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Continuity of Demarcation Process of the Regions for Concentrated State Support

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Anotace

Článek analyzuje kontinuitu procesu vymezování českých regionů (NUTS 4) se soustředěnou podporou státu. Smyslem této podpory je redukovat negativní disparity mezi jednotlivými regiony. Proces vymezování regionů zahrnuje kriteria výběru jako míra nezaměstnanosti, počet uchazečů o práci na jedno pracovní místo, daně z příjmu, počet soukromých podnikatelů a kupní síla. Tato kritéria a jejich váhy se v průběhu 20 let měnily.

V tomto článku jsou analyzovány změny používaných kritérii a jejich vah v letech 1991 – 2010. Pro tuto analýzu a především pro analýzu vah kritérií jsou použity dvě různé metody - Analytický hierarchický proces a Analytický síťový proces. Těmito metodami jsou váhy kritérií syntetizovány a výsledky ukazují kontinuitu procesu výběru regionů i přes změny hodnocení v různých obdobích.

Klíčová slova

Vícekriteriální rozhodování, Analytický hierarchický proces (AHP), Analytický síťový proces (ANP). Regiony se soustředěnou podporou státu.

Abstract

The paper analyses the continuity of the demarcation process of Czech regions for the state support. This support aims to reduce negative disparities among the regions. The process of demarcation of the region includes criteria as an unemployment rate, number of applicants per one job vacancy, income tax rate, number of private entrepreneurs and purchasing power. These criteria and weights of these criteria have been changed during the last 20 years.

The main aim of this paper is the analysis of the criteria set and the criteria weights modification during the years 1991 – 2010 and the examination of the modification of values of the criteria weights using two different methods - Analytic Hierarchy Process and Analytic Network Process. These methods are used for synthesis of the criteria weights, which shows the continuity of the region demarcation process during its modification in time.

Key words

Multi-criteria Decision Making, Analytic Hierarchy Process (AHP), Analytic Network Process (ANP). Regions with Concentrated State Support.

Introduction

State support of the disadvantaged areas within the European Union has to promote the economic development. This kind of the state aid is known as national regional aid. According to the guidelines of the European community the Government and the Ministry for Regional Development and Ministry of Industry and Trade, Czech Republic demarcate regions for concentrated state support. The regions with concentrated state support are divided into three subcategories: structurally challenged regions, economically weak regions and regions with high unemployment. The characteristics of the regions are negative features of structural changes, lower economic level and unemployment exceeding the state unemployment average. From a general point of view, they are less developed in many socio-economic indicators. The state support endeavours to reduce negative

disparities among these regions (Standing 1996).

Regions, their disparities, advantages and disadvantages are studied by many authors (Standing, 1996, Abrhám, 2007, Viturka et al, 2011). Many authors also deal with the process of the demarcation of disadvantaged regions or in evaluation of regions from various points of view; they apply different approaches and criteria of the regions evaluation and comparisons as well as different exact (mathematical) methods used for this evaluation (Klufová et al, 2010, Nevima, Ramík, 2009, 2010, Varivoda et al, 2010, Vostrá Vydrová et al, 2011, Kloudová, 2009, Kloudová, Chwaszcz, 2012) but nobody analyses the used criteria and weights and their changes over time.

Governmental selection process used in the Czech Republic was the subject of modifications during the years 1991 - 2010. The first document dealing with the general issue of regional development after the year 1989 was the Government Resolution No. 481 of 20th November 1991; it considered the fundamental problems of economic and social development of territorial units and defining priorities for regional policy in the Czech Republic. Government Resolution No. 235 of 8th April 1998 "Principles of regional policy of the Government of the Czech Republic" abolished the previous Government Resolution on this issue and confirmed the breakdown of regions with concentrated state support to structurally affected regions and economically weak regions.

Government Resolution No. 682 from 12th July 1999 "The Regional Development Strategy of the Czech Republic" included a strategic vision for regional development till 2010, with detailed breakdown of tasks by 2003. Its annex "Types and definition of regions with concentrated state support" has created a new tool for their establishment and minimized the influence of subjective factors and influences. Methodologies for the definition of problematic regions were selected based on the system of input parameters different for structurally affected regions and economically weak regions.

An organizational change came in 2002. According to the Act No. 47/2002 Collection of Law, the regional business support transferred from the Ministry of regional development to the Ministry of industry and trade.

According to its policy statement, on the 16th of July 2003 the Government adopted the Resolution No. 722 on the definition of regions with concentrated state support for the period 2004 - 2006. The next update is consistent with the new programming period of the European Union beginning in 2007. Annex to this Resolution updated the set of indicators for structurally affected and economically weak regions. In addition, it introduced a new category of regions with far above-average unemployment.

The selection of regions for concentrated state support for the years 2007-2013 was established by Government Resolution No. 560 of 17th May 2006 "Regional Development Strategy of the Czech Republic". Under this Resolution there remains a breakdown to structurally affected regions, economically weak regions and regions with highly above-average unemployment.

The governmental process of demarcation of the region includes criteria as an unemployment rate, number of applicants per one job vacancy, income tax rate, number of private entrepreneurs and purchasing power. The criteria values are from the databases of the Czech Statistical Office and weights of these criteria have been set by the government.

The main aim of this paper is the analysis of the used criteria and their weights modification during the years 1991 – 2010. The synthesis of the criteria weights based on the previous data are calculated using the AHP and ANP method. Comparisons of the received results show the continuity of the region demarcation process during its modification in time.

Materials and methods

The demarcation of the disadvantaged regions required establishing such methodological procedures that would eliminate a subjective approach. In the year 1999 the initial outlines were given by the above-mentioned „Principles of regional policy of the Government of the Czech Republic".

Demarcation of the structurally affected regions

Structurally affected regions were defined according to the following four criteria. The values of each criterion in the given region were transformed into proportional coefficients, with the higher value representing the worth situation. These coefficients were aggregated using the weights set

Proportion of employment in industry	Number of entrepreneurs	Development of employment in industry	Unemployment		
0.3	0.1	0.2	0.4		
			Long-term unemployment	Unemployment	Demand of the job
			0.3	0.4	0.3
Global weights					
0.3	0.1	0.2	0.12	0.16	0.12

Source: own processing

Table 1: Criteria weights for the demarcation of structurally affected regions (SRR 2000).

Tax revenue	Population density	Average wage	Proportion of employment in agriculture, forestry and fishing	Development of employment in agriculture, forestry and fishing	Unemployment		
0.1	0.1	0.15	0.2	0.15	0.3		
					Long-term unemployment	Unemployment	Demand of the job
					0.3	0.4	0.3
Global weights							
0.3	0.1	0.15	0.2	0.15	0.09	0.12	0.09

Source: own processing

Table 2: Criteria weights for the demarcation of economically weak regions (SRR 2000).

Unemployment		
Long-term unemployment	Unemployment	Demand of the job
0.3	0.4	0.3
Global weights		
0.3	0.4	0.3

Source: own processing

Table 3: Criteria weights for the demarcation of regions with far above-average unemployment (SRR 2000).

by the Government. The analysis was carried out till 2006. The criteria and their weights are presented in Table 1 (DVS 2009, SRR 2000).

Demarcation of the economically weak regions

Economically weak regions were selected according to the specific set of criteria (Table 2). The values of each criterion in the given region were again transformed into proportional coefficients. The coefficients were aggregated using the weights set by the Government. The analysis was carried out for the period till the year 2006. The applied set of the criteria and weights is presented in Table 2 (DVS 2009, SRR, 2000).

Demarcation of the regions with far above-average unemployment

The regions with far above-average unemployment were firstly defined in 2003 only from the unemployment point of view. The values of each criterion in the given region were transformed into proportional coefficients, with the higher value representing the higher unemployment. The coefficients were aggregated using the weights set by the Government. The analysis was carried out until 2006.

Tax revenue	Number of entrepreneurs	Purchasing power	Unemployment		
0.15	0.15	0.3	0.4		
			Long-term unemployment	Unemployment	Demand of the job
			0.3	0.4	0.3
Global weights					
0.15	0.15	0.3	0.12	0.16	0.12

Source: own processing

Table 4: Criteria weights for the demarcation of disadvantaged regions after 2006 (DVS 2009).

In the Table 3 there are the used criteria and their weights (DVS 2009, SRR 2000).

Changes of process of regions demarcation in 2006

During the year 2006 the process of selection of the regions for concentrated state support was transformed. The set of the applied criteria was changed as well as the weights of individual criteria. The process is now unified and based only on four criteria and three sub-criteria.

The statistical values of each indicator in the regions were also recalculated into the appropriate relative weighting and the calculation was done under the following principle: the higher value of a coefficient, the worse situation in the region. And again, the coefficients were aggregated using the weights set by the Government. The following criteria (Table 4) were included in a selection process of regions (DVS 2009, SRR 2000).

Multiple criteria methods used for the analysis

The above described process for the selection of the regions represents specific multiple criteria problems. These problems are solved by the Government of the Czech Republic using simple additive weighting method with the data from the statistic databases and politically set weights, but this weights are changed during the time.

In this paper the multiple criteria decision-making methods were also used for the analysis of continuity of this process, mainly of the consistency of the criteria set and their weights. In particular, we chose the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP).

The AHP is a method which derives global preferences from partial preferences that represent relative measurements of the hierarchical dependences of decision elements (Saaty, 1980, 1999, 2006). It is generalized by the ANP method (Saaty, 2001, 2003) which does not require independence among decision elements and therefore incorporates more complex relations.

- Analytical Hierarchical Process

Problem hierarchy construction is the first step of the AHP which describes the simple linear dependency among the elements.

Local weights are calculated using pairwise comparisons in the second step of the AHP. The consistency of these judgements has to be controlled.

In the third step the best alternative selection is based on synthesis of the weights throughout the hierarchy.

- Analytical Network Process

The first step of ANP is based on the creation of a control network which describes dependency among decision elements. The ANP allows inner dependence within a set (clusters) of elements, and outer dependence among different sets (clusters).

In the second step pairwise comparisons of the elements within the clusters and among the clusters are performed according to their influence on each element in another cluster or elements in their own cluster. So the ANP prioritizes not only decision elements but also their groups or clusters as is often the case in the real world. The consistency of these comparisons has to be controlled.

The third step consists of the supermatrix construction. The priorities derived from the pairwise comparisons are entered

into the appropriate position in this supermatrix. This supermatrix has to be normalized using clusters weights.

In the fourth step the limiting supermatrix is computed and global preferences of decision elements are obtained. These preferences serve as the best decision selection or for the purpose of analysis of preferences of decision-making elements.

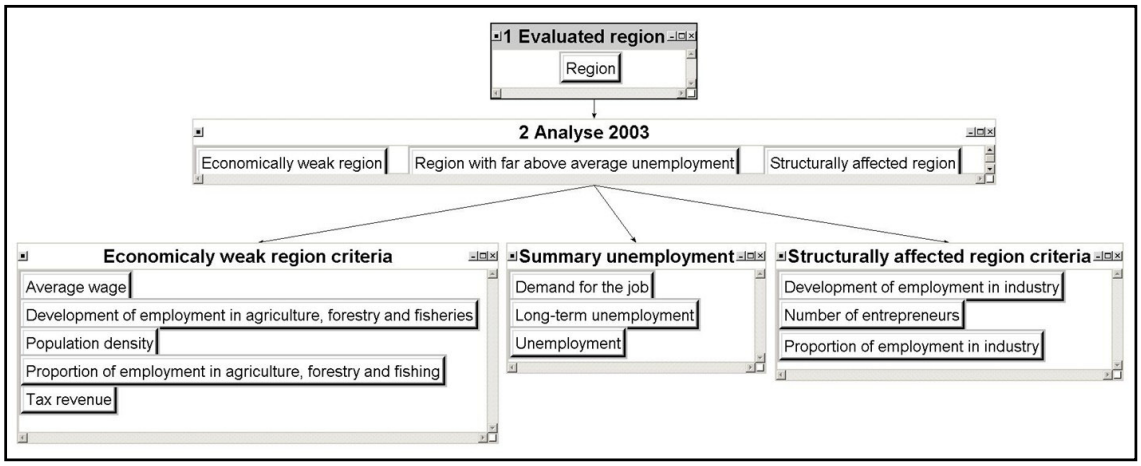
The Super Decisions software system (**http://www.superdecisions.com/**) was used for calculation of following AHP and ANP models. The program was written by the ANP Team working for the Creative Decisions Foundation.

These methods were selected because a decision structure had to consist of all the criteria involved in the regions characteristics which had been mentioned earlier and because there were many existing dependencies among the criteria. The AHP and ANP models used in these analyses are described in the following sections.

Analytic Hierarchy Process model

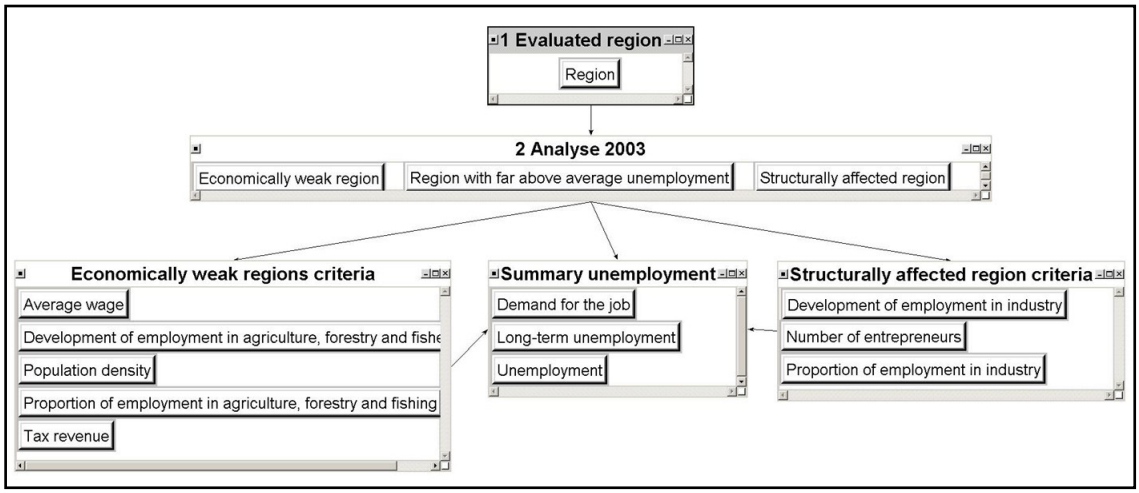
In the first analysis of criteria weights the AHP method was used.

- Problem hierarchy (Figure 1) has the following levels and elements:
  - The first level represents the goal, e.g. the supported region selection according to the criteria weights,



Source: own processing

Figure 1: AHP hierarchy (authors using Super Decisions).



Source: own processing

Figure 2: ANP network (authors using Super Decisions).

- The second level includes all three types of regions according to the analysis from the year 2003,
- The third level includes the groups of criteria, and
- The fourth level includes all criteria.

- Local priorities or preferences were set according to the government policy. Missing information (for instance the weights of different types of regions) were set equally, because the region can be selected by all possible ways.
- The consistency of these judgments was controlled.
- Synthesised weights of decision criteria obtained in the third step of the AHP were then used for a continuous analysis of the whole region selection process.

Analytic Network Process model

The second analysis was made using the ANP method:

- The first step of ANP was based on the creation of a control network which described the inner and outer dependency among used criteria.
- For our analysis we augmented the AHP hierarchy by outer dependencies between criteria which can describe the situation of unemployment from a different point of view.
- Local weights were used as in the AHP model; the added dependencies were estimated according to the expert judgment of the experts from the Department of Economics.
- The super-matrix was constructed and limiting super-matrix was computed to obtain the global criteria weights which were then analysed.

Results and discussion

The analysis of the modification of the criteria and their weights, the investigation of continuity or discontinuity of the selection process of the regions for concentrate state support is based on the dependencies in the initial criteria structure. Using the AHP and ANP methods we synthesised the initial weights and compared them with newly applied criteria weights. The AHP and ANP methods were used because they include the interrelations among groups of criteria, their dependencies.

Using Super Decisions software we can graphically describe criteria dependencies in the evaluation processes of the regions with the concentrate state

	Weights set by the government (1996, 2000)			Authors analysis	Weights set by the government (2003)
WEIGHTS	Economically weak region	Region with far above average unemployment	Structurally affected region	AHP analysis	Regions with Concentrated State Support - 2006
Tax revenue	0.1			**0.03**	**0.15**
Population density	0.1			**0.03**	
Proportion of employment in agriculture, forestry and fishing	0.2			**0.07**	
Average wage	0.15			**0.05**	
Development of employment in agriculture, forestry and fisheries	0.15			**0.05**	
Proportion of employment in industry			0.3	**0.10**	
Number of entrepreneurs			0.1	**0.03**	**0.15**
Development of employment in industry			0.2	**0.07**	
Long-term unemployment	0.09	0.3	0.12	**0.17**	**0.12**
Unemployment	0.12	0.4	0.16	**0.23**	**0.16**
Demand for the job	0.09	0.3	0.12	**0.17**	**0.12**
Purchasing power					**0.3**

Source: own processing

Table 5: The AHP comparison of the criteria weights.

support. The initial systems of evaluation criteria of the regions and their weights were described in Table 1, Table 2 and Table 3 (see above).

The new system of criteria used from the year 2006 consists of the previous criteria covering the unemployment characteristic of the regions and three other criteria; the criteria "Tax revenue" and "Number of individual entrepreneurs" were already used for the evaluation but not for all regions and the criterion "Purchasing power of people" is new one (Table 4).

