (2016) that wheat prices at different international markets rely on past price transmission and are represented by long-run price trend. The main results about the long-run relations are shown in Table 2. The table contains the information about the error

Agri-food market	FP-WP1		WP1-CP1	
Dependent var.	FP	WP1	WP1	CP1
No. Lags	6	6	6	6
Seasonality	S8, S9	S11	No	S5,S10
Adjusted R-squared	0.465423	0.524058	0.422077	0.243574
Agri-food market	FP-WP2		WP2-CP2	
Dependent var.	FP	WP2	WP2	CP2
No. Lags	6	6	6	6
Seasonality	S8, S9	S9	No	S1, S11
Adjusted R-squared	0.470658	0.506717	0.253608	0.080799
Agri-food market	FP-WP3		WP3-CP3	
Dependent var.	FP	WP3	WP3	CP3
No. Lags	6	6	6	6
Seasonality	S9	S9, S10	No	S1
Adjusted R-squared	0.470768	0.514511	0.262991	0.110120

Source: own calculations

Table 1: VECM – main characteristics.

EC	Coefficient	Std. Error	t-ratio	P-value	
FP-WP1	-0.12398	0.03400	-3.6463	0.00039	***
WP1-CP1	-0.19606	0.04788	-4.0944	0.00008	***
FP-WP2	-0.12175	0.03048	-3.9946	0.00011	***
WP2-CP2	-0.10664	0.02534	-4.2087	0.00005	***
FP-WP3	-0.09184	0.02399	-3.8285	0.00020	***
WP3-CP3	-0.12387	0.02822	-4.3895	0.00002	***
EC	Coefficient	Std. Error	t-ratio	P-value	
WP1-FP	0.05062	0.01748	2.8952	0.00447	***
CP1-WP1	-0.08488	0.06277	-1.3521	0.17877	
WP2-FP	0.02712	0.01533	1.7693	0.07928	*
CP2-WP2	-0.07007	0.04329	-1.6188	0.10801	
WP3-FP	0.01897	0.01349	1.4053	0.16241	
CP3-WP3	0.02879	0.02956	0.9742	0.33184	

Source: own calculations

Table 2: VECM – error correction terms.

correction terms of all estimated VECMs describing long-run relationships between the variables. As the table shows long-run relationship was proven in all analyzed agri-food chains. However, significant mutual relations on significance level 1 % were discovered just in the case of FP-WP1. The relationships in other agri-food chains should be considered as one-way relations. Moreover, agri-food chains can be considered as a demand driven. Thus, it might be concluded that nature of the price transmission in agri-food chain of smooth wheat flour, white wheat baked goods and caraway consumer bread can be considered as identical; even some unique differences were detected.

The examination of the price transmission elasticity (PTE) provided also some important results. On the basis of the values of elasticity of price transmission (see Table 3), it can be stated that variously elastic reactions occur on the individual levels of product chains. However, it cannot be stated overall that elasticity increases or decreases with the higher segments of the chain. The preceding indicates that, on the basis of elasticity of price transmission, the analyzed chains cannot be considered to be reacting and developing identically. The most elastic price transmissions occur in the chain of smooth flour between the wholesale price and the consumer price (the elasticity of price transmission achieves a value of 0.6587). The least elastic is the reaction between the farm-gate price and the wholesale price in the chain of consumer bread (the value of elasticity of price transmission is 0.2098) and the wholesale price and the consumer price in the chain of white baked goods (the value of elasticity of price transmission achieves a level of 0.2183). These results are partially supported by the result of other authors. The analysis of price transmissions for partial product chains of soft milling wheat in the Czech Republic, specifically flour and baked goods, was addressed, for example, by Blažková, Syrovátka (2012). In their analysis, the elasticity of price transmission was also calculated. Its results, in some cases, correspond to the results set out above, but significant deviations are evident in some cases. Primarily the relationship of the wholesale price – consumer price appears is shown being more elastic in the said study than according to the results set out in Table 3. The deviations can be attributed to the differently selected analyzed time period.

The results deduced based on the price transmission analysis of three partial agri-food chains of soft milling wheat were finally verified based on the data set containing monthly prices of the soft milling wheat in period from 1/2012 until 12/2015. The author assumed that the main conclusions about the price transmission can be generalized; thus, all conclusion are valid in different period. The assumption was partly proved. All analyzed time series were again considered as non-stationary and integrated of order 1 and co-integration analysis has shown long-run relationships among analyzed prices. The long-run relationships can be described mainly as a one-way and demand driven. However, the elasticity of price transmission has shown partly different results. In the period of January 2012 – December 2015 the price transmission seems to be more elastic compared the period January

	FP-WP1	WP1-CP1	FP-WP2	WP2-CP2	FP-WP3	WP3-CP3
PTE (%)	0.39907	0.65868	0.41299	0.21831	0.20983	0.35663

Source: own calculations

Table 3: Price transmission elasticity.

1999 – October 2011. Thus, one may conclude that the nature of the price transmission in all analyzed agri-food chains is identical; however, partial markets in different periods are also characteristic by some individual specifics.

Conclusion

The objective of the analysis of this article was to assess the price transmissions in selected partial chains of soft milling wheat in the Czech Republic. The analysis was to answer the question of whether the chains can generally be considered, in view of their relationships based on price transmissions, to be identical or not. The analysis itself showed partial similarities between the analyzed chains, but also indicated certain significant differences.

In terms of the nature and basic characteristics of the individual time series, the analyzed chains, or their partial sections, can be considered to be identical. All of the utilized time series are non-stationary and integrated at a rank of one. This is a typical characteristic of the majority of economic time series, as stated, for example, by Ardeni, Freebairn (2002) or Kennedy (2003). All of the time series further show signs of a seasonal character. Relationships between the individual segments of the analyzed product chains can further be considered to be of a long-term nature. Long-term relationships were also established, for example, in the chain of soft milling wheat in Germany (see Bavorová, Hockman (2010)).

Besides the said basic similarities and differences within the analyzed chains, the sphere of results and their significance can be extended to other related agri-food chains. In some cases, the ascertained conclusions can even be generalized for a broader sphere of agri-food markets.

As is known, wheat as an agricultural crop can be utilized not only for foodstuffs purposes, but also as a feed crop for farm animals. For example, Pánková (2010) analyzed price transmission in the agri-food chain of wheat for feed purposes in the Czech Republic. The analysis shows that wheat for feeding (poultry, pork) might be considered a demand-driven system. On the basis of the said analysis itself, it can thus be stated that the wheat market in all of its partial chains can be considered to be demand-oriented.

In the analysis of price transmission, attention was also paid to the volatility of individual time series. Differences were ascertained in its form prior to and after the accession of the Czech Republic to the EU. It can be stated that prior to the accession of the Czech Republic to the EU, the volatility of time series was lower than after its accession. Onour, Sergi (2011) analyzed prices of food commodities on the world market. The analysis shows that their volatility is characterized by the intermediate and short memory behavior and is mean reverting.

The actual functioning of the product chains is, besides the analyzed relationships between the farm-gate price, the wholesale price, and the consumer price and the segments of the chains corresponding to them, more and more strongly affected by the operation of retail chains, retail networks in general, which thanks to their strength and position “deform” economic principles and rules for their own benefit. As stated by Lu et al (2010), in managing a long-term trading relationship within the agri-food chain, it is important to appreciate that exchange partners will only enter into a relationship when they expect to receive returns that are greater than those they can obtain elsewhere. However, in the case of market deformities in the form of asymmetrical information or prices set in imperfect competition, the position of all of the market participants is not equal and thus access to the market relationship and a real opportunity for a “fair” transaction can be distorted. As stated by Grazia et al (2010), the quality and form of relationships in the chain and communication between the individual segments of the chain are closely related to its competitiveness.

In conclusion, it can be stated, as explained by Lu et al (2010), that building and maintaining good business relationships requires care and effort, just like growing agricultural products. However, the emphasis of the elements of managing business relationships differs at various chain stages and with different partners. Thus, it is widely agreed that building and maintaining good, sustainable

business relationships can lower transaction costs and reset in competitive advantages, which will benefit both sellers and buyers in agri-food chains. The major ingredients for planting business relationships are selecting the right partner, aligning business goals and procedures, and allocating appropriate resources.

Acknowledgements

The results set out in this article are the result of research as part of the grant project "P402/11/P591 Modeling of price transmission and its asymmetry in agri-food chain – theoretical-empirical implications" supported by the Grant Agency of the Czech Republic.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

The Influence of Investment Costs on Biogas Station Development and Their Impact on Greenhouse Gas Emissions from Czech Agriculture

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Abstract

The paper present the results for the influence of investment costs into biogas station on the amount of emissions from the agricultural sector. For the evaluation is applied structural analysis of major factors affecting the level of CO_2 emissions from agriculture. Among these factors are: the number of animals (converted to livestock units), cost of investment in biogas plants, the quantity of nitrogen fertilizers and the total amount of CO_2 emissions from agriculture. The results show that the investment costs haven´t significant influence despite the correct direction of effect. Significant impact on CO_2 emissions from agriculture have the numbers of animals (respectively cattle units). In the case of applications reviewed model from the Czech Republic to selected countries of the EU shows that the highest investment costs and also decrease CO_2 equivalent emissions from agricultural biogas plants is in Germany. The high number of agricultural biogas plants is also evident in Italy and the United Kingdom. Investment costs are in these two countries in the range of 115 to 144 mld. CZK. Furthermore, it is evident that the significant investment costs are incurred by the smaller countries (Czech Republic, Slovakia, Belgium). Investment costs in this case are in the range 10-33 mld. CZK.

Keywords

Biogas stations, CO_2 emissions, animal waste, livestock numbers, linear regression model, investment costs.

Slaboch, J. and Hálová, P. (2016) "The Influence of Investment Costs on Biogas Station Development and Their Impact on Greenhouse Gas Emissions from Czech Agriculture", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 143 - 151. ISSN 1804-1930. DOI 10.7160/aol.2016.080413.

Introduction

Because of significant increase in greenhouse gas emissions in the last decades, the pollution has become central global problem. Several countries including EU member states signed Kyoto protocol, which brings compulsory responsibilities. European Union declared to decrease greenhouse gas emissions by 20% on average compared to the level of 1990 by 2020. One of the tools to achieve this goal is to increase the share of renewable resources in energy mix by 20% by 2020 (EEA 2013).

There are many factors influencing the level of CO_2 emissions. The economic grows, number of inhabitants, technological changes, subsidies, institutional structures, transport, life style, international trade etc. are some of these determinants (Escolano and Rosa, 2005).

Agriculture generally including animal production significantly contributes to greenhouse gas emissions (Bellarby et al., 2013, Galloway et al., 2007, Herrero et al., 2011). As a result of this influence the agriculture community has undertaken to decrease emissions, which will lead to better environment protection. Over all agriculture emissions are 5,4-5,8 $GtCO_2e$, which is approximately 12% of total anthropogenic emissions (Tubiello et al., 2013).

When evaluating agriculture emission structure approximately 38% are accounted to nitrous oxid (N_2O) from soil, 32% from ruminants (CH_4), 12% from biomass burning, 11% from rice production a 7% from manure management (Bellarby et al., 2008).

Majority of studies focuses on reduction of only one or several main types of greenhouse gas emissions from agriculture e.g. CH_4 in publication by Petersen et al., 2005, N_2O by Dämmgen a Hutchingsem 2008, ΔC by Scott et al., 2002, CO_2 from fossil fuels researched by Dalgaard et al 2001. Another

possibility to reduce greenhouse gas emissions is to produce bioenergy (Jørgensen et al, 2005).

In the future it is possible to expect (according to individual predictions) an increase in agriculture product demand as a result of population growth, income growth and last but not least changing dietary preferences (higher meat, dairy product etc. consumption namely in Africa, South America and Asia). There have been many studies evaluating current and future situation, nonetheless specific conclusions vary according to chosen areas or agriculture practices taken into account (Yamaji et al., 2004, Oenema et al., 2005, Herrero et al., 2008).

Agriculture and mainly animal production is in global scale one of the most significant environmental polluters (Steinfeld et al., 2006) and biggest contributor to greenhouse gas emission increase (GHG), which causes climatic changes (Johnson et al., 2007).

Impact on emissions using animal waste in biogas plant is calculated, for example in Nigeria, where the use of animal waste amounted to a total production of 1,62x109 m3 of biogas. Such a usage represents a decrease emissions by 683 ths. tonnes of CO_2 per year. (Adeoti, Ayelegun and Osho, 2014)

Most emissions is currently produced by China. In rural areas of this state used by individual households small BPS (fermenter volume to 8 m^3). Zhang, Wang and Song (2013) point to the fact that just the use of renewable resources (biogas) can represent the reduction potential of 1.25 tonnes of CO_2 per household.

European commitment to reduce their emissions is a good opportunity for change in the share of individual sources in total energy production. In Sweden the use of biogas plants with a total production of 39 GWh per year have reduced CO_2 emissions by 32 ths. tonnes / year (if the classic coal plant was replaced by this power). (Amiri, Henning and Karlsson, 2013)

Individual instructions above to reduce emissions (mainly from agriculture) are very interesting from the point of view of environmental protection, on the other hand, are very expensive investment. For example, in India, in the years 2010-2011 was invested to the renewable sources 19 mld. dollars. Decrease in emissions due to these significant investment is estimated at 203 mil. tonnes of CO_2 at an installed capacity of 24 GW in 2012. (Mahesh and Shoba Jasmin, 2013).

Paper focuses on biogas stations (BGS) influence on CO_2 emissions based on presumptions stated in methodology. In the future biogas will have increasingly higher importance as a factor leading to greenhouse gas emissions degrease, considering optimal cost oriented usage of possible sources and technologies. The results of studies imply the fact that it is an ideal combination of electricity and heat production mainly in the area of agglomeration or industrial enterprises. With this necessary condition it is possible (according to calculation based on life cycle - LCC, LCA) to save 198 Euro per 1 ton of CO_2 equivalent using biogas instead of fossil fuels (Rehl, Muller, 2013).

The main goal of this paper is to determine the effect of the investment costs to biogas plants on the amount of emissions of equivalent of CO_2 from agriculture.

Materials and methods

Econometric modelling is used for structural analysis, which derives significant factors effecting the amount of CO_2 emissions produced by agriculture production including quantification of economic variables in the form of time series.

Data sets are for the period 2002 – 2014 and concern emissions (expressed) in CO_2 for the area agriculture, and other branches in the framework of economy (energetics, industry, agriculture, LULUCF, wastes). Particular values in the area of agriculture are further (within the methodology) divided into two groups: enteric fermentation (concerning farm animals and their digestive processes), and further to the area land (concerning use of fertilizers and manure management). This key data were obtained from annual reports of CHMU for particular above mentioned groups[1].

Numbers of livestock are obtained from Czech statistical office for individual categories (cattle, pigs, chicken). Those numbers are recalculated to cattle unit tin accordance with appendix n. 1 of Bill n. 377/2013 Col.[2]

Install power is undertaken from statistics OTE, ERU[3] and investment costs are calculated in accordance to recommend values by Dvořáček

[1] Available at web sites: http://portal.chmi.cz/files/portal/docs/uoco/oez/nis/nis_ta_cz.html

[2] available at web sites: http://eagri.cz/public/web/ws_content?contentKind=image&section=1&id=377-213c.pcx

[3] OTE - Czech electricity and gas market operator, ERU - Energy Regulatory Office

(2010), when coefficient 100 000 CZK per 1kW of install power is used.

For dynamic characterisation of chosen time series base and chain indexes including average rate of growth calculation are used.

Formula 1 – Base index = $\frac{\text{Xi}}{\text{Xz}} * 100$ (result in %) when Xz is base value

Formula 2 – Chain index = $\frac{\text{Xi}}{Xi-1} * 100$ (result in %)

Formula 3 – Geometric mean = $\sqrt[n]{x1 * x2 * x3 \ldots xn}$

ADF test (Augmented Dickey – Fuller) with null hypotheses H0: data are non stationary, H1: data are stationary, was used for data evaluation in the time series form.

The principle of the test is criteria calculation, which in order to accept H0 must be higher than the critical table value. Supporting variables in the form of time series were defined as non-stationary.

The classical regression analysis usage could lead to spurious regression, but considering a short time series a cointegration analysis cannot be used and it is not possible to determine a long-term relation among variables. However, for further mentioned models it is valid that the calculated residues are stationary.

For specification and quantification of significant determinants influence, economic quantities were selected which with their presence and effect will enable to estimate models verified in all respects, from the economic, statistical and econometrical point of view. These chosen variables are a part of below mentioned econometric model (1.1).

$$co2total_t = \gamma_{11} + \gamma_{12}\, invcost_t + \gamma_1\, animals_t + \gamma_{14}\, fertilizers(t\text{-}1) + u_{1t} \quad (1.1)$$

when $u_{it} \sim$ n.i.d. $(0, \sigma^2)$, for i = 1,2…

Authors will use estimations of the linear functions in the work. The estimations of linear function serves as an expression of direction and intensity of effect of predetermined variables from absolute viewpoint.

The submitted work defines several presumptions which it would like to confirm or rebut with the use of a linear regression model which will be applied in a structural analysis of air pollution measured with kt equivalent of CO_2 coming from activities in non-agricultural area.

P1: growing cost investment to agricultural biogas stations (variable invcostt) will have a significant positive effect on pollution which will be shown by reduction of pollutants in the air,

P2: numbers of farm animals are a very important factor which will increase emissions Conversion to cattle units according to EAGRI Conversion of farm animals to a big cattle unit (cows, pigs, poultry) was realized according to coefficients published on web sites of the Ministry of Agriculture (appendix n. 1 of Bill n. 377/2013 Col.).

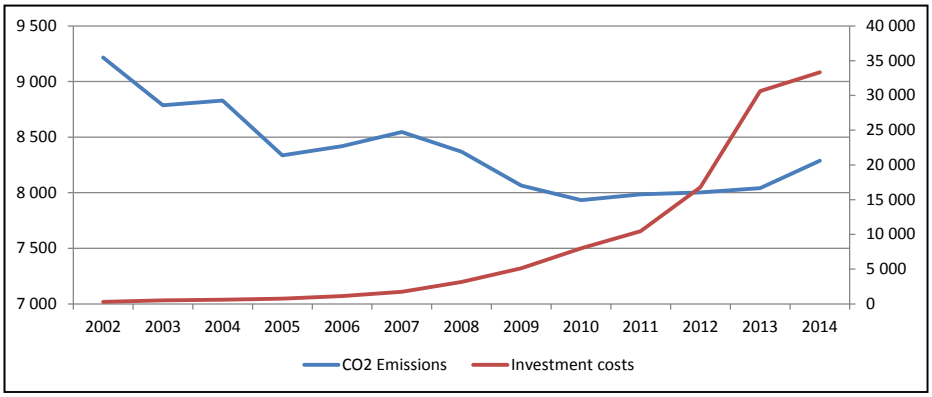
P3: an amount of used fertilizers in last period will have greater effect on the air pollution than numbers of farm animals because we can expect time delay between the usage industrial fertilisers and increase in CO_2 emissions.

Subsequently, the estimated model used for comparison of emission reductions in selected EU countries (Austria, Belgium, France, Germany, Italy, Slovakia, Hungary, Great Britain and Poland). Investment costs in different countries are calculated according to the installed capacity, using the coefficient (1 kW = 100 ths. CZK). Reducing emissions is calculated based on results for the Czech Republic, which are (ceteris paribus) be applied to other selected countries.

Results and discussion

The CO_2 emission development in Czech Republic in accordance with biogas station construction (Graph 1) is possible to describe by elementary characteristics, chain and base indexes with initial year 2002. Their results are in Table 1.