Unweighted Supermatrix		1 Evaluated region	2 Analyse 2003			Economically weak regions criteria					Structurally affected region criteria			Summary unemployment		
		Region	Economically weak region	Region with far above average unemployment	Structural affected region	Tax revenue	Population density	Proportion of employment in agriculture, forestry and fishing	Average wage	Development of employment in agriculture, forestry and fisheries	Proportion of employment in industry	Number of entrepreneurs	Development of employment in industry	Long-term unemployment	Unemployment	Demand for the job
1 Evaluated region	Region															
2 Analyse 2003	Economically weak region	0.33														
	Region with far above average unemployment	0.33														
	Structural affected region	0.33														
Economically weak regions criteria	Tax revenue		0.1													
	Population density		0.1													
	Proportion of employment in agriculture, forestry and fishing		0.2													
	Average wage		0.15													
	Development of employment in agriculture, forestry and fisheries		0.15													
Structurally affected region criteria	Proportion of employment in industry				0.3											
	Number of entrepreneurs				0.1											
	Development of employment in industry				0.2											
Summary unemployment	Long-term unemployment		0.09	0.3	0.12		0.4	0 / 0.7	0.4		0.4		0.4			
	Unemployment		0.12	0.4	0.16		0.6	0 / 0.3	0.2		0.6		0.2			
	Demand for the job		0.09	0.3	0.12				0.4				0.4			

Source: own processing

Table 6: Not weighted super-matrix of the ANP analysis.

Analysis of the criteria and their weights by AHP method

Firstly, the criteria weights were analysed by AHP methods. The criteria hierarchy is presented in Figure 1 and the criteria weights are in Table 1, Table 2 and Table 3.

We suppose the equal weights of all hierarchy elements except the known weights. Using Super-Decisions, we obtained the following result of the analysis (Table 5).

In the Table 5 only five highlighted criteria are those that have nonzero weights in the new region selection process and in synthesis made by the AHP method also. These results seem to show an important discontinuity in the region evaluation process because non-zero weights were calculated for all criteria used in the past. It would mean that the set of criteria used in past was different from the set of the criteria newly used. We expected this result because this way of the weights analysis does not include the evident cross dependencies among the criteria characterizing the unemployment and their relations.

Analysis of the criteria and their weights by ANP method

The set of criteria are now analysed including network dependencies by the ANP methods. The dependencies among the criteria and the pairwise comparisons of these criteria are based on the discussions with the experts from the Department of Economics. The set of criteria were split into three clusters. The connections describe all dependencies among the criteria which are very important for this evaluation. We added the outer dependencies between criteria describing the situation of unemployment. Figure 2 shows this criteria network for comparing the original weights and weights which are used now.

The unweighted supermatrix gives a good impression of used connections and their weights. We used two different data.

- The analysis **ANP 1** uses the weights in Table 6. The preferences of the Long-term unemployment and the Unemployment in view of Average wage were not considered; therefore these weights are equal to 0.
- The analysis **ANP 2** examines the results obtained by adding a new group of interrelations. The preferences of the Long-term unemployment (with weight 0.7) and the Unemployment (with weight 0.3) in view of Average wage were added.

The results of both analyses can be seen in Table 7. The analysis **ANP 2** presents high continuity in the process of region evaluation. The initial

	Weights set by the government (1996, 2000)			Authors analysis		Weights set by the government (2003)
WEIGHTS	Economically weak region	Region with far above average unemployment	Structurally affected region	ANP analysis 1	ANP analysis 2	Regions with Concentrated State Support - 2006
Tax revenue	0.1			**0.03**	**0.03**	**0.15**
Population density	0.1			**0.03**	**0.03**	
Proportion of employment in agriculture, forestry and fishing	0.2					
Average wage	0.15			**0.05**		
Development of employment in agriculture, forestry and fisheries	0.15					
Proportion of employment in industry			0.3			
Number of entrepreneurs			0.1	**0.03**	**0.03**	**0.15**
Development of employment in industry			0.2			
Long-term unemployment	0.09	0.3	0.12	**0.28**	**0.32**	**0.12**
Unemployment	0.12	0.4	0.16	**0.35**	**0.37**	**0.16**
Demand for the job	0.09	0.3	0.12	**0.22**	**0.22**	**0.12**
Purchasing power						**0.3**

Source: own processing

Table 7: The ANP comparison of the criteria weights.

criteria system and their weights are consistent with the criteria system used in the new selection process of regions with state support. The initial and new weights of criteria, which are equal to 0, show the criteria not used in demarcation process, on the contrary the used criteria have non-zero weights in the new region selection process and in synthesis made by the AHP method. These criteria are highlighted in the Table 7. Exceptions are the criteria "Population density" which has not zero weight and is not longer used and the "Purchasing power" criterion which not used in the initial method and is added newly. Generally six criteria are not longer used and five criteria are still used. The differences in values of criteria weights can be explained by the former three types of region (structurally affected or economically weak region or a region with far above-average unemployment) defined by different sets of criteria.

Conclusion

The demarcation process of the regions with concentrated state support is based on the set of criteria and weights specified by the Czech Government according to the EU policies. Applying the weights, all indexes characterising the evaluated regions according to the criteria are aggregated.

The selection process has been modified during the years; the most important modification was in the year 2003, because the Czech regions are from now evaluated according to the single set of the criteria. We show that the idea and the continuity of the whole process of demarcation of the regions with concentrated state support are maintained. The new set of the criteria and their weights corresponds to the criteria and weights obtained by the **ANP 2** analysis based on the initial idea of this process.

This result will be used as a guide for the design of new methods for the selection of regions without the need to establish criteria weights. However the selection of regions for the concentrated state support is a political decision; the different quantitative methods for selection of these regions, the correlation of used criteria, the methods for setting of criteria weights and the application of the Data Envelopment Analysis method, which does not require predetermined weight of criteria will be discussed.

This paper also showed the possibility of the AHP and especially ANP methods not only for multiple criteria decision-making in the classic sense but also for such type of analysis.

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References

[1] Abrhám, J. The New EU Member States: Current Tendencies in Regional Differentiation, Ekonomický časopis, 2008, 55, 10, pp. 1007-1017, ISSN 0013-3035.

[2] Kloudová, J. Measurement of the Creative Economy, Ekonomický časopis, 2009, 57, 3, pp. 247-262, ISSN 0013-3035.

[3] Kloudová, J., Chwaszcz, O. The Application of Creative Economics to Selected Regions of the Czech Republic, In: Pavelkova, D., Strouhal, J., Pasekova, M., Suchacek, J. (Eds.), Advances in Economics, Risk Management, Political and Law Science, WSEAS, Zlín, 2012, pp. 71-76, ISBN 978-1-61804-123-4.

[4] Klufová, R., Friebelová, J., Faltová Leitmanová, I. Normative Economics or Improvement of Economic Life at Regional Level in the Czech Republic, Agris on-line Papers in Economics and Informatics, 2010, II, No. 4, pp.13-26, ISSN 1804-1930.

[5] Nevima, J., Ramík, J. Application of multicriteria decision making for evaluation of regional competitiveness. In: Mathematical Methods in Economics 2009, Kostelec nad Černými lesy, ČZU, Praha, 2009, pp. 239-244, ISBN 978-80-213-1963-9.

[6] Nevima, J., Ramík, J. Application of DEA for evaluation of regional efficiency of EU regions. In: Mathematical Methods in Economics 2010, České Budějovice, JČU, České Budějovice, 2010, pp. 477-482. ISBN 978-80-7394-218-2.

[7] Saaty, T. L. The Analytic Hierarchy Process, McGraw-Hill, New York,1980, ISBN 978-0070543713.

[8] Saaty, T. L. The seven pillars of the analytic hierarchy process, In: Proceedings of the AHPIC, Kobe, 1999.

[9] Saaty, T. L. The Analytic Network Process: Decision Making with Dependence and Feedback, The Analytic Hierarchy Process Series, Pittsburgh: IX, RWS Publications, 2001, ISBN 978-0962031793.

[10] Saaty, T. L. The Analytic Hierarchy Process (AHP) for Decision Making and the Analytic Network Process (ANP) for Decision Making with Dependence and Feedback, Creative Decisions Foundation, 2003.

[11] Saaty, T. L. Rank from comparisons and from ratings in the analytic hierarchy/network processes, European Journal of Operational Research, 2006, 168, 2 Spec. iss., pp. 557-570, ISSN 0377-2217.

[12] Standing, G. Social Protection in Central and Eastern Europe: a Tale of Slipping Anchors and Torn Safety Nets, In: Esping-Andersen, G. (Ed.) Welfare States in Transition, Sage, London, 1996, pp. 225-255, ISBN 0-7619-5048-6.

[13] Varivoda, V., Heijman, W., van Ophem, J. Competitiveness of Agrarian Areas in the Stavropol Region, Agris on-line Papers in Economics and Informatics, 2010, II, No. 1, pp.23-30, ISSN 1804-1930.

[14] Viturka, M. , Žítek, V., Tonev, T., Klímová, V. Application of Microeconomic and Macroeconomic Approach to Evaluating Disparities in the Regional Development, Ekonomický časopis, 2011, 59, 7, pp. 655-687, ISSN 0013-3035.

[15] Vostrá Vydrová, H., Dömeová, L., Jindrová, A. Pozice krajů na základě ukazatelů trhu práce, Scientia Agric. Bohem., 2011, 42, No. 3, pp. 142–146, ISSN 1211-3174.

[16] Law on regional development support, Act No. 248/2000, Collection of Law Vol. 73, 2000.

[17] DVS, Regiony se soustředěnou podporou státu - zhodnocení vývoje po roce 1990, Deník veřejné správy, [cit. 9. 7. 2009], http://denik.obce.cz/clanek.asp?id=6434736&ht=Regiony+se+soust%F8ed%ECnou+podporou+st%E1tu.

[18] SRR, Strategie regionálního rozvoje ČR, Postup při vymezování regionů se soustředěnou podporou státu, 2000, http://www.dhv.cz/regstrat/SRR/Svazek%205/Svazek%205.htm.

[19] GCR - Government of the Czech Republic, [cit. 5.1.2011], http://www.vlada.cz/.

[20] MRD - Ministry of Regional Development of the Czech Republic, [cit. 18.1.2010], http://www.mmr.cz/.

[21] MIT - Ministry of the Industry and Trade of the Czech Republic, [cit. 8.1.2011], http://www.mpo.cz/.

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Comparative Advantage: Products Mapping of the Russian Agricultural Exports

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Anotace

Tento článek obsahuje analýzu ruského zahraničního obchodu s agrárními a potravinářskými sektory ze dvou hledisek: mezinárodní konkurenceschopnosti a obchodní bilance.

Cílem analýzy je charakterizovat specifické skupiny produktů z celkového vývozu, z hlediska jejich komparativní výhody (nebo nevýhody) a obchodní bilance; a zároveň určit změny, které nastaly v těchto charakterizovaných skupinách během období 1998-2010 a vysvětlit, proč došlo k těmto změnám.

Analýza je založena na kombinaci dvou indexů, tj. Revealed Symmetric Comparative Advantage, a Trade Balance Index, které byly použity ke znázornění analytických nástrojů „products mapping“.

V průběhu studie byla z celkových vývozních toků vyčleněna skupina výrobků (skupina A), která zahrnovala 5 % z vyváženého zboží, ale dosahovala přibližně 50 % z celkové hodnoty zemědělského vývozu. Položky v této skupině měly komparativní výhodu a pozitivní obchodní bilanci. Největší význam ve skupině A měla pšenice.

Byla také určena skupina D, v níž 80 % položek představovalo pouze 30 % z celkového vývozu, ale 95-99 % z celkového dovozu. Tyto položky měly komparativní nevýhodu a záporné saldo obchodní bilance. Ale došlo ke snížení hodnot skupiny D, zatímco skupina A měla růst stabilní. Tyto trendy lze považovat za posílení komparativních výhod ruského zemědělského vývozu.

Klíčová slova

Komparativní výhoda, obchodní bilance, Rusko, obchod se zemědělskými produkty, products mapping.

Abstract

This paper contains an analysis of the Russian foreign trade in agricultural products and foodstuffs from the two points of view: international competitiveness and country’s trade balance.

The aim of the analysis is to distinguish from the total agricultural export flows specific groups of products according to their comparative advantage (or disadvantage) and trade balance, to trace changes that have occurred in this groups over the period and to explain why these changes have taken place.

The analysis is based on the combination of two indices i.e. Revealed Symmetric Comparative Advantage, and Trade Balance Index that were used to represent an analytical tool named “products mapping”.

During the study, from the total export flows we distinguished a group of products (Group A) that includes 5% of the exported goods, but accounts for about 50% of the value of total agricultural exports. Items in this group have a comparative advantage and positive trade balance. The greatest weight in the group A has wheat.

There was also identified the group D where 80% of items account for only about 30% of total exports, but 95-99% of the total imports. These items have comparative disadvantage and negative trade balance. But there was a reduction in the value of group D, while the group A has been steadily growing. These trends can be considered as a strengthening of the comparative advantages of Russian agricultural export.

Key words

Revealed Comparative Advantage, Trade Balance, Russia, Agricultural Trade, Products Mapping.

Introduction

Throughout its history, Russia was a major agrarian country. The essential role of agriculture in the Russian economy is determined by vast territory, natural environment, land suitable for agricultural production, national traditions and other factors. The dissolution of the Soviet Union in 1991 marked the beginning of a transition from a centrally-planned to a more market-oriented economy.

Due to the transformation processes, Russian agriculture has experienced a recession in all sectors. According to Federal State Statistics Service of Russian Federation, in the period from 1990 to 2007, size of cultivated areas has been steadily declining. (Rosstat, 2012)

Despite the steady growth of the Russian livestock sector in the last decade (especially in the segments of the poultry and pork), the overall level of production still has not reached the level of 1990, despite the government support.

In the past two decades Russia became a stable net importer of agricultural products and foodstuffs.

The economic reforms that have started in Russia in the early 1990s spurred major changes in the structure and volume of the country's agricultural production and trade.

In 2010, Russian President approved the Food Security Doctrine of the Russian Federation. The doctrine calls for extensive import substitution.

The Doctrine establishes the following minimum production targets as the share of domestic production in the total supply of commodities: grain – 95%, sugar – 80 %, vegetable oil – 80%, meat and meat products– 85 %, milk and dairy products – 90 %, fish products – 80 %, potatoes – 95%, edible salt – 85 %. These goals should be achieved by 2020. (Doctrine of Food Security of RF, 2009)

Furthermore, Russia is seeking not only to achieve a high level of self-sufficiency in basic agricultural products, but also claims to be a major exporter of agricultural products and foodstuffs. In the last decade, exports of agricultural products has been growing at fast pace.

However, in Russia, as in any other country, the different branches of agriculture have different efficiency, due to historical or natural geographical factors. Therefore for the effective development of Russian exports it is necessary to focus on the areas of agriculture that are competitive and have comparative or absolute advantages in the world market.

In the theories of international trade, comparative advantage is an important concept for explaining trade patterns.

The concept of comparative advantages was first developed by the classical economist David Ricardo (1817) building on Adam Smith's (1776) principle of absolute advantages.

Smith and Ricardo explained the occurrence of absolute and comparative advantages as the result of differences in labor productivity. Eli Heckscher (1919) and Bertil Ohlin (1933) developed the idea of comparative advantages in a model based on differences in factors endowments.

However, it is well known that measuring comparative advantage and testing the Hecksher-Ohlin theory have some difficulties (Balassa, 1989) since relative prices under autarky are not observable. Given this fact, Balassa (1965) proposes that it may not be necessary to include all constituents effecting country's comparative advantage. Instead, he suggests that comparative advantage is "revealed" by observed trade patterns, and in line with the theory, one needs pre-trade relative prices which are not observable.

Thereby, the analysis of Russian exports in terms of "revealed" comparative advantage allows us to identify basic segments where Russia is competitive in the global markets.

The methodology proposed Balassa is often used in empirical studies of specialization and comparative advantage of many countries, including Russia.

Tabata (2006) investigated changes in Russia's comparative advantage in 1994-2005 by Revealed Comparative Advantage index, Revealed Comparative Disadvantage index, and Trade Specialization Index. The results of his work show the increasing competitiveness of oil and gas exports (and secondarily those of armaments, selected base metals, roundwood, and fertilizers) and declining competitiveness in (and increasing imports of) meat, plastics, and automobile production and stagnation in the machinery sectors.

Westin (1998) has examined the pattern of revealed comparative advantage of Russia in its trade with the EU using the Balassa index, and an index based on import-export ratios. According to Westin, Russian exports are showing a healthy development in terms of a broader variety of goods being traded in 1995 compared to 1992. His findings show that Russia reveals a comparative advantage in primary

products and that there is no sign of change in terms of manufacturing export, which is still suffering from being unsalable on Western markets due to weakness in quality.

Ahrend (2004) argues that international competitiveness of Russian Federation - as measured by revealed comparative advantage remains limited to a small number of sectors that mainly produce primary commodities (particularly hydrocarbons) and energy-intensive basic goods.

A noted British economist Cooper (2006) compared Russia's scores in 2000 on the Balassa Index of Revealed Comparative Advantage with those of 2004, and also for that year with a selected list of international competitors (Brazil, India, China, Turkey, and the United States) as well. He argues that Russia possesses some very large non-competitive sectors, in particular the motor industry, civil aviation, shipbuilding, tractor and agricultural machine building, and light industry (i.e. textiles, clothing, and footwear).

Savin and Winker (2009) calculated Russian revealed and prospective comparative advantages, analyzed their dynamics during the last five years, and suggested that the Russian Federation has prospective advantages in some medium and high technological industries like pharmaceutical industry, electronic equipment, machinery building and railway transport as well as in some other industries like production of clothes.

However, there are a very limited number of studies concentrating directly on the issue of international trade in agricultural products and foodstuffs in Russian Federation. In this paper we present one such study.

The idea of this article is to examine the structure of Russian foreign trade in agricultural products from the point of view of its specialization and the competitive performance over the period 1998-2010.

The aim of the analysis is to distinguish from the total agricultural export flows specific groups of products from the point of view of comparative advantage and trade balance, to trace the changes that have occurred in these groups over the period and to explain why these changes have taken place.