With the help of chain index detecting interannual changes of individual data according to average rate of growth, we can detect almost 44% increase of investment costs. It is clear, that this situation occurs after implementation of EU fund subsidies. The fast rate of growth is in this case supported by decision of ERU (Energy Regulatory Office) concerning purchase prices and green bonuses of this renewable resource. Biogas stations connected to the end of 2011 obtain 4120 CZK per 1 MWh (purchase price). Biogas stations connected from 1.1.2012 till 31.12.2012 obtain the sum of 3550 CZK per 1 MWh (purches price). Larger biogas stations (over 550 kW of installed power) have from 1.1.2013 purchase price only 3040 CZK per 1 MWh. As a result of significant increase in renewable recourses (solar, wind etc.) there are no set purchase prices of electricity for biogas stations connected in 2016. Unambiguously positive and different development



Source: Authors - own processing

Graph 1: Development of emission in kt CO_2 eq. and investment costs on BGS in mil. CZK.

chain index	base index	chain index	base index
Investment cost	Investment cost	CO_2 emissions	CO_2 emissions
1.73630137	1.73630137	0.953411	0.953411
1.17357002	2.037671233	1.004978	0.958158
1.253781513	2.554794521	0.943955	0.904458
1.516085791	3.873287671	1.010084	0.913579
1.532272325	5.934931507	1.014992	0.927276
1.828043855	10.84931507	0.979354	0.908132
1.617424242	17.54794521	0.963691	0.875158
1.56323185	27.43150685	0.983665	0.860863
1.30474407	35.79109589	1.006624	0.866565
1.604344082	57.42123288	1.002025	0.86832
1.825251983	104.8082192	1.004844	0.872526
1.089367403	114.1746575	1.030661	0.899278
Geometric mean		Geometric mean	
1.439708583		0.991867	

Source: Author – own calculation

Table 1: Changes of investment costs and CO_2 emissions in time.

can be detected for emissions, which decreased on average by 1% in the actual period.

Before estimation of specific linear regression model multicolinearity between explanatory variables was detected with the help of correlation matrix. It proved high measure of association between investment costs and fertilizers and between number of livestock and fertilizers.

In this case it is not possible to separate individual variable influence and their effect is collective. This conclusion corresponds with the fact, that animal and plant production are closely connected. With the help of VIF test multicolinearity problem was confirmed for variables costs and fertilizers. The value of test criteria VIF exceeded recommended number 10. Model estimations stated in Table 2 take into account detected 1st order negative autocorrelation of residual by heteroscedasticity and autocorrelation consistent errors (hac errors).

From economic point of view investment costs growth confirm presumption P1, which was stated in methodology of work, but statistic verification speaks about inversion. The variable does not have statistically significant effect, despite of this influence direction being correct. If investment costs to biogas stations increase, CO_2 emission decrease. The only significant parameters appear to be according to presumptions animal numbers and quantity of fertilizers one year before. From introduced results it is not possible to interpret, which variable has the most significant effect on CO_2 changes caused by multicolinearity. One of possibilities how to remove unwanted multicolinearity influence

	coefficient	standard error	t-share	p-value	
const	957.565	1289.25	0.7427	0.47889	
	-0.00397	0.00649	-0.6103	0.55858	
animals	0.00298	0.00024	12.4650	<0.04304	***
fertilizers_1	9.6471	4.036	2.4021	0.00001	**

Note: Dependent variable: co2total
Coefficient determination 0.942
Adj. coefficient of determination 0.891
D-W statistics 3.212
Source: author – calculations in the software Gretl

Table 2: Estimation of linear regression model.

	coefficient	standard error	t-share	p-value	
const	4905.2	803.331	6.1061	0.00049	***
d_invcost	−0.00296	0.01593	-0.1857	0.85796	
animals	0.002013	0.000472	4.2682	0.00371	***
d_fertilizers_1	8.21751	5.46888	1.5026	0.17664	

Note: Dependent variable: co2total
Coefficient determination 0.82
Adj. coefficient of determination 0.75
D-W statistics 1.57
Source: author – calculations in the software Gretl

Table 3: Estimation of linear regression model after multicolinearity removal.

is primary data transformation to first differences form. It was provided for variable investment costs and fertilizers. Conditioned variables in correlation matrix and VIF test do not prove multicolinearity anymore.

Newly estimated model, which results are in Table 3, provides information which can be interpreted individually. Variable investment costs were included in the model as a significant explanatory variable. In this period was proved, that this variable is statistically insignificant. For this reason, this variable (investment cost) in not further interpreted. It is possible to say, that unit increase of animal number causes the increase of CO_2 emissions by 0.002013 kt. Construction and good management of BGS unambiguously support the elimination of pollutions in the greenhouse gas form arising from animal production. Expressed relatively in the form of elasticity Table 4 shows that increase of animal unit by 1% brings increase of emissions by almost 0.5%.

	Elasticity in %
BGS	−0.0031
animals	0.41
fertilizers	0.25

Source: Author – own calculation

Table 4: Elasticities estimation of total CO_2 emissions model.

Based on the verified model for the Czech Republic is also made a comparison with selected EU countries. The calculation is based on the calculation of investment costs in other countries (calculation is according with the methodology) then is estimated emissions reductions based on the results of the Czech Republic (see Table 5).

	Investment cost (mil. Kč)	Impact on emissions CO_2 from agriculture (kt)
Austria	8100	-23.9760
Belgium	17820	-52.7472
France	29720	-87.9712
Germany	385900	-1142.2640
Hungary	6140	-18.1744
Poland	20930	-61.9528
Italy	115470	-341.7912
Slovakia	10170	-30.1032
United Kingdom	144000	-426.2400
Czech Republic	33339	-98.6834

Source: Author – own calculation

Table 5: Investment cost and their impact on emissions in selected countries EU (2014).

The results show that the sharpest reductions takes place in Germany (a fall of 1142 kt CO_2 equivalent emissions). In this country the biogas plant is widespread, it is also interesting value investment costs (100 ths. CZK per 1 kW of electricity),

amounting to 386 mld. CZK. The high number of agricultural biogas plants is also evident in Italy and the United Kingdom. Investment costs in these two countries, ranging from 115 to 144 mld. CZK. Table 5 shows that the significant investment costs are incurred by the smaller countries (Czech Republic, Slovakia, Belgium). Investment costs in this case are in the range 10-33 mld. CZK.

Conclusion

Exponential growth of investment costs for BGS construction and their quantity was impulse for researching this situation and looking for main determinants effecting them. With the help of chain index detecting interannual changes of individual data according to average rate of growth, we can detect almost 44% increase of investment costs. It is clear, that this unsustainable situation occurs after implementation of EU fund subsidies. Unambiguously positive and different development can be detected for emissions, which decreased on average by 1% in the actual period.

Since 2005, EU has managed to decrease its aggregated emissions by 3.1%. But, the results from this study show, that each EU member state performs very differently in emissions intensities. Even more, the emission intensity results show an alarming tendency of increase in most of the EU member states, which indicates that the measured changes in aggregate agricultural emissions rates are misleading. (Dace and Blumberga, 2016)

In Italy consider of mathematical modeling of the impacts of greening (recent CAP reform 2014–2020). In this study they estimated the potential environmental benefits from greening in terms of GHG emissions in four regions of Northern Italy. The model estimates a reduction in CO_2 emissions of about 2%. Emissions from nitrous oxide show a decrease of 2.1% and the reduction in the methane is about 0.4% compared to the observed scenario. (Solazzo et. al., 2016)

From economic point of view investment costs growth confirm presumption P1, which was stated in methodology of work, but statistic verification speaks about inversion. The variable does not have statistically significant effect, despite of this influence direction being correct. If investment costs to biogas stations increase, CO_2 emission decrease. The only significant parameters appear to be according to presumptions animal numbers and quantity of fertilizers one year before. From introduced results it is not possible to interpret, which variable has the most significant effect on CO_2 changes caused by multicolinearity. Therefore it is not possible to react adequately to presumption P2 and P3.

Newly estimated model, which results are in Table 3, provides information which can be interpreted individually. It is possible to say, that unit increase of animal number causes the increase of CO_2 emissions by 0.002013 kt. Construction and good management of BGS unambiguously support the elimination of pollutions in the greenhouse gas form arising from animal production by using their waste. Expressed relatively in the form of elasticity Table 4 shows that increase of animal unit by 1% brings increase of emissions by almost 0.5%. It is possible to evaluate the reaction as non elastic. Number of livestock significantly influence emission quantity however their forceful decrease does not come to effect in the end.

Suitable technology for animal and plant waste management can provide sources for plant production which does not need to use mineral fertilizers to such extend. In this case sludge (liquor) and digestate from biogas stations is used. According to legislation digestate is type organic fertilizer if it complies with the condition of minimum of 25% burnable matter in dry substance and minimum content of nitrogen 0.6% in dry substance and it falls into the category of fertilizers with rapid release nitrogen.

Usage and digestate dose as fertilizer is comparable to slurry considering the amount of nutrients mainly nitrogen. Similar principles defined for fertilizing with liquid organic fertilizers are valid for their application. (Fuksa and Hakl, 2009)

Construction of BGS is long time investment which becomes profitable approximately in ten years. Mužík and Abrham (2006) consider the return rate of investment in 5 years to be very good, in 10 years to be acceptable. This results are confirmed by other studies by Wu et. al, 2016; Mel et. al, 2015 or Kang et. al, 2014. If animal production is further reduced and unstable situation namely in milk production is deepened, the question is whether this initially valuable idea does not paralyse the agriculture enterprises in the future.

In the case of applications reviewed model from the Czech Republic to selected countries of the EU shows that the highest investment costs and also decrease CO_2 equivalent emissions from agricultural biogas plants is in Germany.

The high number of agricultural biogas plants is also evident in Italy and the United Kingdom. Investment costs are in these two countries in the range of 115 to 144 mld. CZK. Furthermore, it is evident that the significant investment costs are incurred by the smaller countries (for example Czech Republic, Slovakia and Belgium). Investment costs in this case are in the range 10-33 mld. CZK. In the framework of the emission reduction is CR 4th place (-98 kt CO_2 equivalent) after Germany (-1142 kt CO_2 equivalent), United Kingdom (-426 kt CO_2 equivalent) and Italy (-341 kt CO_2 equivalent).

Acknowledgements

This paper was supported by grant IGA FEM No. 20131030 - Alternatives for biomass processing and animal waste in biogas plants and their impact on the economics of enterprises.

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Subsidies on Investments in the EU Member States

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Abstract

The article compares the investment subsidies in agriculture within the EU member states throughout the period of 2004 – 2013 based on the FADN database. Low investment level affects the cost and efficiency of agricultural production and thus the overall competitiveness of agricultural production. European programs providing support for the investments for agriculture aim at improving agricultural competitiveness. Development of subsidies on investment, property and Farm Net Income adjusted to economic size of enterprise by correlation analysis is compared in every EU country. Using cluster analysis, the member states were divided into groups according to subsidies on investments, their share in gross investment and the share of gross investments in fixed assets. The relationship between subsidies on investments and gross investment ranges from middle to higher dependency. The amount of subsidies on investments does not significantly affect the amount of current Farm Net Income.

Keywords

Subsidies on investments, gross investment, farm net income, fixed assets, economic size.

Svoboda, J., Lososová, J. and Zdeněk, R. (2016) "Subsidies on Investments in the EU Member States", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 153 - 162. ISSN 1804-1930. DOI 10.7160/aol.2016.080414.

Introduction

In the Rural Development Program for the period 2014-2020, the European Commission has set three main objectives for the future CAP: viable food production, sustainable management of natural resources and climate policies and balanced territorial development. Six priorities have been defined: the promotion of knowledge transfer in agriculture and forestry, improvement of agricultural competitiveness and viability of farming and forestry, support for the food chain organization and risk management, restoration, protection and maintenance of the ecosystems dependent on agriculture and forestry, support of the efficient resource usage and transition to the low carbon economy in the agri-food sector and forestry, the promotion of social inclusion, poverty reduction and economic development of rural areas. Fulfilment of these objectives requires mobilizing both European and national resources. Strengthening the competitiveness of agriculture requires primarily increasing the labour productivity, which is not possible without additional investments.

The investment issue is important because the current farm production is a function of several inputs, including the current level of capital, which depends on past investment decisions. Annual investment decisions affect both current and future production. Thus, any policy that increases investment will influence farm output for some years into the future (OECD, 2001).

In the program period 2007 – 2013 the Member States drew the resources to support agricultural and rural development from EAFRD (Agricultural Fund for Rural Development) and also for the current programming period it is possible to draw resources for investment in agriculture through this fund based on the approved Rural Development Programs for the years 2014 – 2020.

A lot of works deal with effects of various types of subsidies on investment (Viaggi, Raggi, and Paloma, 2011; Rizov, Pokrivcak, and Ciaian, 2013; O'Toole and Hennessy, 2015; Michalek, Ciaian, and Kancs 2016). The major concern of evaluation studies is assuring the causality between programme measures and estimated effects (Bergschmidt, 2009; Blandford et al., 2010; Margarian et al., 2010). Programme effects might show time lags or even underlie other dynamics. Since establishing agricultural investments often requires long timespans (Hoffmann, et al. (1997), Forstner (2000) and Bradley et al. (2010) point out that chosen observation periods might be too

short to be able to measure the full implementation success of investments. Findings in the literature focus on the effects of coupled subsidies in narrowly defined agricultural industries. Latruffe et al. (2009) find a negative impact of coupled CAP subsidies on the efficiency of French farms specialised in cereals, oilseeds and beef production. Lakner (2009) shows, that the agrienvironmental payments and investment programmes have a negative effect on the efficiency of organic dairy farms in Germany. Yee et al. (2004) find a positive relation between the TFP of US farms and public expenditure on investment in research, extension and infrastructure. Mary (2012) estimates the impact of various types of CAP subsidies on the efficiency of French crop farms. Targeted coupled subsidies that are not automatic but subject to project approval, such as investment and environmental measures, are found to have no significant impact on productivity. The aim of paper Kirchweger, S., & Kantelhardt, J. (2015) is to identify the effects of the Austrian farm-investment support programme on structural change in agriculture. The authors say that, the intensification effect of the European investment programme is in contrast to the goals of the European agri-environmental schemes, even though both are part of the European RD programme.

According to Richardson (2000) and Shucksmith et al. (2005) more policy focus is required on places instead of sectors, acknowledging the heterogeneity of rural regions as complex economic, cultural and natural location. This is in line with OECD recommendations which promoted a paradigm shift in rural development in response to the observed heterogeneity of challenges for rural regions. The OECD calls for a place-based approach with stronger emphasis on investments and the valorisation of local assets (OECD, 2006).

Sckokai and Moro (2009) quantifies the impact of farm policies on investment and output decisions, with specific reference to the CAP arable crop regime. The policy impact on farm investment is not strongly reflected in a positive impact on farm output, since the investment effects tend to be quite small.

Article of authors Zasada, et al. (2015) is clarifying the interactions between capital investments and capacity building, and on the relevance of the regional conditions and factor endowments in determining rural development priorities. For the new programming period 2014–2020 improved conditions towards the recognition of development potentials through a multi-level governance process have been established, which also allow space for more first place-based initiatives and projects. Lucian (2014) says that the absorption level of European funds for the financial period 2007-2013 was low for several reasons: lack of strategic vision for programming development, poor quality of projects, excessive bureaucracy, lack of optimization of financial flows etc. For the financial programming period 2014-2020, the European Commission will improve the absorption of EU funds.

The objective of this report is to analyse the investment subsidies in the EU in the period 2004 – 2013, which is based on the comparison of selected economic indicators and to find the connections and links between economic indicators and investment subsidies.

Materials and methods

In this report there are used calculations based on the database FADN sample survey, the standard output (SO) within the 2004-2013 period. The SO represents an average monetary value of agricultural production in the prices of agricultural producers for each commodity in the region. The SO is calculated, by the Member States, per hectare or per livestock unit using basic data application for the period of 5 consecutive years. The SO of the agricultural enterprise is calculated as a sum of the SO of farm livestock. The SO coefficient is expressed crops and livestock. The large number of items not only reflects the diversity of agriculture in the EU but also indicates the level of mandatory surveys required for the comprehensiveness and reliability of the outputs.

Of the many recorded indicators there were chosen these items which are relevant to the issue and also are linked to investments. Specifically, these are the following indicators:

- Economic size-ESU (code SE 005).
- Subsidies on investments-EURO (SE 406)
- Farm Net Income-EURO (SE 420) FNI: Remuneration to fixed factors of production of the farm (work, land and capital) and remuneration to the entrepreneurs risks (loss/profit) in the accounting year.
- Total fixed assets-EURO (SE 441): Agricultural land and farm buildings and forest capital + Buildings + Machinery and equipment + Breeding livestock.

- Gross Investment-EURO (SE 516): Purchases (exp. land, improvements, machinery, building) - Sales of Fixed assets + breeding livestock change of valuation.

For the reason of higher data comparability, the indicators were recalculated to the economic size of farms thereby the size of particular agricultural farms in states were taken into account.

In this article was used annual growth rate $\sqrt[n-1]{\frac{EV}{BV}}$ and for the reasons zero beginning value average annual increment $\frac{EV-BV}{n-1}$ where EV are the ending value, BV are the beginning value and n are the number of periods.

Based on the data, processed by cluster analysis, a multi-variable statistial method dividing the large groups of observation into smaller and more homogeneous groups could be carried out. This method can be applied similarly to the classification of EU Member States according to the economic performance of farms (Giannakis and Bruggeman, 2015) 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, that minimize the increase in the sum of squares of error within a cluster, IAB (Rencher (2002), Řezanková, Húsek and Snášel, (2009)),

$$I_{AB} = \frac{n_A n_B}{n_A + n_B}\left(\bar{\mathbf{y}}_A - \bar{\mathbf{y}}_B\right)^T\left(\bar{\mathbf{y}}_A - \bar{\mathbf{y}}_B\right).$$

where n_A, n_B are the numbers of points in A, B; $\bar{\mathbf{y}}_A$, $\bar{\mathbf{y}}_B$ are centroids of A and B, respectively. As a distance function is used Eucliean distance 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)

$$d(\mathbf{x},\mathbf{y}) = \sqrt{(\mathbf{x}-\mathbf{y})^T(\mathbf{x}-\mathbf{y})}.$$

Dividing EU states into groups which allows for a more understandable assessment and defines the aim of its evaluation (Svoboda, Lososová and Zdeněk, 2015). The commentary of these groups includes basic descriptive statistical characteristic. The next part contains the description of the relationship between defined and relative indices by the methods of correlation and regression analysis (Farm Net Income/ Subsidies on investments, Total fixed assets/ Subsidies on investments, Gross Investment/ Subsidies on investments).

Results and discussion

The development of the subsidies on investments was monitored on the basis of FADN data converted into economic size (ESU) - see Table 1. They are listed their absolute value and the average annual increment for the period of monitoring. Differences in the amount of investment subsidies are considerably between countries, some NMS started to support investments in agriculture to during the reporting period. Of the EU 15 countries are most encouraged investment in agriculture in Luxembourg and the lowest in Sweden.

During the period 2004–2013, the average increment of subsidies on investment in the EU was 0.25 €/ESU per annum. Luxembourg (3.62 €/ESU), Lithuania (2.88), Bulgaria (2.55), Malta (1.69), Portugal (1.45), Slovakia (1.39), Czech Republic (1.29) show the highest average increment of subsidies on investment per annum. On the contrary, the highest decrease in subsidies on investment was recorded in Slovenia (-7.2 €/ESU per annum), Latvia (-6.13), Estonia (-0.67), Romania (-0.59), Greece (-0.31), Ireland (-0.24), France (-0.11) and Sweden (-0.01) (Table 1).

EU Member States were divided using cluster analysis into 4 groups, which have similar development investment grants during the period (Figure 1).

Group 1 (Belgium, Poland, UK, France, Finland), where investment subsidies recalculated to the economic size of a company approaches the EU average and grow in time (except France). The average growth rate of investment subsidies is the highest in Poland (36 % annually), Finland (18 %) and Belgium (15 % annually).