Materials and methods

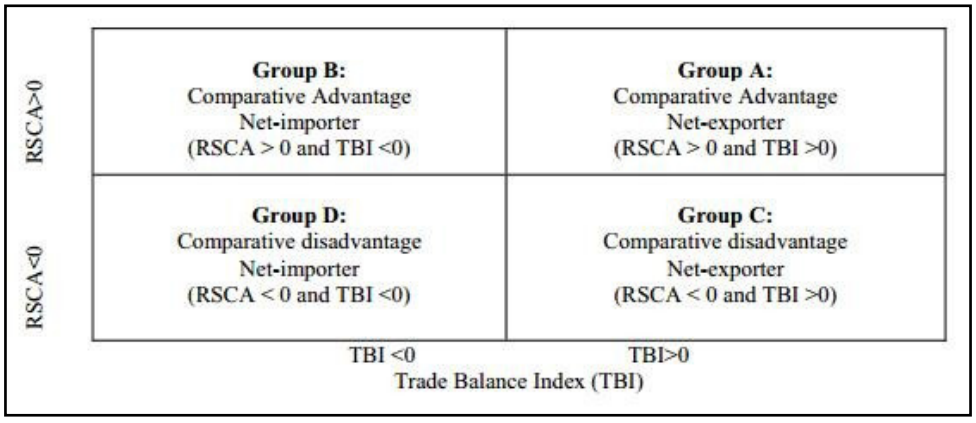
The analysis presented in this paper was conducted using the analytical tool, named "products mapping". This tool enables to assess leading exported products from two different points of view, i.e. domestic trade-balance and international competitiveness. (Widodo, 2009)

The classification of agricultural commodities used in the paper is the FAOSTAT Commodity List (FCL) that is originally based on the Standard International Trade Classification of the United Nations. It includes 683 commodities and covers crops and livestock, both primary and derived products. All value figures are calculated at current prices in USD.

There are two crucial variables for analyzing comparative advantage, i.e. domestic trade-balance and international competitiveness (Widodo, 2009).

The figure 1 represents a matrix for the distribution of the entire set of exported products into 4 groups according to the two selected indicators.

The Revealed Symmetric Comparative Advantage (RSCA) by Dalum et al.(1998) and Laursen (1998) is the indicator of comparative advantage and



Source: Widodo T. (2009)

Figure 1: Product mapping scheme.

Trade Balance Index (TBI) by Lafay (1992) is the indicator of export-import activities.

The RSCA index is a simple decreasing monotonic transformation of Revealed Comparative Advantage (RCA) or Balassa index. In practice, Balassa index is a commonly accepted method for analyzing trade data. This index tries to identify whether a country has a "revealed" comparative advantage rather than to determine the underlying sources of comparative advantage.

$$RCA = (X_{ij}/X_{it})/(X_{nj}/X_{nt}) = (X_{ij}/X_{nj})/(X_{it}/X_{nt}) \quad (1)$$

where x represents exports, i is a country, j is a commodity and n is a set of countries, t is a set of commodities .

RSCA index is formulated as follows:

$$RSCA = (RCA_{it}-1)/(RCA_{ij}+1) \quad (2)$$

The values of $RSCA_{ij}$ index can vary from minus one to one. $RSCA_{ij}$ greater than zero implies that country i has comparative advantage in group of products j. In contrast, $RSCA_{ij}$ less than zero implies that country i has comparative disadvantage in group of products j. (Dalum et al.,1998)

Trade Balance Index (TBI) is employed to analyze whether a country has specialization in export (as net-exporter) or in import (as net-importer) for a specific group of products. TBI is simply formulated as follows:

$$TBI_{ij} = (x_{ij}-m_{ij})/(x_{ij}+m_{ij}) \quad (3)$$

where TBI_{ij} denotes trade balance index of country i for product j; x_{ij} and m_{ij} represent exports and imports of group of products j by country i, respectively. (Lafay, 1992)

Values of the index range from -1 to +1. Extremely, the TBI equals -1 if a country only imports, in contrast, the TBI equals +1 if a country only exports. Indeed, the index is not defined when a country neither exports nor imports. A country is referred to as "net-importer" in a specific group of product if the value of TBI is negative, and as "net-exporter" if the value of TBI is positive. (Widodo, 2009)

Results and discussion

Products mapping of the Russian agricultural exports

The analysis of the comparative advantage and specialization of Russian foreign trade in agricultural products and foodstuffs is conducted by the distribution of the whole range of the exported and imported commodities in accordance with the methodology described before.

From the domestic point of view, leading exported products are supposed to be the products that can give bigger amount of foreign exchange for domestic economy. It means that the higher the share of a specific product in the total domestic exports, the more significant the contribution of the exported product to the domestic economy becomes. Such product can be considered as foreign exchange creator for domestic economy. (Widodo, 2009)

From international competition point of view, a specific exported product becomes leading exports if its share in the total world export is dominant.

This way we distinguish from the total export flows a group that creates the foundation of the country's exports, the group that contains the best products in term of their comparative advantage and trade balance. We also separate a group that has no revealed comparative advantage and keep negative trade balance as opposed to the first group. (Widodo, 2009)

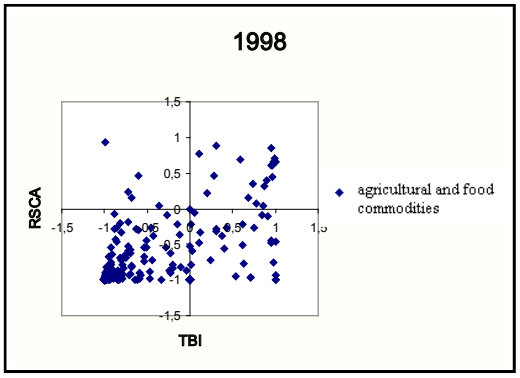
The remaining two groups can be considered as a transient from group D to group A, or vice versa.

Figure 2 presents the products mapping for 1998-2010. As we can see, the lower left area of the chart is the most filled with dots representing exported products. This is a group D that has no comparative advantage and keeps negative trade balance. The upper left area of the chart is the emptiest one. This is a group B. Items in this group have comparative advantage but negative trade balance. On the right of the chart there is a list of commodities included in the group A. These products are considered as the best products in term of their comparative advantage and trade balance. They are in the position of having comparative advantage in the international trade and the country has positive trade balance in this products.

Next, consider these groups in more detail (Table 1).

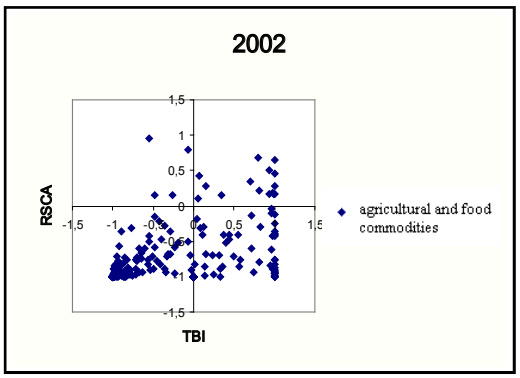
From 1998 to 2010, the number of products in each group did not change significantly.

The most of the products is part of the group D. They have no revealed comparative advantage and keep negative trade balance. However, this is a normal phenomenon for any country, where different branches of agriculture have different efficiency, due to economic, historical, natural or geographical



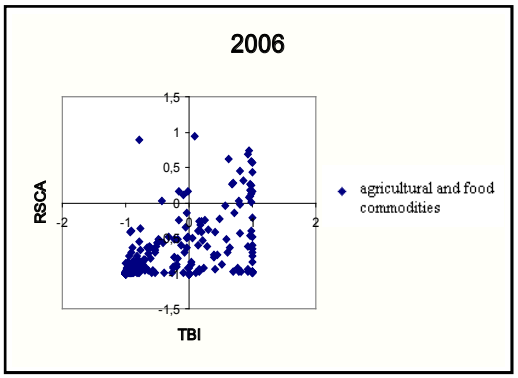
Group A*

1) Chicory roots (659, 0.06%)
2) Sunflower seed (214013, 20.69%)
3) Pot Barley (314, 0.03%)
4) Skins Wet Std Calves (23210, 2.24%)
5) Walnuts (9508, 0.92%)
6) Hides Wet Salted Horses (1147, 0.11%
7) Hides Nes (6722, 0.65%)
8) Millet (2736, 0.26%)
9) Hides Wet Salted Cattle (150638, 14.(
10) Hidesdry S.Cattle (3529, 0.34%)
11) Bran of Rice(570, 0.06%)
12) Beeswax (1209, 0.12%)
13) Rye (2602, 0.25%)
14) Cereals, nes (856, 0.08%)
15) Molasses (9060 ,0.88%)
16) Skin Furs (23993, 2.32%)
17) Peas,green (1446, 0.14%)
18) Meat nes (1437, 0.14%)



Group A

1) Barley (214316, 11.65%)
2) Bran of Rice (1763, 0.1%)
3) Wheat (773067, 42.02%)
4) Skins wet Sltd. Pigs (228, 0.01
5) Wafers (7063, 0.38%)
6) Flour of Cereals (3184, 0.17%
7) Hemp Tow Waste (183, 0.01%
8) Sunflower Cake (7522, 0.41%
9) Peas, dry (14241, 0.77%)
11) Skin Furs (35805, 1.95%)
12) Millet (1143, 0.06%)
13) Nuts, nes (8045, 0.44%)
14) Sunflower seed (16772, 0.91%)
15) Milk Whole Cond. (5304, 0.29%)



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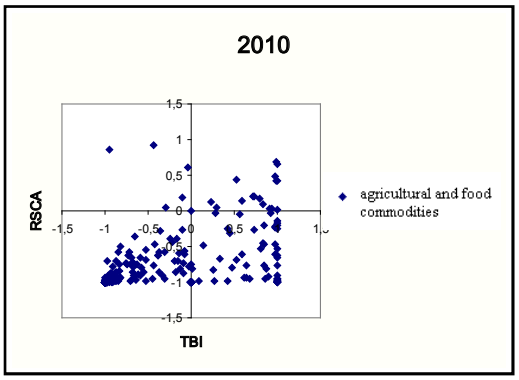

Group A

1) Sunflower Cake (111534, 1.91%
2) Beet Pulp (41059, 0.70%)
3) Linseed (45480, 0.78%)
4) Sunflower oil (379106, 6.5%)
5) Hair Coarse Nes (497, 0.01%)
6) Wheat (2069121, 35.48%)
7) Barley (197095, 3.38%)
8) Pot Barley (162, 0.01%)
9) Bran of Wheat (20567, 0.35%)
10) Rice Flour (1173, 0.02%)
11) Cereal Prep., Nes (13944, 0.24%)
12) Barley Flour and Grits (596, 0.01%)
13) Offals Liver Chicken (9445, 0.16%)
14) Milk Whole Cond (15517, 0.27%)
15) Barley Pearled (267, 0.01%)
16) Butterm.,Curdl,Acid.Milk (46137, 0.79%)

* note: The right part of the fig. 2 represents products in Group A, in decreasing order of the index RSCA. In brackets next to the name of the product its value is specified (in thousands of U.S. dollars), as well as its share in total Russian export.

Source: FAO, author's calculation (2012)

Figure 2: Products mapping of Russian export (1998-2010).

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Group A	5.8	4.7	4.7	4.3	4.8	4.4	4	5.3	5.8	5.9	5.6	5.3	5.3
Group B	1.5	1.2	0.9	1.6	1.3	1.9	2	1.4	1.4	1.1	0.8	1.1	1.1
Group C	8.6	8.7	12.5	13	17.5	13.8	12.4	14.6	15.5	15.8	14.3	18.2	15.8
Group D	84	85.4	81.9	81.1	76.4	79.9	81.6	78.7	77.3	77.1	79.2	75.4	77.8

*the term "total number of agricultural products" here means the set of 683 commodities according to FAOSTAT Commodity List

Source: FAO, author's calculation (2012)

Table 1: The share of individual groups in total number of agricultural products* exported by Russian Federation (%).

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Group A	43.8	35.3	32.9	30.8	59.3	56.9	40.8	53.1	51.0	65.7	59.1	59.4	50.6
Group B	1.3	0.8	6.9	5.0	4.5	5.3	8.3	3.6	4.1	0.4	0.5	0.4	2.2
Group C	20.4	6.4	15.4	18.7	11.7	7.2	11.3	13.0	12.2	9.5	9.9	15.0	15.7
Group D	34.5	57.5	44.8	45.6	24.4	30.6	39.6	30.3	32.7	24.3	30.5	25.2	31.5
Total	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: FAO, author's calculation (2012)

Table 2. The share of individual groups in the total value of Russian agricultural export (%).

factors. Such products are for example tropical fruits (bananas, apricots, coconut, etc.), meat, and most of the meat products, tea, coffee etc.

During the analyzed period, there was a decrease of number of products in group D, and the increase in the group C.

Group C contains the part of the products, not having comparative advantage according to the RCSA index, but having a positive trade balance. The comparative disadvantage in this case, may occur in relation to the whole world, while in bilateral trade with individual regions or countries comparative advantages quite possibly exist.

Group B consists of products, which have comparative advantage but the country is a net-importer of these products. For example, in 2010 this group included Flour of Sorghum, Tomatojuice Concentrated, Flour of Mixed Grain, Fat Preparations Nes., and Cheese Processed.

The existence of this group can be explained as follows. The total volume of global trade in these commodities is rather insignificant. Meanwhile, in this small-scale market Russia plays a significant role both as the exporter and the importer. This determines the comparative advantages of the country in these items. However, imports of these products exceed exports. There are very few such small-scale markets. These cases can be considered as specific, unusual for the system as a whole. Otherwise, this group is a transitional group for goods which is obtaining or losing their comparative advantages over time.

Generally, the higher the comparative advantage of a specific product, the higher the possibility of a country to be a net-exporter.

The export value of each group

To rationally judge about any changes in the structure of Russian exports, in the context of this grouping, we must investigate not only the number of products included in each group, but primarily their values and their share in the total value of foreign trade in agricultural products.

Table 2 shows the share of each group in the total agri-food export value of the Russian Federation.

Considering the value of products in each group instead of the number of products, we have got completely different results. According to the results of calculations, much of the export value is concentrated in Group A.

In 1998, the Group A comprised 43.8% of the total value of agricultural exports, in 2002-2003 increased to almost 60%, in 2007 reached its maximum of 65.7% and in 2010 it was 50.6%.

As we can see in the figure 2, since 2002, wheat has the greatest weight in the group A and amounted to 42.02% of total exports in 2002, 31.3% in 2006 and 35.5% in 2010, while the whole group A represented 59.3%, 51% and 50.6% of total exports respectively. Russia exports large volumes of wheat due to the following reasons. After the collapse

of the Soviet Union, during the transition from planned to market economy, livestock sectors contracted, thereby freeing up feed grain area to produce for export. In addition Russian wheat production rose because of an increase in yield, especially in 2007-2009. (Liefert, 2012)

At the beginning of the period, in 1998, wheat had no comparative advantage and Sunflower seed (20.7% of the total export) and Hides Wet Salted Cattle (14.6%) constituted the basis of group A. Later they have lost their relevance. In the case of sunflower seed it was likely caused by increase in production capacity for oilseed processing and by increase of the export of vegetable oils instead of raw materials (sunflower seeds), as it was in the 90‘s. In relation to Hides Wet Salted Cattle, the reduction of export performance was caused by the continued decline in the livestock sector.

Moreover, in October 1998, Russian Government established a licensing for export of hides and skins of cattle, sheep and other animals (The Decree of the government of the Russian Federation „On establishment of licensing export of cattle, sheep and other raw hides from Russian Federation“” October 31, 1998 № 1267). These export restrictions were aimed at protecting domestic leather industry.

At the same time, there is a reduction in the value of groups D and C. These trends can be considered as a strengthening of the comparative advantages of the total Russian exports.

To avoid fluctuations in the time series we calculate a fixed-base index and a chain base index for the series of the values of exports and imports.

A fixed-base index is an index number for which the base period for the calculations is selected and remains unchanged during the lifetime of the index.

According to the results of calculation of the fixed-base index, we can see that the decline in international trade in Russia after the economic crisis of 1998 affected all product groups, but most of all - the group C.

Group A had been growing until 2008, when due to another economic crisis and the low yields of wheat, the value of its exports, and consequently, the cost of the whole group A decreased.

For clarity, we also calculate a chain-base index and a geometric mean of chain indices.

A chain base index is an index number in which the value at any given period is related to a base in the previous period. It measures changes in volume from period to period.

A geometric mean (GM) of chain indices is the average change in the value of export or import.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Group A	100	48	78	76	241	294	198	404	492	1121	1030	986	651
Group B	100	36	561	421	628	929	1383	935	1367	247	302	227	974
Group C	100	18	78	99	102	79	117	213	251	348	371	536	432
Group D	100	99	135	143	126	201	244	294	400	528	675	533	516

Source: FAO, author’s calculation (2012)

Table 3: Changes in export value of agricultural products in each group: the fixed-base index (at current prices, %).

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	GM_1	GM_2
Group A	48	164	97	317	122	67	204	122	228	92	96	66	117	127
Group B	36	1551	75	149	148	149	68	146	18	122	75	430	121	135
Group C	18	426	126	103	78	148	181	118	139	106	145	81	113	133
Group D	99	137	106	88	159	121	120	136	132	128	79	97	115	116
Total Russian agricultural export	59	176	104	165	127	94	157	127	177	102	95	77	116	123
Total world agricultural export	95	99	101	107	119	116	108	110	121	122	89	113	108	109

Source: FAO, author’s calculation (2012)

Table 4: Changes in export value of agricultural products in each group: the chain index (at current prices, %).

GM1 is a geometric mean of chain indices for the period from 1999 to 2010; GM2 is a geometric mean of chain indices for the period from 2000 to 2010. We calculated two geometric means for the following reason. In 1999, after the crisis, there was a strong decline in exports. It significantly affected the value of geometric mean. So the second geometric mean was calculated for the period 2000-2010, to avoid the impact of the crisis.

During the analyzed time period, the value of each group fluctuated considerably. The possible reasons for such oscillations are following. Firstly, the index is calculated at current prices. Prices for agricultural products were fluctuating and the chain index was changing respectively. In addition, contents of the groups had been changing over time, creating fluctuations in their value.

For example, in 2000-2004 sunflower oil belonged to group B. It created a large part of the value of the group. Then, in 2005, it moved to group A. The value of group A rose. The value of group B decreased.

In 2002-2006, tobacco products were in group B (before they were in the group D). Then, in 2007, tobacco products moved to group A causing a sharp decline in the value of group B.

The average annual increase in the value of group A is 17%, group B – 21%, group C – 13% and group D – 15%, that can be described as quite proportional growth along with the overall increase in exports. At the same time average growth of the world agricultural export was only 8%. These figures are higher than the world growth of 8%.