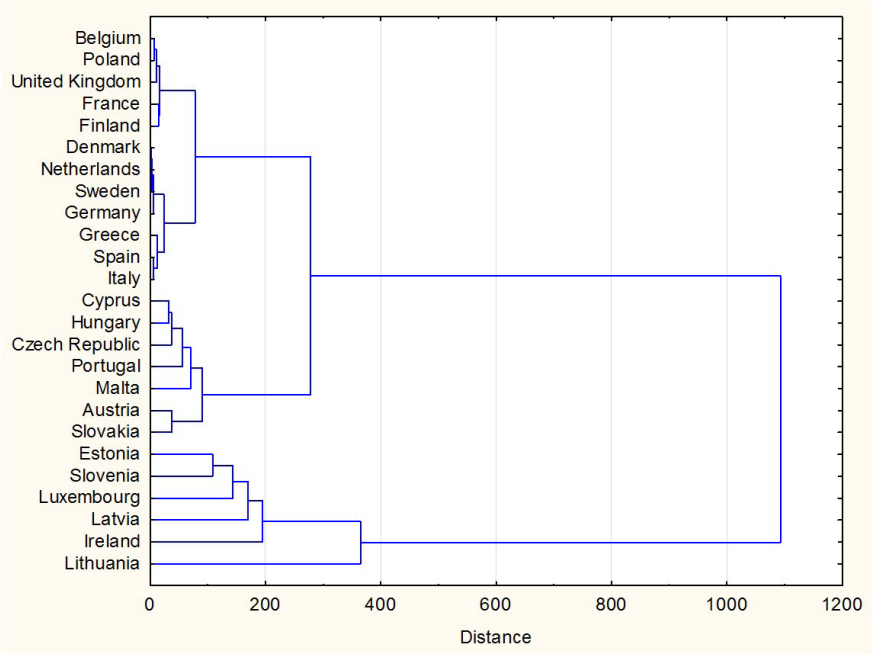
Group 2 (Denmark, Netherlands, Sweden, Germany, Greece, Spain, Italy) is characterized by below-average investment subsidies recalculated to the economic size of a company or in individual years distinct divergences are evident in the size of investment subsidies (Greece), in Sweden investment subsidies have been zero recently. The average growth rate is the highest in the Netherlands (53 %) and Germany (15 %), Greece shows the average inter-annual decrease.

Group 3 (Cyprus, Hungary, the CR, Portugal, Malta, Austria, Slovakia) has above- growth average investment subsidies, and the CR shows the highest (by 20 % on the average annually), Malta and Slovakia proves distinct divergences in individual years and average decrease can be

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average increment
Belgium	2.63	3.02	4.06	5.11	7.82	8.84	11.62	9.94	11.96	9.45	**0.76**
Bulgaria				4.06	2.07	4.03	2.55	5.93	12.23	19.36	**2.55**
Cyprus	0	0	7.57	1.52	10.75	41.65	20.03	16.01	22.58	6.65	**0.74**
Czech Republic	2.76	5.00	5.60	8.38	10.21	15.89	17.94	35.32	27.02	14.34	**1.29**
Denmark	1.25	0.92	0.88	0.56	0.72	0.17	0.53	0.13	1.89	2.48	**0.14**
Germany	1.06	0.64	1.30	1.04	1.62	2.00	2.54	2.70	2.31	3.83	**0.31**
Greece	4.68	1.57	11.48	7.06	5.41	3.33	1.70	0.92	0.76	1.92	**-0.31**
Spain	1.68	3.08	4.58	2.01	5.17	4.33	4.08	5.13	4.11	2.67	**0.11**
Estonia	63.73	33.23	14.63	15.44	138.04	77.48	42.32	54.29	59.01	57.73	**-0.67**
France	9.54	9.29	10.93	8.58	9.05	7.36	8.64	7.98	8.64	8.57	**-0.11**
Croatia										0	
Hungary	12.09	15.11	6.80	14.26	19.72	32.11	17.10	14.77	8.60	17.67	**0.62**
Ireland	7.43	11.40	11.71	42.83	87.05	134.66	18.56	6.68	3.77	5.27	**-0.24**
Italy	3.59	5.09	5.79	4.09	1.07	3.27	4.15	5.10	3.79	5.68	**0.23**
Lithuania	33.58	93.94	190.67	62.65	125.10	220.93	168.63	148.84	94.26	59.51	**2.88**
Luxembourg	61.74	72.85	76.97	94.24	83.03	81.12	79.70	81.86	96.54	94.33	**3.62**
Latvia	55.16	79.88	67.62	86.76	84.08	51.74	42.50	118.10	0	0	**-6.13**
Malta	0	3.92	7.70	0.27	6.33	0	56.47	47.22	19.51	15.18	**1.69**
Netherlands	0.04	1.99	0.63	0.26	0.30	0.38	1.04	0.26	0.87	1.81	**0.20**
Austria	22.17	24.33	28.76	22.45	34.37	41.44	34.74	35.22	27.67	23.30	**0.13**
Poland	0	0.93	2.22	7.73	11.65	7.58	10.71	10.72	11.06	11.08	**1.23**
Portugal	21.06	26.67	26.59	10.79	9.65	15.79	18.26	33.13	34.48	34.12	**1.45**
Romania				4.23	3.20	2.80	0.65	1.32	0.34	0.71	**-0.59**
Finland	2.66	5.84	7.31	11.34	14.40	13.14	13.28	12.82	11.67	12.06	**1.05**
Sweden	0.10	1.34	0.35	0	0	1.29	0	0	0	0	**-0.01**
Slovakia	1.69	0	31.74	28.94	46.16	47.10	39.14	43.66	28.67	14.17	**1.39**
Slovenia	128.79	42.00	14.56	34.47	62.59	80.67	78.08	55.58	54.30	64.01	**-7.20**
United Kingdom	3.66	4.55	5.74	5.93	4.38	8.80	7.20	6.14	13.00	7.35	**0.41**
EU	4.93	5.74	7.18	6.14	7.86	9.54	7.81	8.15	7.44	7.22	**0.25**

Source: FADN

Table 1: Investment subsidies (in €/ESU).



Source: FADN, Authors´own research

Figure 1: Dendrogram of EU Countries according to Investment Subsidies on Economic Size of a Company.

seen in Cyprus (by - 2 %).

Group 4 (Estonia, Slovenia, Luxembourg, Latvia, Ireland, Lithuania), where investment subsidies are distinctly above average, nevertheless, in most of them the average inter-annual decrease can be seen, a slight increase can be noticed only in Luxembourg (by 5 %) and Latvia has zero investment subsidies in the last two years.

In view of the fact that the investment subsidies should be reflected in gross investment, in table 2 is tracing the evolution of gross investments converted into economic size (ESU) and again, the absolute values are complemented by an annual average increment.

Gross investments grew fastest in Bulgaria (37.8 €/ESU per annum), Lithuania (33.8), Estonia (23.9), Czech Republic (21.7), and Latvia (21.5) per annum, while the highest value of gross investments recalculated on the economic size of the enterprise was recorded in Luxembourg, the Baltics, Slovenia and in Austria. The decline in gross investments in agriculture is recorded in Poland, Denmark, Romania, Spain, Malta and Italy, while the lowest values are in Cyprus, Greece, Spain, Italy and Malta (Table 2).

According to the share of investment subsidies on gross investments, the EU states can be divided into 5 groups (Figure 2).

Group 1 (Belgium, UK, Finland) has the share of investment subsidies on gross investments slightly above the EU average and the trend is slightly dropping in the whole group and in the whole EU. The biggest dropping rate of this indicator can be seen in Finland (by -15 % annually).

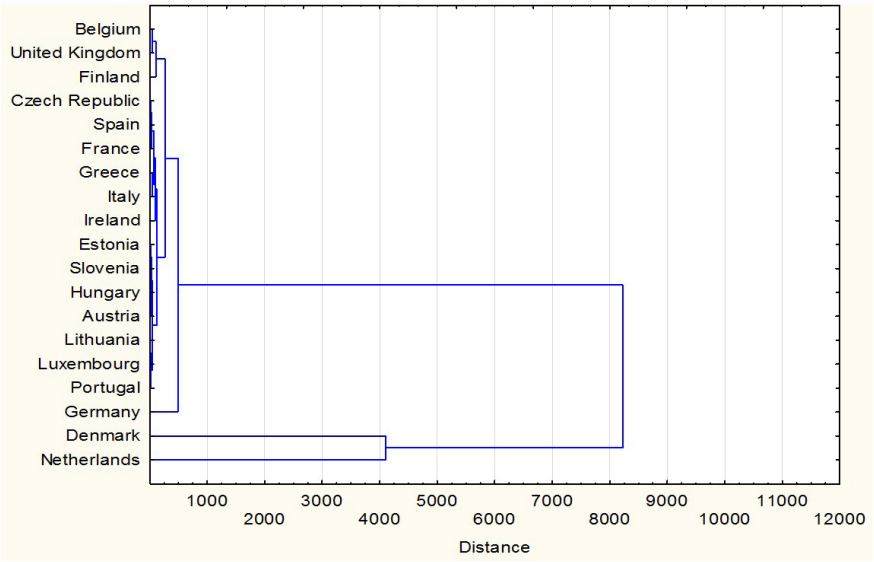
Group 2 (the CR, Spain, France, Greece, Italy, Ireland) is characterized by slightly below-average share of investment subsidies on gross investments and the average growth rate is the highest in Greece (11 %), France and Ireland. The dropping trend can be seen in the CR, Spain and Italy.

Group 3 (Estonia, Slovenia, Hungary, Austria, Latvia, Luxembourg, Portugal) has a distinctly

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	**Average increment**
Belgium	121.6	134.7	163.3	200.3	192.0	187.8	176.0	200.5	160.3	196.3	**8.30**
Bulgaria				146.8	323.6	195.9	277.8	275.5	303.2	373.7	**37.81**
Cyprus	-6.0	-2.1	-38.8	39.0	13.6	192.2	39.4	38.7	90.9	31.4	**4.15**
Czech Republic	81.7	105.6	134.3	156.7	183.7	131.2	140.6	226.2	253.9	276.7	**21.67**
Denmark	309.0	389.5	390.9	435.2	442.1	211.3	169.8	204.2	197.3	246.6	**-6.93**
Germany	113.3	117.7	140.7	146.0	160.2	152.7	177.5	196.5	204.3	240.1	**14.09**
Greece	31.7	36.1	49.3	45.9	32.8	34.8	39.2	23.4	47.6	33.8	**0.23**
Spain	49.5	36.3	36.4	46.4	33.8	52.5	42.4	47.2	52.2	38.9	**-1.18**
Estonia	298.7	368.4	343.3	352.9	569.6	172.9	231.0	356.9	393.9	513.8	**23.90**
France	185.7	182.0	166.6	182.3	206.8	169.5	159.1	179.4	193.3	196.3	**1.18**
Croatia										75.4	
Hungary	132.8	123.4	117.5	172.0	162.0	187.8	116.0	159.4	143.4	174.3	**4.61**
Ireland	150.4	-87.0	-67.9	290.1	435.2	162.7	78.7	233.0	221.4	305.3	**17.21**
Italy	50.2	192.8	67.9	46.5	25.3	50.8	41.5	64.2	151.5	49.4	**-0.09**
Lithuania	186.2	309.0	514.6	457.4	596.5	423.3	450.8	510.8	477.1	490.4	**33.80**
Luxembourg	437.0	387.1	392.4	410.5	435.2	342.4	491.1	522.1	704.4	583.2	**16.25**
Latvia	349.1	542.2	538.5	531.4	641.3	185.7	168.8	437.9	514.9	542.7	**21.52**
Malta	61.7	123.2	98.3	115.3	-353.6	139.7	201.8	122.8	142.8	57.8	**-0.43**
Netherlands	167.7	176.9	180.8	244.8	200.7	205.5	177.9	218.0	217.2	189.5	**2.42**
Austria	295.1	332.3	297.9	359.7	411.7	373.9	334.5	414.1	405.7	410.0	**12.77**
Poland	352.6	161.7	194.8	218.2	202.5	144.4	155.9	149.4	202.2	169.0	**-20.40**
Portugal	163.6	136.7	128.0	148.4	93.3	82.5	119.9	110.3	161.4	172.7	**1.01**
Romania				102.4	58.8	97.5	67.3	52.2	79.0	83.0	**-3.24**
Finland	332.5	412.7	370.2	555.2	451.6	350.4	348.9	313.3	340.0	350.5	**2.00**
Sweden	243.3	221.1	260.5	336.5	349.7	246.6	342.4	397.2	330.4	273.6	**3.36**
Slovakia	123.7	181.5	116.0	235.7	368.2	260.5	192.2	271.7	230.3	224.2	**11.16**
Slovenia	389.0	270.2	304.4	368.5	482.5	452.8	356.7	363.3	419.7	412.6	**2.62**
United Kingdom	166.1	156.1	185.5	213.7	208.0	194.0	224.0	253.2	264.9	254.9	**9.87**
EU	143.31	155.40	142.36	162.36	163.12	142.55	139.19	161.23	182.87	169.04	**2.86**

Source: FADN

Table 2: Gross investments recalculated on the economic size unit (€/ESU).



Source: FADN, Authors´own research

Figure 2: Dendrogram of EU States according to the Share of Investment Subsidies on Gross Investments.

below-average share of investment subsidies on gross investments and the dropping trend of this indicator is in Hungary, Luxembourg, and Portugal. On the contrary, growth of this indicator can be seen in Estonia, Latvia, Austria and in Slovakia.

Group 4 (Germany) shows above-average share of investment subsidies on gross investments and the trend is dropping by 5.8 % a year.

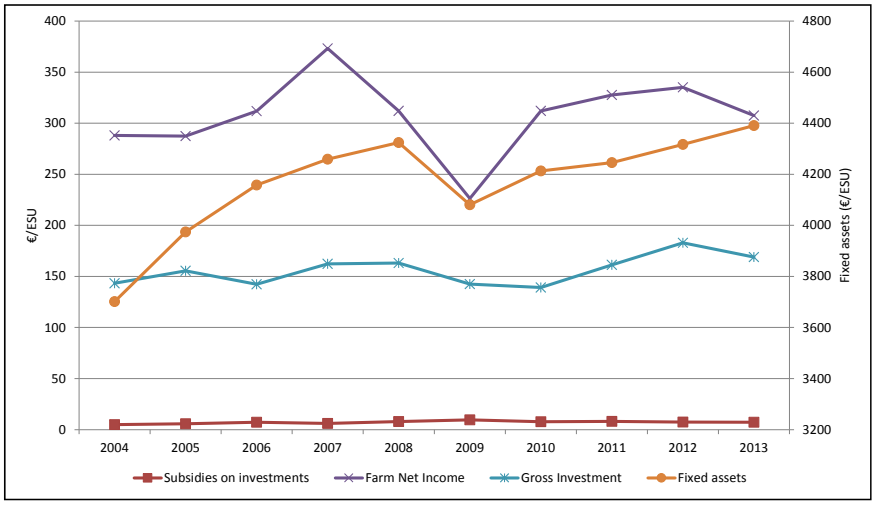
Group 5 (Denmark, Netherlands) is characterized by a distinctly above-average share of investment subsidies on gross investments and the trend is dropping in Denmark by 10% a year and in Netherlands by 34 % a year.

As an effect of investment subsidies can be expected with an increase in fixed assets and farm net income (relative to economic size - ESU). This analysis was utilized Figure 3, which includes the development of evaluated indicators. The figure has already presents summary of the results for the EU (because of the extent of the paper there are not presented data according to each country). However, there was also an assessment of these partial indicators in the various countries from which the following conclusions:

- The highest value of fixed assets recalculated on the economic size of enterprise is recorded in Ireland, the UK, Slovenia and Denmark while the lowest value is in Slovakia, France and Bulgaria. Slovakia also showed the highest decline in Fixed Assets by an average of 12% per annum, a slight decline was recorded in Malta, Italy, Portugal and Slovenia. Lithuania, Poland and Slovenia show the highest increase in Fixed Assets.
- Farm Net Income (profit/loss) is variable in particular years, in the EU an average of FNI ranges from 226 €/ESU (2009) to 373 €/ESU (2007).The negative values appear in most of the years in Slovakia and within 2008 - 2009 in Denmark. The average drop occurs in Malta (by 4%), in Finland (3.8%), in Estonia and Spain by 3.3%, in Greece (2.7%), Slovenia (2.6%), Italy (2.4%), Lithuania (2.1%), France, Luxembourg, Austria and Belgium. The CR recorded an average growth of 8.5% per annum, but still below the EU average. The highest average profit growth per annum is recorded in Sweden (12%), Hungary (10.5%), Cyprus (9.5%) and Romania (9.4%).

The expected thesis was that the increase in investment subsidies leads to an increase in other indicators. The graph shows that the value of the investment subsidies is compared with other indicators significantly lower and therefore we cannot expect a similar development is monitored indicators.

In many countries, the investment subsidies have character renewal of obsolete assets (esp. NMS). Fixed assets bringing new technologies to enhance of productivity and thus income growth, some precision farming technologies are already a "superstructure". However, in terms



Source: FADN, Authors´own research

Figure 3: Development of monitored indicators - EU average.

of co-financing of this type of subsidy is for many farmers less available type of property. Therefore, these investment subsidies can contribute more to maintain their current income, eventually a little increase. It is understandable that the development of income is influenced by other factors (e.g. climatic conditions, price volatility).

Analysis of individual relations of monitored indicators and investment subsidies is further complemented by correlation. Considering the dependence of particular factors on subsidies on investments in each year, the lowest correlation coefficient and the lowest value of regression coefficient is in the relationship between fixed assets and subsidies on investment. The dependence of gross investments on subsidies on investment show the middle and higher dependency, i.e. 30 – 47% of gross investment changes can be explained by the change of subsidies of investments. An increase in subsidies on investments by 1 € has meant an increase in gross investments by 4.5 – 1.2 €. The correlation coefficient of investment subsidies influence on Farm Net Income indicates low values which have significantly reduced in the last two years. It is therefore possible to conclude that the amount of subsidies on investment doesn't significantly affect the amount of Farm Net Income.

The lowest correlation coefficient in individual countries is in the relation of investment subsidies and Farm Net Income. Only in Romania does the dropping trend of investment subsidies and growing trend of profit result in negative dependence. The highest positive correlation between subsidies on investment and FNI is in Denmark, where an increase in investment subsidies by 1 € will increase profits by 115 €. The dependence of gross investments on investment subsidies was proven in Cyprus, in the CR, in Germany, in Hungary and in the UK. For example, in Germany 89 % of changes in gross investments can be explained by the change in investment subsidies. On the contrary, in Sweden the negative correlation is caused by the fact that investment subsidies have been zero in the last four years. The lowest value of regressive coefficient is in the relation of investment subsidies and fixed assets. The dependence of fixed assets on investment subsidies is evident in the CR, Finland, Germany, Luxembourg and Poland. In these countries 41 to 84 % of changes in fixed assets can be explained by the change in investment subsidies. The increase of investment subsidies by 1 € meant the increase of fixed assets by 220 € in Poland and by 187 € in Germany. The decreasing trend of fixed assets in Slovakia and coincident increase of investment subsidies result in negative dependence, therefore, the increase of investment subsidies by 1 € means the decrease of fixed assets by 52 €.

The Correlation matrix implies (Table 3) that gross investments recalculated to the economic size of a company depend on investment subsidies (r = 0.581), the negative dependence was proved in the share of subsidies on income(r = -0.215), in the share of subsidies on fixed assets (r = -0.180) and share of subsidies on gross investments (r = -0.168). In the case of Farm Net Income, the highest dependence proved as a negative dependence on the share of subsidies on gross

Variable	Investment subsidy	Income	Gross Investments	Fixed Assets	Income/ Subsidies	GI/ Subsidies	FA/ Subsidies
Investment Subsidies	1	0.193	0.581	0.062	-0.215	-0.168	-0.180
Income	0.193	1	-0.061	0.217	0.214	-0.255	-0.196
Gross Investments	0.581	-0.061	1	0.006	-0.229	0.008	-0.058
Fixed Assets	0.062	0.217	0.006	1	-0.016	0.019	0.074
Income/Subsidies	-0.215	0.214	-0.229	-0.016	1	0.542	0.585
GI/Subsidies	-0.168	-0.255	0.008	0.019	0.542	1	0.951
FA/Subsidies	-0.180	-0.196	-0.058	0.074	0.585	0.951	1

Note: Marked correlations are significant at $p < 0.01$, $N = 265$ (Casewise deletion of missing data)
Source: FADN, Authors´own research

Table 3: Correlation Matrix of Monitored Indicators.

investments (r = -0.255). The size of fixed assets depends only on the size of Farm Net Income (r = 0.217). The share of investment subsidies on the income depends on the share of investment subsidies on gross investments (r = 0.542) and on the share of investment subsidies on fixed assets (r = 0.585). The share of subsidies on gross investments shows the most significant dependence (r = 0.951) with the share of investments subsidies on fixed assets.