In the post-crisis period, the growth of each group was even higher. The average annual increase in the value of group A was 27%, group B – 35%, group C – 33% and group D – 16%. Thus the growth of Russian agricultural export is much higher than the global rate of 9%.

The import value of each group

Next, we consider the value of imports in the context provided by the methodology.

Here we can see that the first three groups of products for the entire investigated period have not exceeded the share of 3-4% of the total import (with the exception of 2003 and 2004 when the share of groups A, B and C for a total was 5-7%, which in fact is also not a big amount).

Group D accounts 95-99% of the total imports. Production of these commodities is ineffective for any reason within the Russian Federation, so country has to import them.

In the case of imports, there are also visible negative effects of the crisis in 1998 in relation to the total foreign trade.

There is also a visible increase in the value of group A. The main reason is the growth in the import of wheat.

Since 2002, wheat has been in the group A. Despite the comparative advantage and significant share of wheat in the total value of Russian agricultural export, the country imports this product. Russia

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Group A	0.2	0.3	0.2	0.8	0.8	1.3	2.6	1.9	1.5	1.8	1.5	0.7	0.6
Group B	0.8	0.5	1.3	1.3	2.0	3.2	3.2	1.2	1.2	0.2	0.2	0.2	0.6
Group C	1.6	0.2	1.2	1.3	1.0	0.5	1.0	1.5	1.4	1.1	0.9	1.4	0.8
Group D	97.4	99.1	97.2	96.6	96.2	95.0	93.2	95.5	95.9	96.8	97.4	97.7	98.0
Total	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: FAO, author's calculation (2012)

Table 5: The share of individual groups in the total value of Russian agricultural import, (%).

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Group A	100	82	68	272	302	587	1307	1159	1175	1790	1932	801	804
Group B	100	45	119	137	234	434	488	219	293	73	91	65	219
Group C	100	10	52	70	54	33	72	140	159	170	168	222	159
Group D	100	77	69	82	88	102	113	144	181	232	299	255	305

Source: FAO, author's calculation (2012)

Table 6: Changes in import value of agricultural products in each group: the fixed-base (at current prices, %).

imports mainly high quality wheat and seeds. For example, durum wheat does not yield in the climatic conditions of the most of Russia but it is the main raw material for the production of pasta. Therefore, country has to import it. (Gaidar, 2009)

Thus the value of group A grew and fell along with the value of wheat imports.

During the whole analyzed period, the average annual increase in the import value of group A is 19%, group B – 7%, group C – 4% and group D – 15%.

If we do not take into account the post-crisis year 1999, the average annual increase in the value of group A is 23%, group B – 15%, group C – 29% and group D – 13%. The growth of Russian agricultural import is also higher than the global rate of 9%.

However, during the period 2000-2010, the average export growth was higher than average import growth.

The balance of trade in each group

Then we calculate the balance of trade of each group as the difference between exports and imports of agricultural products.

Considering the balance of trade in each group, it can be seen that in groups A and C these figures constantly increased. The absolute changes in import values are higher in comparison with exports. In group D, on the contrary absolute changes in import values are lower in relation to absolute changes in exports value.

Considering the current picture as a whole, we can see that 5% of the exported goods, belonging to group A, account for about 50% total agricultural export value. In turn, the group D includes about 80% of items, but it accounts for only about 30% of total export value, but 95-99% of the total import value of agricultural products and foodstuffs.

On this basis, we can consider the contents of the group A as the foundation of the Russian agri-food export.

At the same time, Group C products are also important. They do not have comparative advantages, but have a positive trade balance. The comparative disadvantage in this case, may occur in relation to the whole world, while in bilateral trade with individual regions or countries comparative advantages quite possibly exist. We can assume that, for example in bilateral relations with the CIS countries many products belonging to the group C have comparative advantages. So the items included in the Group C require a separate assessment from the point of view of bilateral relations with specific countries and regions.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	GM_1	GM_2
Group A	82	83	400	111	194	223	89	101	152	108	41	100	119	123
Group B	45	263	116	171	185	113	45	134	25	125	72	336	107	115
Group C	10	529	135	78	61	217	196	114	107	99	132	72	104	129
Group D	77	90	120	107	116	110	128	125	128	129	389	120	110	113
Total Russian agricultural export	75	91	120	107	117	112	125	125	127	128	85	119	110	113
Total world agricultural export	97	98	102	105	119	116	106	111	121	122	88	112	108	109

Source: FAO, author's calculation (2012)

Table 7: Changes in import value of agricultural products in each group: the chain index (at current prices, %).

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Group A	428 614	337 376	1 016 425	572 652	1938756	4 193 719	2 752 874	1159	1175	1790	1932	801	804
Group B	-68 546	-22 822	-108 605	-216 220	-58857	-34 715	-50 347	219	293	73	91	65	219
Group C	45 968	80 297	125 966	129 515	267283	504 869	649 816	140	159	170	168	222	159
Group D	-9 868 326	-6 552 076	-8 554 286	-10 652 111	-17 084 438	-28 153 957	-29 363 013	144	181	232	299	255	305

Source: FAO, author's calculation (2012)

Table 6: Changes in import value of agricultural products in each group: the fixed-base (at current prices, %).

Conclusion

The analysis presented in this paper was conducted using the analytical tool, named "products mapping", that enables to assess leading exported products from two different points of view, i.e. domestic trade-balance and international competitiveness.

During the analysis four specific groups of products were distinguished from the total agricultural export flows.

According to the results of "products mapping", the largest number of the agricultural products exported by Russian Federation is part of the group D. They have no revealed comparative advantage and keep negative trade balance. Production of these commodities is ineffective due to economic, historical, natural or geographical factors within the Russian Federation, so country has to import them. Such goods are, for example, tropical fruits (bananas, apricots, coconut, etc.), meat, and most of the meat products, tea, coffee etc.

But considering the value of products in each group instead of the number of products, we got completely different results. According to the results of calculations, much of the export value is concentrated in Group A.

Wheat has the greatest weight in the group A and accounted 42.02% of total exports in 2002, 31.3% in 2006 and 35.5% in 2010, while the whole group A represented 59.3%, 51% and 50.6% of total exports respectively.

During the analyzed period there were significant changes in the volumes and structures of these groups.

In 1998, the Group A comprised 43.8% of the total value of agricultural exports, in 2002-2003 increased to almost 60% of the total value and in 2007 reached its maximum of 65.7% of the total value of Russian agricultural exports. In 2010, its share was 50.6%. Despite some fluctuations, the overall trend can be assessed as a steady growth of the share of the group A in the total value of Russian agricultural exports.

At the same time, there is a reduction in the share of groups D and C in the total exports value.

These trends can be considered as a strengthening of the comparative advantages of Russian exports on the whole.

At the beginning of the period, in 1998, wheat had no comparative advantage and Sunflower seed (20.7% of the total export) and Hides Wet Salted Cattle (14.6%) constituted the basis of group A. Later they have lost their relevance. In the case of sunflower seed it was likely caused by increase in production capacity for oilseed processing and by the increase of the export of vegetable oils instead of raw materials (sunflower seeds), as it was in the 90's. In relation to Hides Wet Salted Cattle, the reduction of export performance was caused by the continued decline in the livestock sector and by the establishment of licensing for export of hides and skins of cattle, sheep and other animals.

Thus, there is a situation when 5% of the exported goods, belonging to group A, account for about 50% total agricultural exports. In turn, 80% of items included in the Group D, account for only about 30% of total exports, but 95-99% of the total imports. On this basis, we can consider the contents of the group A as the foundation of the Russian agri-food export.

It should be noticed that Group C products are also important. They do not have comparative advantages, but have a positive trade balance. The comparative disadvantage in this case, may occur in relation to the whole world, while in bilateral trade with individual regions or countries comparative advantages quite possibly exist.

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References

[1] Ahrend R. Russian industrial restructuring: Trends in productivity, competitiveness and comparative advantage. Routledge Journals, Taylor & Francis Ltd, England. 2004, 18, No 3, p. 277-295, ISSN: 1463-1377.

[2] Balassa, B. Comparative Advantage, Trade Policy and Economic Development. New York University Press. 1991, 336 s., ISBN 0814711677.

[3] Balassa, B. 'Revealed' Comparative Advantage Revisited - Analysis Of Relative Export Shares of Industrial Countries, 1953-1971", Manchester School of Economics and Social Studies. 1977, 45, p. 327-44, ISSN: 0025-2034.

[4] Balassa, B. Trade liberalization and "revealed" comparative advantage, The Manchester School of Economics and Social Studies. 1965, 33, No. 2, p. 99-123, ISSN: 0025-2034.

[5] Cooper, J. Can Russia compete in the global economy? Eurasian Geography and Economics. 2006, 47, No. 4, s. 407-425, ISSN: 1538-7216.

[6] Dalum, B., Laursen K., Villumsen G. Structural change in OECD export specialization patterns: de-specialization and 'stickiness'". International Review of Applied Economics. 1998, Vol. 12, p. 447-467.

[7] Dictionary of Statistical Terms, 5th edition, prepared for the International Statistical Institute by F.H.C. Marriott. Published for the International Statistical Institute by Longman Scientific and Technical. 2008, 602 p., ISBN: 978-92-64-025561.

[8] Gaidar, Y., Sinelnikov-Mourylev, S., Glavatskaya, N. Russian Economy in 2010. Trends and Outlooks. Gaidar Institute Publishers, 2011, 32, 544 p., ISBN 978-5-93255-316-9.

[9] ICTSD Possible Effects of Russia's WTO Accession on Agricultural Trade and Production. Programme on Agricultural Trade and Sustainable Development. 2012, No. 40, 66 p., ISSN 1817-356X.

[10] Lafay, G. The Measurement of Revealed Comparative Advantages. M.G. Dagenais and P.A. Muet eds. International Trade Modeling, Chapman & Hill, London. 1992, ISBN 10: 0412450003 / 0-412-45000-3.

[11] Laursen, K., Revealed comparative advantage and the alternatives as measures of international specialization, Danish Research Unit for Industrial Dynamics DRUID, Working Paper No. 98-30. 1998.

[12] Liefert, W. and Liefert, O. Russian Agriculture during Transition: Performance, Global Impact, and Outlook. Applied Economic Perspectives and Policy. 2012, 34, No 1, s. 37-75, ISSN: 2040-5790.

[13] Ricardo, D. On the Principles of Political Economy and Taxation. John Murray, London. 1817, ISBN 0-86597-965-0

[14] OECD. Russia Agriculture Policy Review, Economic Survey, Paris. 2008, p. 1-5, ISBN: 978-0-662-47669-6

[15] Russian Presidential Administration, Doctrine of Food Security, Strategy of National Security of the Russian Federation till 2020 (enacted by the RF President Decree No. 537 of May 12, 2009), Official website of the President of the RF [Online] – 2010. http://kremlin.ru/acts/6752.

[16] Savin I., Winker P. Forecasting Russian Foreign Trade Comparative Advantages in the Context of a Potential WTO Accession. Central European Journal of Economic Modelling and Econometrics. 2009, 1, No 2, s. 111-138, ISSN: 2080-119X.

[17] Simsek N., Seymen D., Utkulu U., Turkey's competitiveness in the EU market: a comparison of different trade measures. Dokuz Eylul Univeristy. 2010, ISSN: 1302 – 3284.

[18] Tabata, S. Observations on changes in Russia's comparative advantage, 1994-2005. VH Winston & Son Inc. 2006, 47, No 6, s. 747-759, ISSN: 1538-7216.

[19] Westin P. Comparative Advantage and Characteristics of Russia's Trade with the European Union. Bank of Finland, Institute for Economies in Transition. 1998, ISSN 1235-7405.

[20] Widodo T. Comparative Advantage: Theory, Empirical Measures and Case Studies. 2009, 2, No 2, p. 58-65.

[21] Widodo T "Products Mapping" and Dynamic Shift in the Patterns Of Comparative Advantage: Could India Catch Up China? Journal of Chinese Economic and Foreign Trade Studies. 2008, 1, No 3, p. 200-213.

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A Study on Forecasting Prices of Groundnut Oil in Delhi by Arima Methodology and Artificial Neural Networks

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Abstract

Forecasting of prices of commodities specially those of agricultural commodities is very difficult because they are not only governed by demand and supply but by so many other factors which are beyond control like weather vagaries, storage capacity, transportation etc. In this paper times series namely ARIMA (Autoregressive Integrated Moving Average) methodology given by Box and Jenkins has been used for forecasting prices of edible oils and this approach has been compared with ANN (Artificial Neural Network) methodology.

Key words

Forecasting, Prices, Groundnut oil, Delhi, ARIMA, ANN, Feed forward network.

Introduction

Price forecasting is very essential for planning and development and therefore it becomes pertinent to develop methods which helps the policy makers to have some idea about the prices of commodities in the future. One approach is to consider causes and their effects and the other approach is to forecast prices without taking in to consideration the causes. The time series approach to forecasting is one such approach which relies on the past pattern in a time series to forecast prices in the future. De Gooijer and Hyndman (2006) have provided an excellent review of time series methods in forecasting. There are many methods for analyzing a time series like exponential smoothing with a damped multiplicative trend Taylor (2003) etc., but one of the most simple and bench mark method is that of Box and Jenkins which is popularly known as ARIMA methodology. Dorfman and McIntosh (1990) suggest that structural econometrics may not give better results as compared to time series techniques even if the structural modelers are given the hard to find true model. The ARIMA approach has attracted researchers because it is a parsimonious approach which can represent both stationary and non-stationary stochastic processes as suggested by Harvey (1990). Numerous studies have shown that this univariate method is very effective as compared to some other multivariate methods like linear regression and vector autoregressive models. The problem with ARIMA methodology is that it assumes a linear structure of the process of which a particular times series is a realization, which is often not correct. To overcome this limitation of the ARIMA methodology, artificial neural networks (ANN) has also been used to forecast the prices as shown by Kohzadi Nowrouz et al. (1996). Apart from this artificial neural networks can also be used for classification problems as was shown by Ripley (1994). Artificial neural networks do not make any assumption about the process from which a particular time series has generated. Artificial neural networks effectively cover both linear and non linear processes. Combination of forecasts also increases the forecasting abilities of different methods as is being suggested by studies by Newbold et al. (1974), Zhang (2003), Zou et al. (2004), Hibon et al. (2005) and Makridakis and Hibon (2000) . In this paper time series of prices of groundnut oil in New Delhi from January 1994 to July 2010 has been analyzed with both the ARIMA methodology and artificial neural networks and the forecasting abilities of both the models has been compared.

Rest of the paper is organized as follows - in Section 2, the traditional univariate time series approach to forecasting is described and the neural network architecture that is designed for this study is discussed. It also discusses the evaluation methods for comparing the two forecasting approaches. Data and forecast procedure are discussed in Section 3. Section 4 shows the results obtained

from the ARIMA and the artificial neural network estimations. Section 5 shows conclusion.

Materials and Methods

Auto Regressive Integrated Moving Average (ARIMA) Time Series Model

Introduced by Box and Jenkins (1970), the ARIMA model has been one of the most popular approaches for forecasting. In an ARIMA model, the estimated value of a variable is supposed to be a linear combination of the past values and the past errors. Generally a non seasonal time series can be modeled as a combination of past values and errors, which can be denoted as ARIMA (p,d,q) which is expressed in the following form:

$$X_t = \theta 0 + \Phi_1 X_{t-1} + \Phi_2 X_{t-2} + ... + \Phi_p X_{t-p} + e_t - \theta_1 e_{t-1} - \theta 2 e_{t-2} - ... - \theta e_{t-q} \text{ ... Eq} \quad (1)$$

Where X_t and e_t are the actual values and random error at time t, respectively, Φ_i (i = 1,2,……., p) and θ_j (j = 1,2,……, q) are model parameters, p and q are integers and often referred to as orders of autoregressive and moving average polynomials respectively. Random errors et are assumed to be independently and identically distributed with mean zero and the constant variance, σ_e^2. Similarly a seasonal model is represented by **ARIMA (p, d, q) x (P, D, Q)** model, where P = number of seasonal autoregressive (SAR) terms, D = number of seasonal differences, Q = number of seasonal moving average (SMA) terms. Basically this method has three phases: model identification, parameters estimation and diagnostic checking.

The ARIMA model is basically a data oriented approach that is adapted from the structure of the data itself.

Artificial Neural Network (ANN) Model

Neural networks are simulated networks with interconnected simple processing neurons which aim to mimic the function of the brain central nervous system. Mcculloch and Pitts (1943) for the first time proposed the idea of the artificial neural network but because of the lack of computing facilities they were not in much use until the back propagation algorithm was discovered by Rumelhart et al. in 1986. Neural networks are good at input and output relationship modeling even for noisy data. The greatest advantage of a neural network is its ability to model complex non linear relationship without a priori assumptions of the nature of the relationship. The ANN model performs a nonlinear functional mapping from the past observations ($X_{t-1}, X_{t-2},……., X_{t-p}$) to the future value X_t i. e.,

$$X_t = f(X_{t-1}, X_{t-2}, ..., X_{t-p}, w) + e_t \text{ ... Eq} \quad (2)$$

Where w is a vector of all parameters and f is a function determined by the network structure and connection weights.

Training of the neural network is essential factor for the success of the neural networks among the several learning algorithms available in which back propagation has been the most popular and most widely implemented learning algorithm of all neural networks paradigms. The important task of the ANN modeling for a time series is to choose an appropriate number of hidden nodes, q, as well as the dimensions of the input vector p (the lagged observations). However in practice, the choices of q and p are difficult.

To assess the prediction accuracy of the models understudy - the following Forecast Evaluation methods were applied:

Different criteria were used to make comparisons between the forecasting ability of the ARIMA time series models and the neural network models. The first criterion is the absolute mean error (AME). It is a measure of average error for each point forecast made by the two methods. AME is given by

$$AME = (1/T)\sum|P_t - A_t| \text{ ...Eq} \quad (3)$$

The second criterion is the mean absolute percent error (MAPE). It is similar to AME except that the error is measured in percentage terms, and so allows comparisons in units which are different.

The third criterion is mean square error (MSE), which measures the overall performance of a model. The formula for MSE is

$$MSE = (1/T)\sum(P_t - A_t)^2 \text{ ... Eq} \quad (4)$$

where P_t is the predicted value for time t, A_t is the actual value at time t and T is the number of predictions and the 4th criterion is RMSE which is the square root of MSE.