Conclusion

The support of investment subsidies represents not only possibilities for extending new property, but in many cases, (especially in post-transforming countries like Poland, the CR and Bulgaria with the highest growth rate of investment subsidies 20-36%) also a return of written-off assets.

As a consequence of their becoming outdated, they do not bring necessary profits and also from the technological viewpoint they are inconvenient. The average of investment subsidies recalculated to the economic size of a company increased in the EU during the monitored period from 4.93 to 7.22 €/ESU, i.e. one and a half times. This fact undoubtedly influences also the highest rate of gross investments of these countries (e.g. Bulgaria 17%, the CR 14.5%). On the other hand, there are countries whose values of assets are at a high level (e.g. Ireland, the UK) although investments subsidies do not reach such values – growth rate, volume. It is obviously caused by the general economic level of these countries where the investment growth is not so dependent on provided subsidies.

Especially the economically more advanced countries (Germany, Denmark, Sweden) amounting to investment subsidies per ESU below average or average in the EU - i.e. 5 - 9.5 €/ESU in the period. On the contrary, the Baltic countries or V4 countries acquired higher investment subsidies than the EU average in most of the monitored years.

The dependence of gross investments on investment subsidies shows medium and higher dependence, i.e. 30 - 47 % of changes in gross investments can be explained by a change of investment subsidies. The dependence of gross investments on investment subsidies was proven in Cyprus, in the CR (45 % of changes in gross investments result from a change of investment subsidies), in Germany, Hungary, and the UK. According to the share of investment subsidies on gross investments, the EU states were divided into 5 groups and most states belong to groups with below-average values (the EU average in monitored years oscillates between 15 % and 29 %). The above-average values of the share of investment subsidies on fixed investments are reached by Germany, Denmark, and Netherlands.

The correlation coefficient of the influence of investment subsidies on the Farm Net Income has low values, which have been dropping considerably in the last two years. Thus, it is possible to state that the size of investment subsidies does not influence the size of Farm Net Income considerably or does not influence a current profit; therefore, the size of subsidies on investments will probably prove with a delay. The dependence of impact of investment subsidies on fixed assets is apparent in the CR, Finland, Germany, Luxembourg and Poland.

Acknowledgements

The authors thank the Ministry of Education of the Czech Republic for financial support, Research Program of the Department of Accounting and Finance (RVO160).

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Architecture of a Management Information System for Farmers

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Abstract

In view of growing importance of data, information and knowledge in companies has become very actual issue of the quality of their processing through the information system modules. Using of modules of the management information systems for qualified analyzes conducted over primary data stored in companies in the Czech Republic is not too widespread. The aim of this article is based on a long-term investigation conducted to analyze the situation and propose for agricultural holdings architecture management information system for farmers to support their decision-making activities.

Keywords

Data, information, knowledge, information systems, management, architecture of information systems.

Šilerová, E., Heynnyeová, K. and Jarolímek, J. (2016) "Architecture of a Management Information System for Farmers", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 4, pp. 163 - 169. ISSN 1804-1930, DOI 10.7160/aol.2016.080415.

Introduction

Data, information and knowledge in the last two decades become one of the most important corporate resources. The process of their processing and further use in decision-making nowadays is impossible imagine without high-quality information systems and in particular without the modules that support management decisions. In the most of companies are stored in the databases a huge capacity of data and information. These data and information have for company further added value only if they will also further used and if on the basis of their processing will be performed qualified decisions. The volumes of data stored in databases regularly every year increase several times (statistics show that the annual growth enterprise database is equal to 5-year increase in previous years). Stored primary data and information in databases have only registered character. With these data is necessary to continue to working. They became significant when they are connected to knowledge and wisdom. Knowledge and wisdom in most of cases are not stored in information systems. Owner of knowledge as well as wisdom, are people who are in the company and are able to use and work with company databases and information.

Therefore, for highly qualified decisions is necessary to connect knowledge of employees with the data and information stored in company databases. It is the primary company databases which provide the basis for the formation of databases on the tactical level management. Data and information stored in these databases have already been processed according to the requirements of managers, according to their requirements of outputs. Lack of data and information has a negative impact on the entire decision-making process.

The most important factor of every company in today's economic environment is the ability to process information with high precision. For the processing of data and information is important to use technological innovation that the company becoming more competitive. The importance of farmer's information systems (FMIS) is highly respected in this regard. For instance, Lewis (1998) stated that "innovative tools for managing computer and databases have the potential to increase the quantity and quality of information available for decision making." Just few FMIS use technologies of information processing with the option of using the Internet and all of its added value. Currently, in the Czech Republic there is not such an information system available at all. For example, Zeman company offers only the basic modules of information systems -accounting, wages, materials storage, herd turnover, land registration. Making use of these modules is not supporting decision-making or economic modelling, it is used only to store data.

The data and information in agricultural holdings arise in all segments, however, their integration is almost zero. The data and information are stored in modules of individual segments of the company and they are mostly used for the further processing only regions where the data originated and where it is stored. Therefore, nowadays senior managers gain information throughout the entire agriculture holding at one place very problematic. This is the currently situation in the Czech Republic. The same situation is in other European countries, as stated Nikkila et al. (2010). FMIS has little decision support functionality, using enterprise data and increasing competitiveness.

Until now the research data usage in agricultural holdings primarily aimed at supporting decisions of computational biological models - for instance crop yield forecasts (Australian project focused on decision support functions in connection with the cultivation of wheat - a system called WHEATMAN) for field operations - planning machines planning the consumption of fertilizers, determining the driving speed depending on predicted revenue, soil nutrient stocks and other technological decisions. Use of systems for data processing and informed decisions for nitrate fertilization deals Fiez et al. (1994).

In recent years, the development of automated systems in agriculture gained increased interest, which led to that the research teams devoted to exploring the development of rational and adaptable systems based on a behavioral approach (Sørensen et al., 2010). Combined use of new communication technologies, sensor systems, GPS systems, geographic systems (GIS) enable the development of new systems for growing and harvesting crops (Slaughter et al., 2008). Robotic applications in agriculture, forestry and horticulture have been developed for different activities - dairy robots, robots for growing tomatoes, strawberries.

The precision agriculture is technically and computationally more difficult than traditional agriculture. This complexity results not only from the practical implementation of precise measurement and precise applications, but also work with the information system, which is a central element in the system of precise agriculture. For traditional FMIS is usually output (report) is made in the form of documents and paper forms.

The structure of the current output reports is predefined and the farmer gets the assembly at regular intervals, in which changes only the data. There is no change in the structure of demand for outputs, nor is it feasible. Changing the structure of the output report is a long-term matter and often is associated with a considerable financial burden on businesses. Precise agriculture allows the structuring of output on-line and is realized with much greater precision on individual properties, stables, equipment, employees, directly depending on the requirements of managers. Principles of development of information systems solves Stail and Reynolds (2011).

In 2009, the EU funded project that will bring a new model and a prototype of a new information system for management of agricultural enterprises. In a study of the project Sørensen et al. (2011) defined and analyzed boundaries of the system and identified relevant decision-making processes FMIS. Related studies Lawson et al. (2011) solves potential benefit for the introduction of agricultural information management systems in Germany, Greece, Denmark and Finland. From The results of the study show that "More than 40% of companies surveyed in Germany, Denmark and Finland were unsure about usefulness of information systems." (Lawson et al, 2011). However, the authors also concluded that is needed more research utilization of innovative technologies and benefits information system. The research project FutureFarm continues by identification of content "process" information flow model entities that represent the use of information processes, and "information" entities that represent data elements (Sorensen et al., 2011). Collection of data for the system of agricultural management is done, for example, Steinberger et al. (2009) by software architecture for the management of agricultural information systems in the field of precision agriculture is engaged Nikkilä et al. (2010), who addresses the integration of individual sections of the agricultural company and utilization for control processes. The importance of using data from information systems in agriculture solves Demiryurek. (2010). Solved issue with long-term investigations Heynnyeyova and Depes (2010), Šmída (2007), Welch and Welch (2007) and are jointly managed and consulted

Via declared benefits FMIS is this type of research in the Czech Republic only sporadic. There is still no coherent information system specializing in agricultural production on crop and livestock production with technical services, economics and management, to support decision-making of farmers.

Materials and methods

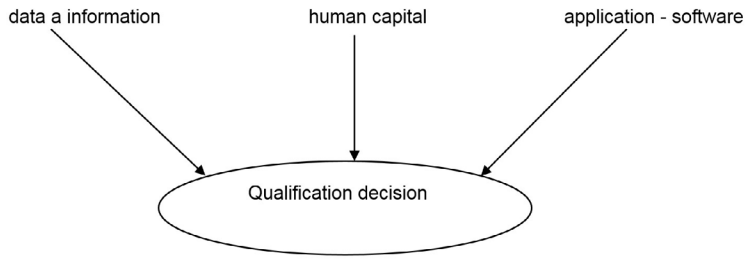
The article was prepared on the basis of scientific methods - analysis, synthesis, induction and deduction. The theoretical part was created by using secondary sources, the study of scientific and professional articles. The analyzed data are obtained by carrying out regular surveys in selected sample of 186 companies. The survey is doing by polling personal managers who directly use data and information from the company information system for their decisions. Was elected structure of companies, which corresponds to the representation of companies in the national structure. In a sample of companies investigation was carried out, which specifies the types of outputs from management information system in the company. Based on the investigation and identify the situation and the need for agricultural holdings will be designed architecture management module that will creates the conditions for improve the management of the whole agriculture holding.