Data and Forecast Procedure

Monthly cash prices of groundnut oil in Delhi from April 1994 to July 2010 are used to test the prediction power of the two approaches. Data are obtained from the official website of ministry of agriculture. An ARIMA model was estimated using the SPSS 16.0 statistical package. The model

was then used to forecast on its respective three month out-of-sample set.

In the case of the neural networks, the time series was divided into a training, testing, and a validation (out-of-sample) set. The out-of-sample period was identical to the ARIMA model.

1. ARIMA Model

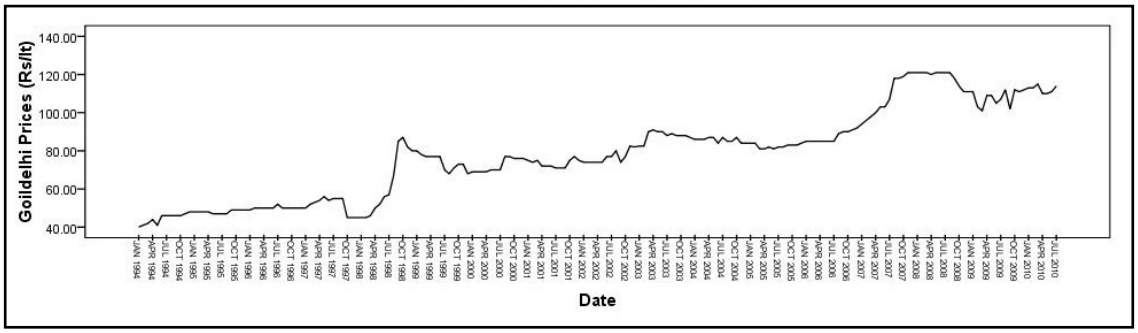
For fitting the ARIMA Model, the three stages of modeling as suggested by Box and Jenkins namely, identification, estimation and diagnostic checking was undertaken. Identification was done after examining the autocorrelation function and the partial autocorrelation function. After that, estimation of the model was done by the least square method. In the diagnostic checking phase the model residual analysis was performed.

In Figure 1 shows the time plot of prices of the groundnut oil in Delhi. By looking at the graph it can be inferred that the series is not stationary because the mean of the time series is increasing with the increase in time. So the time series is showing an increasing trend. But to confirm this, autocorrelation function should also be seen. Box and Jenkins suggested that the most autocorrelations which may safely be examined is about one-fourth of the number of observations. So in the present case 50 autocorrelations were calculated.

In figure 2 is shown the autocorrelation function of the time series and it certainly shows that the series is not stationary because autocorrelation coefficients does not cut off to statistical insignificance fairly quickly. All the first 50 autocorrelations are significantly different from zero at about the 5% level: all the first 50 spikes in the ACF extend beyond the square brackets. The position of those brackets is based on Bartlett's approximation for the standard error of estimated autocorrelations. The brackets are placed about two standard errors above and below zero. To make the series stationary it was first differenced.

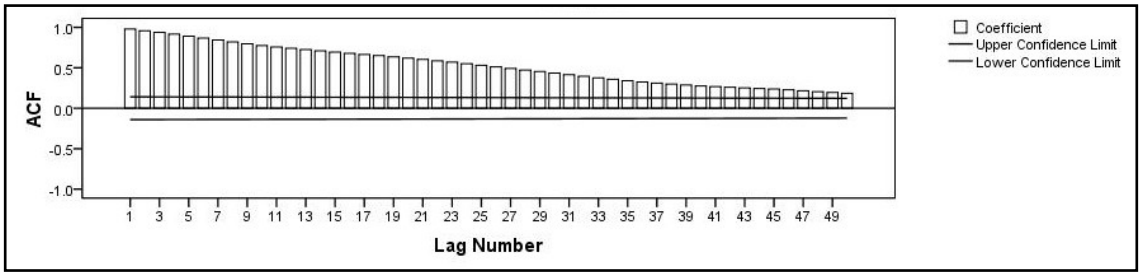
Figure 3 shows the time plot of the differenced series and it clearly depicts that the series has now become mean stationary. By looking at the variance of the series log transformation of the data was taken. The observations seem to fluctuate around a fixed mean, and the variance seems to be varying over time. However, the judgment about stationarity of the mean was withheld until the estimated ACF and perhaps some estimated AR coefficients were examined.

In figure 4 autocorrelation function and partial autocorrelation function (PACF) of the differenced series are shown. The autocorrelations decay to



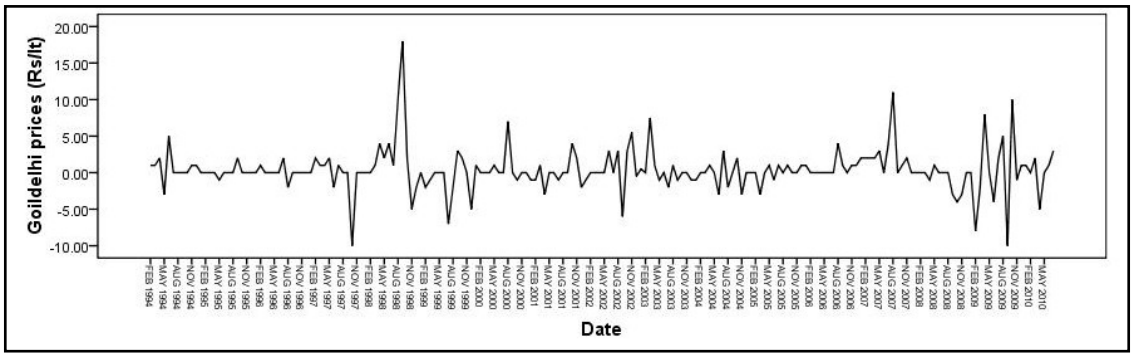
Source: Processing with use Statistical Package for Social Sciences

Figure 1: Time plot of the prices of groundnut oil in Delhi.



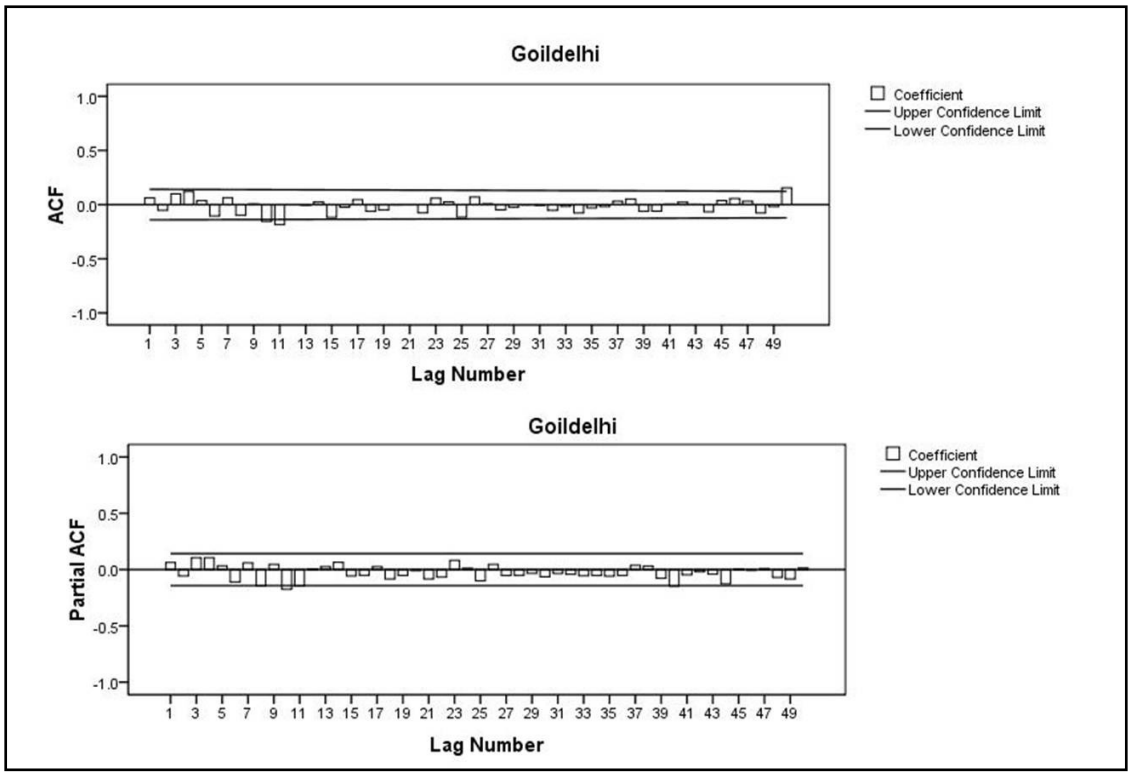
Source: Processing with use Statistical Package for Social Sciences

Figure 2: Autocorrelations at different lags



Source: Processing with use Statistical Package for Social Sciences

Figure 3: Transforms: difference (1).



Source: Processing with use Statistical Package for Social Sciences

Figure 4: ACF and PCF of the differenced series.

statistical insignificance rather quickly. It was concluded that the mean of the series is probably stationary. The data series and the autocorrelations didn't indicate to the presence of seasonality. However spectral density of the price by frequency was observed and there was no seasonality in the data. The PACF are significant at around lag 10 and 11.

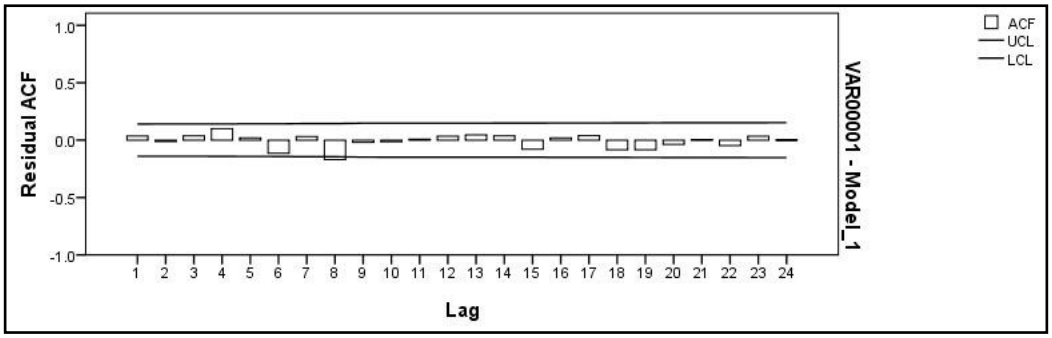
Once the time series has become stationary Using Expert Modeler option in SPSS, the ARIMA model was estimated. After going through these stages ARIMA (0,1,11) model was found to be the best among the family of ARIMA models. ARIMA Model parameters and model Fit statistics are given in the Table 1.

In the Table 1, it is shown that constant = 0.005 with a S.E. of .001 which was significant at 1% level of significance. Although ARIMA (0, 1, 11) was found to be the best model only moving average (MA) terms at lag 10 and lag 11 were found to be statistically significant at 1% level of significance and therefore only significant values are being shown in the Table 1., with an estimate of 0.195 at lag 10 and 0.37 at lag 11 and a standard error of 0.072 and 0.073 at lag 10 and lag 11 respectively .

	Estimate	SE	t	Sig	Model Fit Statistics	
Constant	0.005	0.001	4.282	0	Stationary R Squared	0.139
Difference	1				R Squared	0.985
MA Lag 10	0.195	0.072	2.697	0.008	RMSE	2.821
Lag 11	0.37	0.073	5.08	0	MAPE	2.227
					MAE	1.736
					Normalized BIC	2.155

Source: Processing with use Statistical Package for Social Sciences

Table 1.



Source: Processing with use Statistical Package for Social Sciences

Figure 5: ACF of the residuals.

This model satisfies the stationarity requirement $\theta_{11} + \theta_{10} < 1.0$. Also θ10 , and θ_{11} are highly significantly different from zero since its absolute t-value of 2.697 at lag 10 and absolute t-value of 5.08 at lag 11 which is greater than 2.0. Also R^2 value is 0.985 and RMSE, MAPE, MAE, BIC are 2.821, 2.227, 1.736 and 2.155 respectively showing satisfactory model fitting.

At the diagnostic checking stage residual were examined and their autocorrelation coefficients were found to be non significant (Figure 5). Which shows that the model is satisfactory.

To determine if model is statistically adequate, the random shocks for independence using the residuals from the estimated equation were tested. The residuals are estimates of the random shocks, and these shocks are assumed to be statistically independent. The estimated ACF of the residuals were used to test whether the shocks were independent. With 150 residuals about 24 residual autocorrelations were examined. The residual ACF appears below the estimation results in the Figure 5. None of the residual autocorrelations has an absolute t-value exceeding the warning levels ie 1.25 at lags 1, 2, and 3 and 1.6 elsewhere. If there is no dependence among the residuals then we can regard them as observations of independent random variables and there is no further modeling to be done.

Since, θ_{10} and θ_{11} meets the stationarity requirement and is statistically different from zero, constant is significant and the shocks appear to be independent according to the t-tests. Thus, forecasting can be done.

2. Neural network model

A feed forward neural network was fitted to the data with the help of SPSS 16.0 where values of the time series at 1st, 2nd and 3rd lags were taken for forecasting. The data was divided into 3 sets viz. training, testing and holdout. 81.6 % observations were used for training, 16.8% for testing and 1.5% for forecasting (Table 2).

		N	Percent
Sample	Training	160	81.60 %
	Testing	33	16.80 %
	Holdout	3	1.50 %
	Valid	196	100.00 %
	Excluded	0	
	Total	196	

Source: Source: Processing with use Statistical Package for Social Sciences

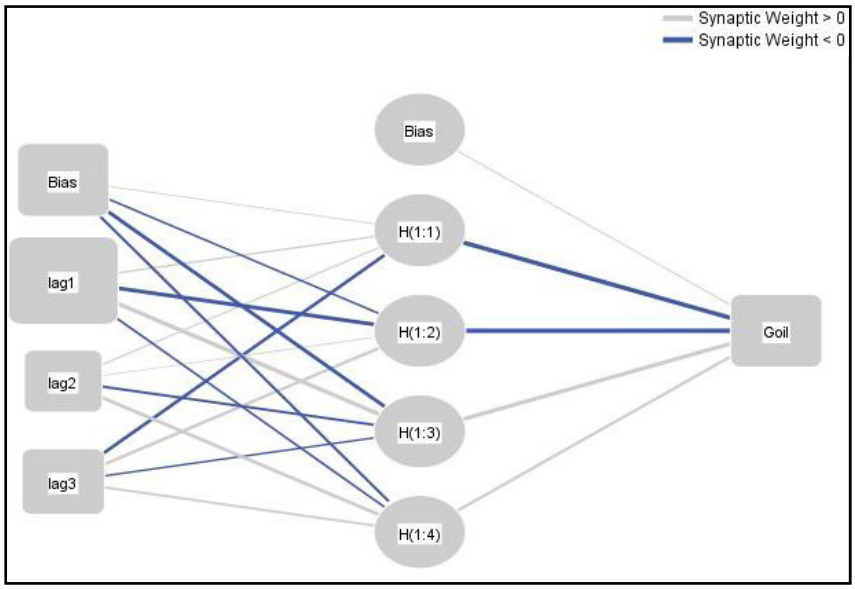
Table 2: ANN Case processing summary of groundnut oil in Delhi.

The information about the neural network

Input layer	Covariates	Lag1, lag2, lag3
	No. of units	3
	Rescaling methods of covariates	Standardized
Hidden Layers	No. Of hidden layers	1
	No. of units in hidden layers	4
	Activation Function	Hyperbolic tangent
Output Layer	Dependent variables	1
	Number of units	1
	Rescaling methods for scale dependents	Standardized
	Activation function	Identity
	Error function	Sum of squares

Source: Source: Processing with use Statistical Package for Social Sciences

Table 3: Network information for groundnut oil in Delhi



Source: Processing with use Statistical Package for Social Sciences

Figure 6: Hidden layer activation function: Hyperbolic tangent.
Output layer activation function: Identity.

Training	Sum of Squares Error		3.795
	Relative Error		0.048
	Stopping Rule Used	Maximum number of epochs (100000)	exceeded
Testing	Sum of Squares Error		1.021
	Relative Error		0.461
Holdout	Relative Error		0.454

Source: Processing with use Statistical Package for Social Sciences

Table 4: The training summary and the fit statistics of ANN of groundnut oil in Delhi.

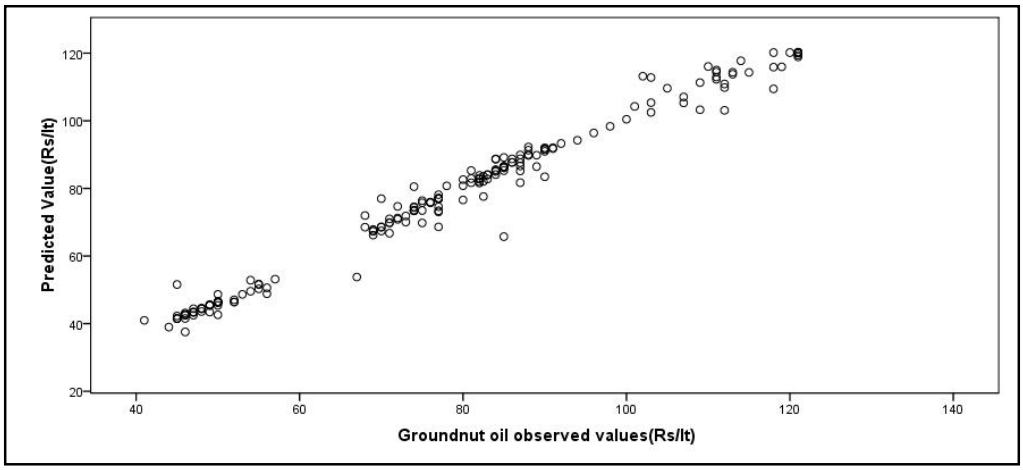
architecture is given in Table 3 which shows that network has an input layer, a single hidden layer and an output layer. In the hidden layer there are 4 units and the activation function used is the hyperbolic tangent

The architecture of the network has been shown in the Figure 6, light color lines show weights greater than zero and the dark color lines show

		Predicted				
		Hidden Layer 1				Output Layer
Predictor		H(1:1)	H(1:2)	H(1:3)	H(1:4)	Goil
Input Layer	(Bias)	0.021	-0.197	-0.562	-0.272	
	lag1	0.086	-0.646	0.712	-0.235	
	lag2	0.073	0.018	-0.253	0.468	
	lag3	-0.429	0.363	-0.102	0.237	
Hidden Layer 1	(Bias)					0.024
	H(1:1)					-1.548
	H(1:2)					-1.704
	H(1:3)					0.66
	H(1:4)					0.349

Source: Processing with use Statistical Package for Social Sciences

Table 5: The estimates of the weights and Bias of ANN fitted to groundnut oil in Delhi.



Source: Processing with use Statistical Package for Social Sciences

Figure 7: Observed vs predicted prices

weight less than zero.

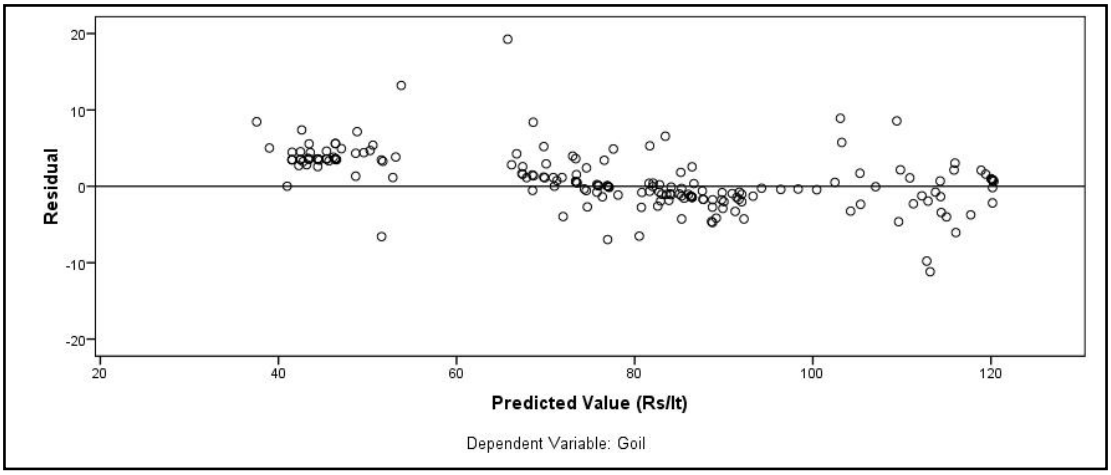
The training summary and the fit statistics for the training, testing and the holdout sets are given in Table 4.

The estimates of the weights and bias are given in Table 5. This table shows the value of weights from input to the hidden layer and from the hidden layer to the output layer. H(1:1) means Hidden layer 1 and 1St neuron. The weight attached to the neuron from bias is 0.021, from lag 1 is 0.086, from lag 2 is 0.073 and from lag 3 is -0.429. H (1:2) means Hidden layer 1 and 2nd neuron. The weight attached to the neuron from bias is -.197, from lag 1 is -.646 from lag 2 is.018 and from lag 3 is .363. H (1:3) means hidden layer 1 and 3rd neuron. The weight attached to the neuron from bias is -.562, from lag 1 is .712 from lag 2 is-.253 and from lag 3 is -.102. H (1:4) means Hidden layer 1 and 4th neuron. The weight attached to the neuron from bias is -.272, from lag 1 is -.235 from lag 2 is.468 and from lag 3 is .237.

The weights from the hidden layer to the output layer for bias .024 and from 1st neuron in the hidden layer to the output is -1.548, from 2nd neuron in the hidden layer to the output is -1.704. from 3rd neuron in the hidden layer to the output is .660 and from 4th neuron in the hidden layer to the output is .349.

The observed vs. the predicted graph is shown in the Figure 7 which depicts that except for few outliers it is a straight line. It indicates almost one to one correspondence among the observed and predicted values. Hence it can be inferred that the performance of ANN is satisfactory.

The residual vs. predicted graph (Figure 8) also



Source: Processing with use Statistical Package for Social Sciences

Figure 8: Residuals vs predicted plot

Months	Observed(Prices Rs/lt)	Predicted(Prices Rs/lt)				
		ARIMA	ANN	Combined		
				Equal weights	Weights = 1/RMSE	Weights = 1/MAPE
V.10	110	111.89	111.21	111.55	111.54	111.59
VI.10	111	111.75	112.08	111.915	111.92	111.89
VII.10	114	114.01	112.86	113.48	113.47	113.55
MSE		4.1446	3.93	3.5	3.51	3.53
RMSE		2.036	1.98	1.86	1.87	1.88
MAPE		0.83	1.02	0.89	0.89	0.88

Source: Processing with use Statistical Package for Social Sciences

Table 6: Observed and predikted prices of Groundnut oil in Delhi.

shows that the residual do not follow a definite pattern and therefore are not correlated. If there is no dependence among the residuals then we can regard them as observations of independent random variables and believe that the ANN is satisfactory.

Results and discussion

The ARIMA and ANN models were compared for their forecasting capabilities with the help of RMSE and MSE. The results are shown in the Table 6.

The one step ahead forecast for May 2010 (110) was best predicted by ANN model (111.21) followed by combined forecast with weights equal to 1/ RMSE (111.54), followed by combined forecast with equal weights (111.55), by combined forecast with weights equal to 1/MAPE (111.59) and forecast by the ARIMA model (111.89).

The two step ahead forecast for June 2010 (111) was best predicted by ARIMA model (111.75) followed by combined forecast with weights equal to 1/MAPE (111.89) (111.54), by combined forecast with equal weights(111.915) , by combined forecast with weights equal to 1/RMSE (111.92) and forecast by the ANN model (112.08).

The three step ahead forecast for July 2010 (114) was best by ARIMA model (114.01) followed by combined forecast with weights equal to 1/MAPE (113.55), by combined forecast with equal weights(113.48), by combined forecast with weights equal to 1/RMSE (113.47) and forecast by the ANN model (112.86).

Overall the forecast by ARIMA model was found to be the best with MAPE(0.83),RMSE (2.036), MSE (4.1446) followed by combined forecast with weights equal to 1/MAPE with MAPE(0.88),

RMSE(1.88), MSE(3.53), by combined forecast with equal weights with MAPE(0.89), RMSE (1.86), MSE(3.50), by combined forecast with weights equal to 1/RMSE with MAPE(0.89), RMSE(1.87), MSE(3.51) and forecast by the ANN model with MAPE(1.02), RMSE (1.98), MSE(3.93).

Conclusion

Agricultural commodity marketing data, especially the price data are vital for any future agricultural development project because they can influence potential supply and demand, distribution channels of agricultural commodity and the economics of agriculture. So price forecasting is expected to reduce the uncertainty and risk in the agriculture commodity market and can be used to determine the quantity of food grains and food product consumed, and to identify and make appropriate and sustainable food grain policy for the government.

Further, forecasting of prices can be of great help to poor farmers in deciding what to cultivate and when to sell. This will certainly help in reducing the exploitation of farmers by the middlemen and will uplift the socio-economic status of the poor farmers.

This study compared neural network and ARIMA models to forecast monthly prices of groundnut oil in Delhi one of the major Indian markets. It is well known that forecasting of prices of agricultural commodities is always and will remain difficult because such data are greatly influenced by economical, political, international and even natural shocks. Neural networks have the ability to model nonlinear patterns and learn from the historical data. ARIMA models were used as a benchmark. In the literature of time series forecasting with neural networks, most studies use the ARIMA models as the benchmark to test the effectiveness of the ANN model like Zoua et al. (2007) and Tang et al (1991). Monthly data was used from 1994 to 2010. The mean squared error, root mean square error and mean absolute percent error were all lower on average for the ARIMA forecast than for the neural network. Following conclusions were drawn from the study.

- Accuracy depends upon the forecasting horizon-The relative performance varies across forecasting horizons and different methods perform best for different forecasting horizons this definitely point out the effect of time period on the performance of the method. This can be seen from the fact that for May 2010, forecast by ANN model was found to be better but for two and three step ahead forecasts i.e. for June 2010 and July 2010, ARIMA model performed better than the ANN.
- Performance ranking varies by metric. The rankings of the contestants based upon the MAPE, MSE, and RMSE each result in different relative performances of the methods used across all datasets and data conditions. This can be inferred from the fact that for the overall performance we compare the methods by looking at the values of RMSE than ANN model performed better but if we check the value of MAPE, the ARIMA model performed better. However, some methods performed consistently well on multiple metrics, and vice versa, increasing the confidence in their relative performances and predictive capabilities.

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References

[1] Box, G. E. P., Jenkins, G. M. Time Series Analysis: Forecasting and Control. revised ed Holden-Day, San Francisco. 1976. ISBN:0816210942.

[2] De Gooijer, Jan. G., Hyndman, R. J. 25 years of time series forecasting. International Journal of Forecasting.Elsevier. 2006, vol. 22(3), pages 443-473. ISSN:0169-2070.

[3] Dorfman, J. H., Mcintosh, C.S. Results of a price forecasting competition, American J. Agricultural Economics. 1990,72, 804-808. ISSN:0002-9092.

[4] Harvey, A.C. The Econometric Analysis of Time Series.1990 (MIT Press,). ISBN-0860031926

[5] Hibon, M., Evgeniou, T. To combine or not to combine: selecting among forecasts and their combinations. International Journal of Forecasting. 2005, 21, 15–24. ISSN:0169-2070.

[6] Kohzadi N., Boyd M. S., Bahman K., Iebeling K. A comparison of artificial neural network and time series models for forecasting commodity price. Neurocomputing. 1996,10., 169-181. ISSN:0925-2312.

[7] Makridakis, S., Hibon M. The M3-Competition: results, conclusions and implication., International Journal of Forecasting. 2000, 16, 451–476. ISSN:0169-2070.

[8] Mcculloch, W. S., Pitts, W. A Logical Calculus of the Ideas Immanent in Nervous Activity. Bulletin of Mathematical Biophysics.1943, 5, 115-133. ISSN:0007-4985.

[9] Newbold, P., Granger C. W. J. Experience with forecasting univariate time series and the combination of forecasts. Journal of the Royal Statistical Society (A). 1974, 137, 131–165. ISSN:0035-9238

[10] Ripley, B. Neural Networks and Related Methods for Classification. (with discussion). Journal of the Royal Statistical Society. 1994, Ser. B, 56, 409-456. ISSN:1467-9868.

[11] Rumelhart, D. E., Hinton, G. E., Williams, R. J. Learning Internal Representations by Error Propagation, in Parallel Distributed Processing: Exploration in the Microstructure of Cognition., Cambridge,MA: MIT Press. 1986. Vol.l. pp. 318-362. ISBN:0-262-68053-X.

[12] Tang, Z., De Almeida, C., Fishcwick, P. A. Time series forecasting using neural networks vs. Box Jenkins methodology. Simulation. 1991,57 5, p. 303-310. ISSN:0037-3497.

[13] TAYLOR, J.W. Exponential smoothing with a damped multiplicative trend, International Journal of Forecasting. 2003,19, 273–289. ISSN:0169-2070.

[14] Zhang G. P. Times series forecasting using a hybrid ARIMA and neural network model. Neurocomputing.; 2003,50,159–75. ISSN:0925-2312.

[15] Zou, H., Yang, Y. Combining time series models for forecasting. International Journal of Forecasting. 2004, 20, 69–84. ISSN:0169-2070.

[16] Zoua, H. F. , Xiaa, G. P. , Yangc, F. T., Wanga, H. Y. An investigation and comparison of artificial neural network and time series models for Chinese food grain price forecasting. Neurocomputing. 2007, 70 , 2913–2923. ISSN:0925-2312.

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Assessment of the Economics and Resource-Use Efficiency of Rice Production in Ogun State, Nigeria

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Abstract

Nigeria is a major importer of rice in the world with over 756 million USD annual expenditure on rice importation. This is probably due to insufficient domestic production occasioned by inefficient utilization of resources and other farm inputs. This study is therefore designed to estimate the costs and returns to rice production; and analyze resource use efficiency in rice production in Ogun State, Nigeria. A three-stage sampling technique was used to select a total of 120 rice farmers. Gross margin and regression analyses were used to analyse the data for the study. The study revealed that an average small scale rice farmer realizes a gross margin of N 90, 634.35 per hectare. While farm size, labour and crop production systems account for 80.5% (coefficient of multiple determination, R^2) of the changes in rice production, the study revealed that farm size, labour and seeds were grossly underutilized in rice production. The study therefore recommends the need for policy that would enhance increase in the allocation of land, seeds and labour in the production of rice.

Key words

Resources, Rice Production, Regression, Gross Margin, Ogun State.

Introduction

Background to the Study

Farming is arguably mankind's most important activity. Management of farms has therefore always been critically important for the production of food, fibre and fuel (Kemp, 2004). Agriculture is an important sector of the Nigerian economy. In spite of the various efforts by the government to break the cycle of low production and productivity which have characterized the sector and limited its ability to perform its traditional role in economic development, the sector is still dominated by small scale farmers (Ezeh et.al., 2012; Ajibefun and Aderinola, 2004). The small-scale agricultural entrepreneurs exist at the margins of modern economy. They are neither fully integrated into that economy nor wholly insulated from its pressure. It is therefore not surprising that many agricultural policies and programmes since Nigeria's independence in 1960 have been directed toward these small-scale farmers (Ayinde et. al., 2012). Small scale farmers have important role to play in the development of the agricultural sector of the Nigerian economy (Ojo et. al., 2012).

Agricultural growth in Nigeria is increasingly recognized as central to sustained improvement in economic development. Yet, its contribution to the Gross Domestic Product (GDP) has suffered setback as portrayed in the report of Amaza and Maurice (2005) which states that contribution of agriculture to the GDP between 1960-1964 declined from 56 to 47 percent in 1965-1969 and further declined to 35 percent between 2002-2004. Being a major agricultural commodity, decline in the contribution of agriculture to the economy to about 30 percent potentially has great implication for access to rice as a staple food item (Adeoye, 2003).

Rice is an important basic food commodity for certain populations in Sub-Saharan Africa, particularly West Africa. Since 1973, regional demand for rice has grown at an annual rate of 6%, driven by a combination of population growth and change in taste traditional coarse grains (Ismail et. al., 2012).

The consumption of traditional cereals, mainly sorghum and millet, has fallen by 12 kg per capita, and their share in cereals used as food decreased from 61% in the early 1970s to 49% in the early 90s. In contrast, the share of rice in cereals consumption has grown from 15% to 26% over the same period. The demand for rice has been increasing at a much faster rate in Nigeria than in other West African countries since the mid 1970s. For example, during the 1960's, Nigeria had the lowest per-capita annual consumption of rice in the sub-region (average of 3 kg). Since then, Nigerian per-capita consumption levels have grown significantly at 7.3% per annum. Consequently, per-capita consumption during the 1980's averaged 18 kg and reached 22 kg in 1995-1999. The increased average growth rate in Nigerian per capita rice consumption is likely to continue for some time (Akpokodje et. al. 2001). Rice, cultivated in a wide range of environments, from tropical to temperate climates as a major crop for more than 7000 years currently sustains more than half the world population (Ismail et.al., 2012; Izawa and Shimamoto, 1996).

Though rice contributes a significant proportion of the food requirements of the population, production capacity is far below the national requirements for rice (Wudiri and Fatoba, 1992; and Ladebo, 1999). Nigeria is currently the largest rice importer in the world. Hitherto, Indonesia had until 2004 been the world's largest importer of rice. Today Indonesia has with a sense of patriotism surpassed all odds to become self sufficient in the commodity. Annual demand for rice in Nigeria is estimated at 5 million tons, while domestic production is 3million, resulting in a deficit of 2 million tons (Ezedinma, 2002). Between 1990 and 2002, Nigeria imported 5,132,616 tons of rice valued at US$1.883553 billion. In 2002 alone, the country imported 1.882 million tons of rice (FAO 2002). This was estimated at about $756 million (Bello, 2003).

Rice producing farmers are mostly small scale farmers with limited capital resources (Babafade, 2003). Based on this situation, there is limited capacity in terms of farm inputs that is directed towards the production of rice. In spite of this, there is high level of waste that accompanies resource utilization. Given the trend of the population increase in the country, there is likelihood of an increase in the dependence on importation of rice to meet demand if domestic production is not increased. This study is therefore designed to provide answers to the following research questions:

1. How profitable is the rice production enterprise in the study area?
2. What are the factors affecting rice production?
3. What is the level of resource-use efficiency in rice production in the study area?

Objectives of the Study

The main objective of this study is to carry out an assessment of the economic analysis of rice production in Ogun state, Nigeria. The specific objectives are to:

1. determine the socio economic characteristics of the rice farmers in the study area;
2. calculate the cost and returns of the rice production enterprise in the study area; and
3. examine the resource use of the rice production enterprise.

Material and methods

Study Area

This study was carried out in Ogun State which covers a total land area of 16,762km2 and population of about 3,728,098 (Nigerian Tribune, 2007). The State has Lagos, Oyo, Osun, Ondo and Benin States along its borders. The rainy season falls between April and October while the dry season falls between November and March. There are four agro-ecological zones in the state out of which two, namely, Ikene and Abeokuta zones are very prominent for rice production.

Sampling Technique

Data for this study were collected through a three-stage random sampling technique. The first stage was the purposive sampling of Ikene and the Abeokuta zones that are predominantly known for rice production in the state. The second stage involved the random selection of ten (10) villages within each of the two zones. The third stage involved a random selection of twelve (12) rice farmers drawn from the list of all rice farmers in each of the selected villages.

Method of Data Collection

The data employed for this study were collected through the use of well structured questionnaire. Data collected included socio-economic characteristics of the rice farmers such as sex, education, years of experience. Data on the output of rice were also collected. The data collected were

based on the 2006/2007 planting season.