Results and discussion

However, the economic benefits of precision agriculture is still unknown. Positive effects can be caused by being precisely specify the cost of the entire production process. Figure 1 shows that precision agriculture requires accurate information, highly skilled human capital and local applications - factors that create an ideal source of data for further processing and evaluation of economic efficiency. That means a guarantee that the used amount of input exactly corresponds to cost. Seeds, fertilizers and pesticides are applied exactly according to soil quality. In the same way can modify the soil depending on the exact space conditions. Using GPS positioning system can precisely map the fields imbalance and also in response to induce application technique to be responsive to the variability of fields and allow the most effective use of all resources.

The most valuable of these process are stored data and information. In the crop production, farmers can work with data relating precisely to each plot for each plant species to each tractor to each worker. Based on available technology can be listed data monitor almost online. The manager can monitor the movement of the machine and the effectiveness of the monitored device. These are the data obtained from the activities related directly to work on individual plots - tillage, seeding, crop protection, harvesting. Therefore it is possible to calculate precisely and accurately the cost per unit. The obtained data, which are stored in data storage, are a source of further qualitative shift in land use - the data can be used directly in the design of solutions to crop rotation, determine how the special use of the principle of precision agriculture on the whole company efficiency. Growing measures is useful for better comparison to convert into a graphic form and matching them with the proposed silvicultural treatments. Problems of processing and use of data and information in agriculture is also engaged Šimek et al. (2015).

If a farmer focuses a lot of information to all land plots, yet does not practice the principles of precision farming. He has to know how to further deal with this amount of information that are stored throughout the whole year, and all the monitored years. It is necessary to make sense of stored data, the data must be converted to a specific operational solutions. Nowadays is successful only that one who can produce not only economically, but mostly sells very effectively. Therefore it is important to work with the data that was established on the agricultural holding. This requires using of high-quality software. Impact on quality of management decisions has using of well-prepared companies data. Currently it is possible to using tools for work with stored data - using the Business Intelligence software. The Business Intelligence software helps to make better use of corporate resources. With Business Intelligence (BI) applications can get our own data, quickly and easily find out the results of business activities - production, sales, circulation material. At present



Source: own processing

Figure 1: Data processing requirements.

is counting with absolute course to access individual reports and with on-line access to the requested reports. To a greater extent, ensures the accuracy and quality of outputs and BI tools also no longer just the prerogative of senior management, but it is also used by ordinary users increasingly.

Since 2006 is regularly carry out investigations in a sample of companies - among selected companies included companies from the entire production and processing spectrum, including agricultural holdings, range of services, public administration. It is observed how the data and information for decision making in companies acquired. A total of 168 companies is monitored. Four options of acquisition were selected - Regular reports, outputs from corporate databases into Excel, meetings and software Business Intelligence. From the following graph is clear that there are still data and information in most companies acquired by regular reports. Based on carried out investigations, we can say that regular reports are still in 50% forwarded to senior managers in printed form. In the last three years we have seen increased usage of software type BI that allows very well, carry over corporate data analysis and further with acquired data working.

In monitored 8 years was the largest decline of outputs provided in an environment of periodic reports, which are mostly represented outputs in printed form. In this form of output in the monitored period there was a decrease by 23%. On the contrary the highest increase occurred in the using of business intelligence software more than tripled - 233%. However, there are still remain regular reports in printed form as most widely used output from an information system for further decisions.

Investigation showed that the use of on-line output gradually increases. The strength of on-line outputs for decision-making processes is high and needed.

The situation in the agricultural sector is very different. Outputs for decision is very difficult to establish because the modules are not integrated and outputs work only the heads of department - an agronomist with the data in crop production, livestock specialist in livestock production. Modules in agricultural holdings are not integrated, and therefore can not access the data for the entire company uniform. Respondents who answered to question „Usage of data and information for further work“ positively, ie. they using the data for other activities, to implement the principles of precise agriculture and they work with data in creating model situations. Very often they use only the data stored in the database and process the data by hand on paper. 45% of all respondents use data to further improve the quality of tillage, fertilization, sowing and harvesting. Basically everyone using connection to GPS and according to data about the status of land are being made these further activities. Only 15% of respondents in relation to acquired data modified crop rotations. Data about stock of nutrients in the soil and knowledge requirements of each crop and the market price of crops may affect crop rotation. In the Czech Republic in relation to growing market prices of grain sown area is already exceeds 60% of the total area sown farmland. In such cases the use of the principles of precision agriculture has a big impact on the amount of income and opportunities for economic monitoring of individual plots.

Only 4% of respondents continue to work with the data that gain when using applications related with the precise agriculture. They form

Source: own processing

Graph 1: A method of obtaining data and information.

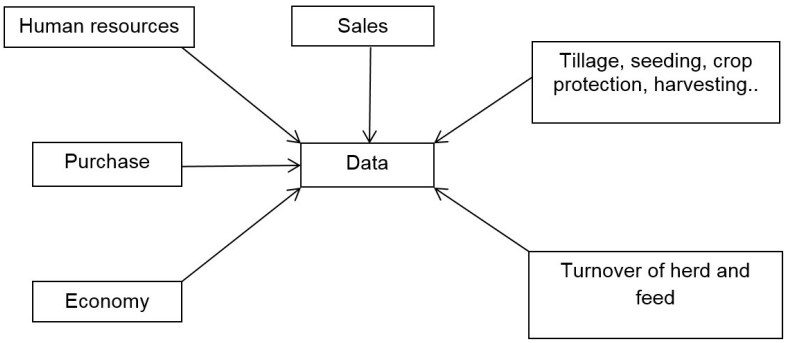
on basic of acquired data about the quality individual property, the economic situation of the company and the expected development of commodity price analysis of the current situation and forecasts for the coming years. Which crops will be the most economical and particularly in relation to the quality of land to cultivate. Unfortunately, the software that would allow carrying out these activities firms does not have. In many cases, they using the options of available spreadsheet (Excel) and often data sourcing again, they do not have the option of using stored data. There is thus a multiple data redundancy.

It is necessary to design an integrated database and then work with these data for the entire company. It is important to link data from crop production, livestock production with other data in the company - sales, economic data, and data from the field of human resources. Appropriate data sharing leads to a qualitatively higher utilization of all resources, resulting in reducing costs, increasing revenues and precision agriculture and also improve environmental quality.

On the Figure 2 is a draft of creation an integrated database. In a single database or individual interconnected databases are stored data from individual processes in the company. Stored data will be further used by appropriate tools – for instance through Business Intelligence software. Knowledge of management staff in the field (in our case, agriculture) and also their ability to work with stored data creates long-term competitive advantage. You can use the software that will be created for working directly with the proposed data - this option will be more expensive, but for many users easier. Inquiries carried over enterprise data will already created. The user will only learn using of those queries (functions). The second option is a software solution with the type of database environment, or spreadsheet. Employees directly create queries in the selected software according to specific requirements. Selecting the appropriate options will be affected:

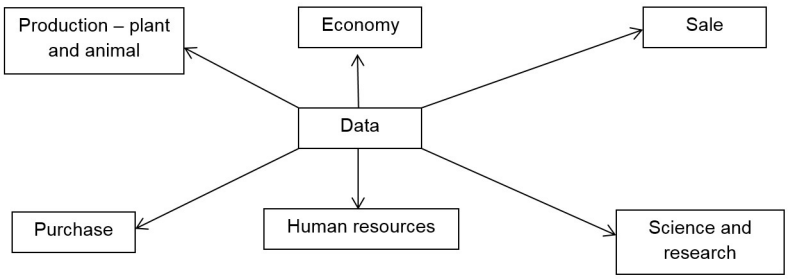
1. financial resources of the enterprise
2. human factor - knowledge in the field, the ability to control and use ICT

The advantage of the database created is the ability to access, according to the user and his access rights to the selected data. Can be generated models (Figure 3) when creating the prediction in plant production, animal husbandry, trade, economics, human resources, entire company - using business data (internal) and for modelling efficiency is the best process with external data (for instance expected market prices, sales volumes and others).



Source: own processing

Figure 2: Draft integrated database.



Source: own processing

Figure 3: Prediction models.

In the current economic environment, an important aspect of improving competitiveness is not only use the latest scientific findings, but also involved to the activities.

Conclusion

Creating of architecture has to be closely associated with the creation of an information strategy. Data and information become one of the most valuable corporate resources. Their use, importance and influence on the further development of the company are fully affected by the ability of managers to use all the data and information (internal and external). The quality of the information strategy is determined by the team's ability to define information needs. By creating a database that will individual modules of information system use, has to be clearly defined its individual components. By creating the database has to be a team representative of each corporate department, to create high-quality base of data that will become an essential starting point for the creation of reports for further decisions. Fiez, Lewis and Sørensen focus mainly on the use of the principles of precision agriculture in crop and livestock production, processing technology throughout agriculture. For the creation of information strategies and architectures can be used and the conclusions Dohnal and Pour (1999) and Kourdi (2009).

In this environment of rapid technological changes, agricultural development, economic situation, acceptance of strategy should be based on the option with the best value x power (variant of creating the highest quality reporting according to actual requirement).Agriculture is becoming a knowledge-intensive sector, where what employees will know (what data and information acquire) is a key factor in profitability. Ownership of tools of precision agriculture has its place in business and information strategy, but it is not the only option for increasing competitiveness. More important element is the involvement of the tools of precision agriculture throughout the corporate chain of production - sale - employees - the economy. Precision agriculture will fully support the development of the company, if will be done the interconnection in all parts of the company and it is only possible for the situation when we model the stored data from all ongoing activities of the company. Architecture design makes this possible specifically for agriculture holding.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 20161028, "Assessment of quality, usability and accessibility of electronic services from the perspective of small and middle sized enterprises in the agrarian sector".

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Agris on-line Papers in Economics and Informatics

Volume VIII Number 4, 2016

Editorial board

Agris on-line Papers in Economics and Informatics

The international reviewed scientific journal issued by the Faculty of Economics and Management of the Czech University of Life Sciences Prague.

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ISSN 1804-1930