Method of Data Analysis

Descriptive statistics such as mean, frequency and percentages were used to analyse the socio-economic characteristics of the respondents. Other analytical tools, namely, Gross Margin analysis and Ordinary Least Square regression were used to analyse the profitability and the level of resource-use efficiency of rice production respectively. Data used for the study were tested for normality by comparing the p-value of the Shapiro-Wilk Test with 0.05. If it is greater the 0.05 then the data is normal. If it is below 0.05 then the data significantly deviate from a normal distribution (Laerd Statistics, 2012). Furthermore, tests for the presence of heteroscedacity and autocorrelation were carried out using Levene's test and Durbin-Watson statistics respectively. The decision criteria for Durbin-Watson test is to reject null hypothesis (H_0) that there is no positive autocorrelation, if $0 < d < d_L$; no decision is taken in respect of H0 that there is no positive autocorrelation, if $d_L \leq d \leq d_U$; reject H_0 that there is no negative correlation if $4\text{-}d_L<d<4$; no decision taken on H_0 that there is no negative correlation if $4 - d_U \leq d \leq 4 - d_L$; and accept the H_0 that there is no autocorrelation either positive or negative if $d_U < d < 4 - d_U$ (Gujarati, 20003). The tabulated Durbin – Watson values are $d_L = 1.571$ and $d_U = 1.780$.

Gross Margin Analysis

This was used to capture the profitability of the rice production enterprise. This model was specified as follows:

$$GM = TR - TVC$$

Where:

GM = average gross margin (N/ha)

TR = average total revenue (N/ha)

TVC = average total variable cost (N/ha)

Regression Analysis

Economic model commonly used to determine the relationship between the various factors and the output in agriculture is production function model. The production function of any farmer is determined by resource availability of the farmer (Wongnaa and Ofori, 2012). As such, the general model of the Ordinary Least Square (OLS) regression model specified for this study is presented as follows:

$$Y = (X_1, X_2, X_3, X_4, d_1, u)$$

where:

Y = output of rice (kg);

X_1 = Farm size (ha);

X_2 = Labour input (man day);

X_3 = Quantity of chemical fertilizer (kg);

X_4 = Quantity of seeds (kg);

d_1 = production system (dummy variable. It takes the value of 1 for lowland rice production system; 0 for upland production system); and

u = error term.

The apriori expectation is that all the independent variables have positive relationships with the rice output.

The following functional forms of the production functions were fitted to the data:

1. Linear Function:
   $Y = a_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + z_1d_1 + u$
2. Semi Log:
   $Y = a_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + z_1d_1 + u$
3. Exponential:
   $\log Y = a_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + z_1d_1 + u$
4. Cobb Douglas:
   $\log Y = a_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + z_1d_1 + u$

The lead functional form for this study was determined using the four criteria: conformity with apriori expectation; highest R^2 value; highest number of significant variables; and highest F-value (Olayide and Heady, 1982).

One of the effective factors for improving the quantity and quality of agricultural products is optimal application resources (Behrouzi, et.al., 2012). The production function with best fit was thereafter used to compute the resource-use efficiency as follows:

Resource Use Efficiency (RUE) of each input = Marginal Value of Product (MVP) /Unit Factor Cost (UFC).

$$MVPx_i = MPPx_i \,.\, Py$$

where:

$MVPx_i$ = marginal value product of xi inputs;
$MPPx_i$ = marginal physical product of xi inputs;
Py = average unit factor cost or unit price

To ensure maximum profit and efficiency of resources, a farmer must utilize resources at the level where their marginal value product

(MVP) is equal to their marginal factor cost (MFC) under perfect competition (Kabir Miah et al, 2006; Tambo and Gbemu, 2010). In line with Goni et al. (2007) and Fasasi (2006), the efficiency of a resource was determined by assessing the ratio of MVP of inputs (based on the estimated regression coefficients) and the MFC.

Results and discussion

Socio-Economic Characteristics of Respondents

This section presents the socioeconomic characteristics of rice farmers such as sex, age, marital status, household size, level of education, farming experience, farm size and place of farming as a source of occupation of the respondents. The distribution of the respondents according to their socioeconomic characteristics is as presented in Table 1.

Variables	Frequency	Percentage
i. Sex:		
Male	98	81.7
Female	22	18.3
ii. Age(years):		
<30	2	1.67
31-40	13	10.83
41-50	46	38.33
51-60	45	37.5
>60	14	11.67
iii. Marital status:		
Single	2	1.67
Married	118	98.3
iv. Household size:		
<5	10	8.33
6-10	75	62.5
11-15	30	25
>16	5	4.17
v. Education level:		
No formal education	46	38.33
Adult education	11	9.167
Primary education	36	30
Secondary education	18	15
Post secondary	9	7.5
vi. Farming Occupation		
Major occupation	79	65.83
Minor occupation	41	34.167
vii. Farming experience(years);		
<10	25	20.83
10-20	36	30
21-30	40	33.33
>30	19	15.83
viii. Farm size (ha);		
< 1	11	9.167
1-2	52	43.33
3-4	45	37.5
5-10	12	10

Source: Field Survey, 2007

Table 1: Socioeconomic Characteristics of Rice Farmers.

Analysis of the socioeconomic characteristics of the rice producers as shown in Table 1 indicates that rice production is a male dominated enterprise. The modal age group of the farmers falls between ages 41-50. The mean age of these farmers is 43years with the youngest being 25 years of age and the eldest 75 years old. The results show that majority of the farmers (87.5%) are above 40 years of age. The study further shows that most of rice farmers have large family size; about 62.50% have between 6-10 household members. Overall, 91.67% have family size greater than six members. With regards to education, the study shows that 61.67% of the respondents have some forms of formal education. While the majority of the respondents have farming as their major occupation, 60.00% of the farmers have more than 10 years farming experience. Considering the fact that 90.10% of the farmers cultivated less than 4 hectares of land to rice, rice production in the study area could be seen as being carried out at small scale level.

Costs and Returns to Rice Production

An assessment of the profitability of rice production in the study area presented in this section was based on analysis of the average costs and returns to production. The result of the analysis is as presented in Table 2. It should be noted that the figures are based on the average estimated figures per hectare per rice producer within a cropping season.

The result of the gross margin analysis presented in Table 2 shows that rice production enterprise is profitable. It is seen that cost incurred on labour was highest during rice production. This is in accordance with Olayide and Heady (1982) that labour accounts for the highest cost in agricultural production in small scale farming. Further analysis of the costs and returns shows that rice production has a net return to investment of about 81.64%.

Items		N/ha	
Average total revenue/ha			201,654.90
	Average fertilizer cost /ha	6,243.30	
	Average cost of seeds/ha	5,339.90	
	Average cost of labour/ha	20,291.20	
Average total variable costs/ha			111,020.50
Average gross margin/ha			90,635.35

Source: Data Analysis, 2007

Table 2: Estimated Gross Margin of Rice Producers in Ogun State.

Determinants of Rice Production

Data used for the OLS regression analysis were subjected to normality test using the Shapiro-Wilk test and test of homogeneity of variance using Levene's test. The results of the normality tests are as presented in Tables 3.

Variables	Statistics	df	p-value
Output (Y)	0.698	120	0.821
Farm size X_1	0.951	120	0.814
Labour input X_2	0.917	120	0.802
Agrochemicals X_3	0.834	120	0.785
Quantity of seeds X_4	0.405	120	0.673

Source: Data Analysis, 2007

Table 3: Test of Normality using Shapiro-Wilk Test.

The results of Shapiro-Wilk test in Table 3 show that the variables are not significant. Therefore, the null hypothesis that the variables have normal distribution is accepted. To test for the presence of homogeneity of variance (absence of heteroscedacity), this study used the Levene's test as presented in Table 4.

Variables	levene Statistics	df_1	df_2	p-value
Output (Y)	1.097	5	114	0.366
farm Size X_1	1.547	5	114	0.181
Labour input X_2	2.056	5	114	0.763
Fertilizer X_3	1.803	5	114	0.137
Quantity of Seeds X_4	1.976	5	114	0.125

Source: Data Analysis, 2007

Table 4: Test of Homogeneity of Variances.

The results of Levene's test of homogeneity of variance in Table 4 show that the two groups of the respondents based on production systems, namely, upland and lowland rice production have variables that have equal variance. In order to determine the factors affecting rice production among small scale farmers in the study area, four functional forms of the Ordinary Least Square (OLS) regression model were estimated for this study. The results of the OLS regression model are as presented in Table 5.

Equations	Constant	X_1	X_2	X_3	X_4	d_1	R^2	F- value	Dubin-Watson
Linear	191.86	961.75**	3.25**	-2.07E+04	41.62	-1702.49**	0.936	334.77	1.906
	(119.767)	(214.77)	(0.706)	(0.04)	(3.93)	(464.43)			
	1.602	4.49	4.606	-0.047	0.413	-3.67			
Semi-Log	-15136.12	1284.58	3344.660**	892.98*	3371.56*	-222.05	0.732	62.25	1.924
	(4026.9)	(1678.37)	(1103.16)	(657.59)	(1580.95)	(946.52)			
	-3.763	0.765	3.03	-2.35*	2.133	1.36			
Exponential	3.178	8.56E-02*	3.99E04**	-7.12E-05	-2.27E+05	-0.121	0.746	66.89	2.083
	(0.023)	(0.041)	(1.357E04)	(8.37E-05)	(7.57E+06)	(0.089)			
	138.12	2.074	2.94	-0.851	-0.03	-1.36			
Cobb Douglas	2.175	0.386**	0.349**	3.37E-02	0.113	-0.196*	0.805	94.22	1.913
	(0.33)	(0.138)	(0.09)	(0.054)	(0.13)	(0.078)			
	6.59	2.8	3.86	0.625	0.873	-2.52			

Note: **p<0.01 and *p<0.05, figures in parenthesis are the standard errors. Figures below the standard errors are the t-ratios.

Source: Data Analysis, 2007

Table 5: Determinants of rice production.

As shown in Table 5, all the models tested as a whole are significantly different from zero based on F value. 99% confidence interval ($p<0.01$) was obtained and this implies that the models explain the dependent variables at 99% confidence. This implies that the four functional forms are good fit for the model. The coefficient of determination (R^2) of the various regression models ranges from 73.2 to 93.6. These measure the proportion of the variations in the dependent variables (rice output) that was explained by the variations in the independent variables. The results imply that the independent variables account for between 73.2% and 93.6% of the variation in the values of the rice produced. The reliability of the individual coefficient using the T-ratio provides the information of the effect of individual independent variable on the dependent variable (rice output).

Based on the highest R^2, highest number of significant variables, highest F-values and conformity to positive apriori sign of the regression coefficient, Cobb Douglas function was chosen as the lead equation. This is in line with the finding of Eze et al, (2010) and Goni et al, (2007) where double-log gives the best fit among other production functions specified. This is expressed in explicit form as follows:

$$\log Y = 2.175 + 0.38\log X_1^* + 0.349\log X_2^* - 0.03372\log X_3 + 0.113\log X_4 - 0.196X_5^*$$

The Durbin-Watson statistics for the Cobb-Douglas functional form is 1.913. This shows that there is no presence of autocorrelation in the model. With R2 of 0.805, 80.5% of the variation in output can be explained by the explanatory variables while only 19.5% of the variation is due to other factors not specified in the model. Based on the reliability of the estimates of the individual coefficient of the independent variables, this study reveals that farm size and labour input have positive relationships with rice output. These two inputs were also significantly different from zero. This is in line with the findings of Arifalo and Ayilaran (2011) as well as Opaluwa et. al. (2011). They asserted that land and labour inputs are significant variables in production of crops. The production system adopted by the rice farmers also had significant but negative effect on rice production. This implies that upland rice production lead to higher rice production that lowland rice production. Contrary to expectation, this study shows that upland rice production have the potential for increased rice output than lowland rice production. This might however be due probably to better management among upland rice farmers.

Further analysis of the Cobb-Douglas lead equation shows that one percent increase in farmland employed by the farmers, holding other inputs constant will result into about a 0.38 percent increase in rice output. This also applies to labour input which will result into about 0.349 percent increase in output when labour input is increased by one percent while holding other inputs constant. Other variables such as chemical fertilizer input, and seeds were not significantly different from zero. Efforts at increasing production should therefore be directed toward the identified variables that have significant effects on production. This could also be achieved by carryout detailed analysis of the efficiency of the use of the identified factors of production as presented in Table 6.

Resources	MVP (N)	UFC (N)	MVP÷UFC
Farm size	18,943.20	3,000	26.31
Labour	698.8	500	1.39
Chemical inputs	0.62	1.25	0.49
Seed	424.3	100	4.24

Source: Data Analysis, 2007

Table 6: Efficiency of Resource - Use.

Table 6 shows the Unit Factor Cost (UFC) of each of the input used for the analysis as the prevailing average price of each input as at the time the data were collected. The results show that farm size and labour inputs were grossly underutilized. This is on the basis of disparity between the marginal value of product (MVP) and the unit factor cost (UFC) which makes the ratio to be greater than unity. The farmers can therefore increase their allocation of these two production factors until the ratio of the MVP to UFC is unity.

Conclusion

Rice is a very important crop in Nigeria. The study shows that small scale rice production has a gross margin N90,643.35 per hectare. Investment in rice production in Ogun State, Nigeria is therefore a worthwhile and profitable venture. In spite of their positive and significant effect on rice production in the study area, land and labour inputs were grossly underutilized. In order to increase the level of rice production among small scale farmers in the study area, this study makes

the following recommendations:

1. Farmers should increase their level of utilization of land and labour in production of rice. This may require that right policy be put in place to encourage better access to farm land and higher returns to rice output so that farmers would be able to pay for hired labour;
2. Small and medium scale investors should be enlightened on the high level of profitability in rice production; and
3. Cooperatives could be organized among rice producers for easier access to the use of machinery that will reduce the drudgery of the labour intensive farm practices adopted by the farmers.

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References

[1] Adeoye G. O. Rice Revolution in Practice, Lessons From Other Countries. Paper presented at seminar on Sustainable Rice Production in Nigeria organized by Central Bank of Nigeria held at Hamdala Hotel Kaduna from January 14-15, 2003.

[2] Ajibefun, I. A., Aderinola E. A. Determinants of Technical Efficiency and Policy Implication in Traditional Agricultural Production; Empirical Study of Nigeria Food Crops Farmers. Final Report Presented at Bi-annual Research Workshop of African Economic Research Construction, 2004, Nairobi, Kenya.

[3] Akpokodje, G., Lançon F., Erenstein O. The Nigerian Rice Economy in a Competitive World: Constraints, Opportunities and Strategic Choices Nigeria's Rice Economy: State of the Art by West Africa Rice Development Association (WARDA). Bouake, Cote d'Ivoire, 2001.

[4] Arifalo S. F. , Ayilaran C. I. Economic Analysis of the Effect of Micro-Credit Scheme on Agricultural Production among Members of Farmers Development Union in Oyo State, Nigeria. Proceeding of 12th Annual Nigerian Association of Agricultural Economists National Conference, November 12-16, 2011. pp. 313-317.

[5] Ayinde, K., Ayinde, O. E., Muchie M., Omotesho, O. A., Adewumi, M. O. Multi-Risk Model of Small - Scale Agricultural Enterprenuers in Central Part of Nigeria. International Association of Agricultural Economists 2012 Conference, August 18-24, Foz do Iguaçu, Brazil. Retrieved on 9th November, 2012 from http://ageconsearch.umn.edu/bitstream/126732/2/Multi%20Risk%20Model%20of%20Small%20Scale%20Agricultural%20Enterprenuers%20in%20Central%20Part%20of%20Nigeria.pdf.

[6] Babafade M. Integrated Rice Production and Export in Nigeria. Paper presented at a seminar on Sustainable Rice Production in Nigeria held at Hamdala Hotel Kaduna from 14th-15th January, 2003.

[7] Behrouzi, F. G., S. Germchi, Yarnia, M. Effect of Complete Micronutrient Fertilizer Application on Soybean Yield and Yield Components. American Journal of Agricultural and Biological Sciences, 2012, 7: 412-416. Retrieved on 9th November, 2012 from http://thescipub.com/abstract/10.3844/ajabssp.2012.412.416.

[8] Bello A. Rice Importation in Nigeria. New Nigerian Newspaper, Wednesday 5th February 2003: 1-2.

[9] Eze, C. C., Amanze, B., Nwankwo, O. Resource Use Efficiency in Arable Crop Production among Smallholder Farmers in Owerri Agricultural Zone of Imo State, Nigeria. Researcher, 2010, 2 (5): 14-20.

[10] Ezedinma C. Impact of Trade on Domestic Rice Production and the challenge of Self- sufficiency in Nigeria. International Institute of Tropical Agriculture P.M.B 5320, Ibadan, Nigeria, 2002. Retrieved from www.warda.cgiar.org/workshop/riceproduction.

[11] Ezeh, C.I., Anyiro, C.O., Ehiemere, I.O. and Obioma, N.Q. Gender Issues on Poverty Alleviation Programmes in Nigeria; the Case of the National Fadama 1 Development Project in Abia State, Nigeria. Agris on-line Papers in Economics and Informatics 2012, 4(3):15-20. Retrieved on 8th November, 2012 from http://online.agris.cz/files/2012/agris_on-line_2012_3_ezeh_anyiro_ehiemere_obioma.pdf.

[12] Fasasi, A. R. Resource Use Efficiency in Yam Production in Ondo State, Nigeria. Agricultural Journal, 2006, 1 (2): 36-40.

[13] Goni, M., Mohammed, S. and Baba, B. A. Analysis of Resource-Use Efficiency in Rice Production in the Lake Chad Area of Borno State, Nigeria". Journal of Sustainable Development in Agriculture & Environment, 2007, 3 (2): 31-37.

[14] Gujarati, D.N. Basic Econometrics, 4th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi. 2003. pp. 1002.

[15] Ismail, A.M., Johnson, D. E., Ella, E.S., Vergara, G. V., Baltazar, A. M. Adaptation to flooding during emergence and seedling growth in rice and weeds, and implications for crop establishment". AoB PLANTS pls019; doi:10.1093/aobpla/pls019, 2012. Retrieved on 18th November, 2012 from http://aobpla.oxfordjournals.org/content/2012/pls019.full.pdf+html.

[16] Izawa, T., Shimamoto, K. "Becoming a model plant: The importance of rice to plant science" Trends in Plant Science, 1996, 1(3): 95–99. Retrieved on 18th November, 2012 from http://www.sciencedirect.com/science/article/pii/S1360138596800410.

[17] Kabir Miah, M. A, Ashraful Alam, A. K. M., Rahman, A. H. M. A. Impact of Agricultural Credit on MV Boro Rice Cultivation in Bangladesh. Journal of Agriculture & Rural Development, 2006, 4 (1): 161-168.

[18] Kemp, D. R., Girdwood, J., Parton, K. A., Charry, A. A. Farm Management: rethinking directions?" AFBM Journal, 2004 1(1):36-44. Retrieved on 9th November, 2012 from http://ageconsearch.umn.edu/bitstream/120917/2/KempGirdwoodParton05.pdf.

[19] Ladebo, O. J. Determinants of Adoption of New Technology among Rice Farmers in Ifo Local Government of Ogun State, Nigeria. ACTA Universities Agriculturae et silviculturae mendelinae Brunensis, 1999, Vol. 48.

[20] Laerd Statistics. Testing for Normality using SPSS. Lund Research Ltd., 2012. Retrieved on 27th January, 2013 from https://statistics.laerd.com/spss-tutorials/testing-for-normality-using-spss-statistics.php.

[21] Nigerian Tribune. Results of 2007 Population Census in Nigeria, 2007. www.tribune.com.ng, Wednesday 10th January, 2007.

[22] Olayide S. O., Heady E. O. Agricultural Production Economics. Ibadan University Press, 1982, 11-15.

[23] Ojo, C.O., Y. Bila, Iheanacho, A.C. Agricultural Resource Access and the Influence of Socioeconomic Characteristics among Rural Women in Borno State, Nigeria" Agris on-Line Papers in Economics and Informatics, 2012, 4(2):1-7. Retrieved on 8th November, 2012 from http://online.agris.cz/files/2012/agris_on-line_2012_2_ojo_bila_iheanacho.pdf.

[24] Opaluwa H. I., Otitoliaye J. O., Balogun O. R. Cassava Production among Rural Women in Kogi State, Nigeria. Proceeding of 12th Annual Nigerian Association of Agricultural Economists National Conference, November 12-16, 2011: 117-182.

[25] Tambo, J. A., Gbemu, T. Resource-use Efficiency in Tomato Production in the Dangme West District, Ghana. Conference on International Research on Food Security, Natural Resource Management and Rural Development. Tropentag ETH Zurich, 2010.

[26] Wudiri, B. B. Fatoba I. O. Cereals in the Food Economy of Nigeria. In Lawani S.M. and T. Babaleye (eds). Proceedings of the Workshop on Recent Development in Cereals Production in Nigeria, 1992.

[27] Wongnaa, C. A., D. Ofori. Resource-use Efficiency in Cashew Production in Wenchi Municipality, Ghana Agris on-Line Papers in Economics and Informatics 2012, 4(2):73-80 Retrieved on 8th November, 2012 from http://online.agris.cz/files/2012/agris_on-line_2012_2_wongnaa_ofori.pdf.

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Analysis of the Demand for Rice in Kaduna State, Nigeria

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Abstract

The kernel of this study was to ascertain the determinants of rice consumption and the compensated as well as the uncompensated demand for rice in Kaduna State using household consumption data obtained from a sample of 310 households through the instrumentality of a structured questionnaire. LA-AIDS model was employed to analyse the data and the result of the data analysis showed that the price of rice, price of beans, price of maize, price of yam, food expenditure, age of household head, household income and number of household income earners were all significant in influencing the households demand for rice. The estimated compensated (-0.7921) and uncompensated(-0.8887) own price elasticities of rice indicated that rice was price inelastic and the estimated expenditure(0.69) elasticity of rice indicated that rice is not a luxury in the households food basket but a necessity. From the findings of the study, it is recommended that efforts at increasing supply of local rice should be intensified as this will reduce the prices of local rice brands and invariably enhance demand for local rice by households as rice was estimated to be own-price inelastic and also, rice should be prioritized as a core food crop in food security programmes as it was found to be a necessity in households food basket.

Key words

Consumption, Demand, Rice, LA-AIDS Model, Kaduna State.

Introduction

Rice has become a staple food in Nigeria such that every household; both the rich and the poor consumes a great quantity (Godwin, 2012). A combination of various factors seems to have triggered the structural increase in rice consumption over the years with consumption broadening across all socio-economic classes, including the poor. Rising demand is as a result of increasing population growth and income level (GAIN, 2012). The annual demand for rice in the country is estimated at 6.5 million tonnes, while production is 2.3, resulting in a deficit of 4.2 million tonnes (NRIF, 2008). Rice has changed from being a luxury to a necessity whose consumption will continue to increase with per capita GDP growth, thus implying that its importance in the Nigerian diet as a major food item for food security will increase as economic growth continues (Ojogho and Alufohai, 2010). Over the years, Nigeria has relied upon the importation of rice to meet its growing demand for rice but the increased demand in recent years reflect more of increases in the demand for imported rice brands partly to meet the shortfalls in domestic demand and partly to meet consumers demand in the urban areas. The importation of rice to bridge the demand-supply gap is worth N365 billion (Ayanwale and Amusan, 2012) and this implies a loss of considerable foreign exchange for the country.

The Nigerian rice sector has witnessed some remarkable developments, particularly in the last ten years. Both rice production and consumption in Nigeria have vastly increased during the aforementioned period (Ojoehemon et al., 2009). However, the demand for rice has continued to outstrip production given the shift in consumption preference for rice especially by urban dwellers. It is projected to reach 35 million tonnes by 2050 from five million tonnes currently, rising at the rate of 7 per cent yearly due to population growth (Ayanwale and Amusan, 2012). Therefore, rice has become a strategic commodity in the Nigerian economy which have continue to attract the attention of all tiers of government, non-governmental agencies, policy makers, researchers and other stakeholders in the rice industry in an effort to address the widening demand-supply gap situation of rice in Nigeria.

The research efforts in ensuring a viable rice industry in Nigeria is very commendable but it is worth

noting that a greater proportion of such previous researches on rice in Nigeria have inter-alia focused on issues bordering on enhancing the supply side of the Nigerian rice industry (Okoruwa and Ogundele, 2006; Kudi et al., Onoja and Herbert, 2012; Dontsop-Nguezet et al., 2011 2003; Mohammmed, 2011; Ekeleme et al., 2009; Saka and Lawal, 2009). There exists few research outcomes on the demand side of the Nigerian rice industry with respect to determinants of rice consumption, changes in households rice consumption in response to changes in income level and changes in households rice consumption in response to changes in food prices which is the identified gap in the Nigerian rice industry that this study was designed to address. Therefore, this study was aimed at providing empirical information on the factors influencing rice consumption and the compensated (hicksian) as well as the uncompensated (marshallian) rice demand elasticities of households in Kaduna state.

Material and Methods

Description of the study area

The study was carried out in Sabon Gari, Kaduna South and Soba local government areas of Kaduna state. Kaduna state lies between latitudes 10^0 21^1 and 10^0 33^1 North of the equator and longitudes 7^0 45^1 and 7^0 75^1 East of the Greenwich meridian and has 23 local government areas. It occupies a total land mass of about 46,053 km^2 and its population was put at 6,066,526 people in 2006 and had a projected population of 6,903,746 people in 2012 using an annual growth rate of 3.2%. The vegetation in the state is divided into Northern guinea savannah in the northern part of state and southern guinea savannah in the southern part of the state. The state experiences both wet and dry seasons with the wet season commencing in the month of April in the southern part of the state and between May and June in the northern part of the state. Rainfall is heaviest in the southern part of the state and decreases northwards with mean annual rainfall varying between 942 mm and 1000 mm. the rainfall lasts from May to October. The dry season sets in immediately after the rainy season and is characterized by harmattan (dry and dusty West African trade wind that blows between the end of November and the middle of March) period with a temperature ranging from 18^0C to 26^0C and the heat period with a temperature that ranges from 32^0C to 39^0C.

Sampling procedure and sample size

A multistage sampling technique was employed to select the households for the study. The first stage involved a random selection of Sabon Gari, Kaduna South and Soba local government areas. The second stage involved the random selection of two districts from each of the selected local government areas. The districts are Muchia and Hanwa in Sabon Gari local government area, Kurmin Mashi and Kakuri in Kaduna South local government area, Yakassai and Rahama in Soba local government area. The third stage involved the random selection of 5% of the households in the selected districts to give a sample size of 310 pooled from Muchia (48), Hanwa (56), Kurmin Mashi (52), Kakuri (56), Yakassai (54) and Rahama (44).

Method of data collection

Primary data on household food consumption and expenditure patterns was used in this study. The primary data were elicited using well-structured questionnaires from heads of household who consulted with their household members on the households food budgetary planning and purchase. Data were collected on the demographic characteristics of households such as sex, age and educational level of household heads, household size, household income, number of household income earners. Data were also collected on the households rice consumption with respect to the type, frequency, quantity, price and expenditure on rice consumed by the households during the sample period. Similarly, data on the quantities, prices and expenditure on other food items consumed by the households were collected.

Analytical Framework

The tool of analysis that was employed in this study is the Linear Approximate Almost Ideal Demand Sytem (LA-AIDS) Model as used by Thompson 2004; Seale et al., 2003; Armagan and Akbay, 2008; Ngui et al., 2011; Guta et al., 2012. The general form of the LA-AIDS model is expressed as:

$$w_i = a_i^* + \sum_{j=1}^{n} \gamma_{ij} \ln(p_i) + \beta_i \ln\left(\frac{x}{p}\right) + \sum_{j=1}^{n} \delta_{ij} Z_i + e_i$$

The explicit system of demand equations for rice and other food items namely beans, maize, gari (cassava flakes made from processing of fresh cassava tubers into flakes) and yam captured during the survey was estimated simultaneously using Seemingly Unrelated Regression (SUR) with homogeneity and symmetry restrictions

imposed. The adding up property of demand was satisfied by deleting yam demand equation from the system and the parameters in the deleted equation were calculated in accordance with the adding-up restrictions. Using matrix notation, the system of demand equations was expressed as:

$$\begin{bmatrix} w_R \\ w_B \\ w_M \\ w_G \\ w_Y \end{bmatrix} = \begin{bmatrix} a_1^* \\ a_2^* \\ a_3^* \\ a_4^* \\ a_5^* \end{bmatrix} + \begin{bmatrix} \ln P_R \\ \ln P_B \\ \ln P_M \\ \ln P_G \\ \ln P_Y \end{bmatrix} \begin{bmatrix} \gamma_{11} & \cdots & \gamma_{15} \\ \gamma_{21} & \cdots & \gamma_{25} \\ \gamma_{31} & \cdots & \gamma_{35} \\ \gamma_{41} & \cdots & \gamma_{45} \\ \gamma_{51} & \cdots & \gamma_{55} \end{bmatrix} + \begin{bmatrix} \ln\left(\frac{X}{P}\right) \\ \ln\left(\frac{X}{P}\right) \\ \ln\left(\frac{X}{P}\right) \\ \ln\left(\frac{X}{P}\right) \\ \ln\left(\frac{X}{P}\right) \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \end{bmatrix}$$

$$+ \begin{bmatrix} Z_1 \\ Z_2 \\ Z_3 \\ Z_4 \\ Z_5 \end{bmatrix} \begin{bmatrix} \delta_{11} & \cdots & \delta_{15} \\ \delta_{21} & \cdots & \delta_{25} \\ \delta_{31} & \cdots & \delta_{35} \\ \delta_{41} & \cdots & \delta_{45} \\ \delta_{51} & \cdots & \delta_{55} \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \\ e_5 \end{bmatrix}$$

Where:

w_R, w_B, w_M, w_G, w_Y = household budget share on rice, beans, maize, gari and yam respectively

P_R, w_B, w_M, w_G, w_Y = price of rice, beans, maize, gari and yam respectively (N/kg)

Z_1 = age of household head (years)

Z_2 = educational level of household head (number of years of schooling)

Z_3 = household size (number)

Z_4 = household income (N/month)

Z_5 = number of household income earners

X = total household expenditure on all the food items within the system

P = stone's price index

γ_{11} - γ_{55} = price coefficients or the slope coefficients in the share equations of rice, beans, maize, gari and yam respectively.

β_1 - β_5 = expenditure coefficients of rice, beans, maize, gari and yam respectively.

a_1^*- a_5^* = constant terms in the share equations of rice, beans, maize, gari and yam respectively.

e_1 - e_5 = error terms in the share equations of rice, beans, maize, gari and yam respectively

δ_{11} - δ_{55} = coefficients of demographic variables in the share equations of rice, beans, maize, gari and yam respectively.

The marshallian (uncompensated) demand elasticities, hicksian (compensated) demand elasticities and expenditure elasticity of rice were determined from the estimated coefficients of the LA-AIDS model.

The marshallian (uncompensated) own-price elasticity $\left(\varepsilon_{ii}^M\right)$ and cross-price elasticities $\left(\varepsilon_{ij}^M\right)$ of rice demand was computed as follows:

$$\varepsilon_{ij}^M = -1 + \frac{\gamma_{ii}}{w_i} - \beta_i$$

$$\varepsilon_{ij}^M = \frac{\gamma_{ij}}{w_i} - \beta_i\left(\frac{w_j}{w_i}\right)$$

The hicksian (compensated) own-price elasticity $\left(\varepsilon_{ii}^H\right)$ and cross-price elasticities $\left(\varepsilon_{ij}^H\right)$ of rice demand was computed as follows:

$$\varepsilon_{ii}^H = -1 + \frac{\gamma_{ii}}{w_i} + w_i$$

$$\varepsilon_{ij}^H = \frac{\gamma_{ij}}{w_i} + w_j$$

The expenditure elasticity(ϵ_i) of rice demand was computed as follows:

$$\epsilon_i = 1 + \frac{\beta_i}{w_i}$$

Where:

$\varepsilon_{ii}^M, \varepsilon_{ij}^M$ = marshallian own-price and cross-price elasticities of rice demand respectively

$\varepsilon_{ii}^H, \varepsilon_{ij}^H$ = hicksian own-price and cross-price elasticities of rice demand respectively

ϵ_i = expenditure elasticity of rice demand

γ_{ii} = price coefficient of rice in its share equation

γ_{ij} = price coefficients of beans, maize, gari and yam in the share equation of rice

w_i = household budget share on i^{th} food item; where i = rice

w_j = household budget share on j^{th} food item; where j = beans, maize, gari and yam

Results and Discussion

Determinants of the demand for rice

The generalized least squares (GLS) was employed to perform the seemingly unrelated regression of the linear approximate almost ideal demand system model for rice, beans, maize, gari and yam with rice as the focal food item and the other food items taken into consideration for comparative purpose. The wald statistic of 39.02 as presented in table 1 shows that the null hypothesis of the restrictions of valid homogeneity and symmetry for the system of demand equations were accepted. The R-squared of the estimated rice, beans, maize, gari and yam demand equations were

0.73, 0.56, 0.69, 0.69, 0.54 and 0.67 respectively with the rice demand equation having the highest R-squared value. The R-squared of 0.73 indicates that 73% of the variability of households budget share on rice was explained by the explanatory variables included in the model.

The price of rice was found to be positive in line with a priori expectation and statistically significant (P<0.01) and this implies that a unit increase in the price of rice will increase the proportion of households expenditure on rice by a unit of 0.0095 ceteris paribus. This finding does not agree with Omonona et al. (2010) who posited that the price of rice is negatively related to households expenditure on rice. The coefficient of beans was found to be negative and statistically significant (P<0.1). This implies that given a unit increase in the price of beans will decrease the households proportion of expenditure on rice by a magnitude of 0.0103. The price of maize had a negative relationship with the households rice budget share and was significant (P<0.01). The coefficient of yam was statistically significant (P<0.1) and positively related to the households rice budget share. This implies that a unit increase in the price of yam will increase the households rice budget share by a unit of 0.01. Expenditure on food was found to be negative and statistically significant (P<0.01). This implies that a unit increase in food expenditure will decrease the households proportion of expenditure on rice by a unit of 0.0434. Age had a negative relationship with the households rice budget share and was significant (P<0.05). This implies that a unit increase in the age of household heads will decrease the households rice budget share by a unit of 0.0014.

Variable	Rice	Beans	Maize	Gari	Yam
Intercept	0.3759	0.2329	0.4402	0.0324	0.1397
Log of rice price	0.0095†	-0.0103†††	-0.0137†	0.0045†††	0.0052
	(-3.986)	(-1.7414)	(-3.5170)	(-1.809)	(-0.7248)
Log of beans price	-0.0103†††	0.0509†	-0.0166†	-0.0009	-0.0234†
	(-1.7414)	(-8.5304)	(-5.1282)	(-0.1004)	(-4.7763)
Log of maize price	-0.0137†	-0.0166†	0.0490†	-3.52E-05	-0.0105††
	(-3.5170)	(-5.1284)	(-14.1394)	(-0.0263)	(-2.7637)
Log of gari price	0.0045	-0.0002	-3.52E-05	0.0015†††	-0.0178†
	(-1.6093)	(-0.1001)	(-0.0263)	(-1.9332)	(-3.7260)
Log of yam price	0.0100†††	-0.0236†	-0.0187†	-0.0059†	0.0465†
	(-1.6624)	(-5.0591)	(-5.1441)	(-3.1073)	(-5.5439)
Log of expenditure	-0.0434†	-0.0009††	-0.0043†	5.33E-07	1.20E-05
	(-14.6392)	(-2.6470)	(-8.9190)	(-0.692)	(-0.0268)
Age	-0.0014††	0.0005	0.0002	0.0002	0.0006
	(-2.0194)	(-0.7942)	(-0.4211)	(-0.9154)	(-0.5924)
Education	0.0015	-0.0005	-0.0006	0.0002	0.0004
	(-1.1942)	(-0.4313)	(-0.6573)	(-0.6108)	(-0.2318)
Household size	0.0075††	0.0043	-0.0023	-0.0001	-0.0101††
	(-2.5204)	(-1.5201)	(-1.0371)	(-1.0947)	(-2.3700)
Household income	0.0252††	-0.0088	-0.0155††	-0.0040††	0.0063††
	(-2.4323)	(-0.8904)	(-2.0240)	(-2.2520)	(-2.4424)
Income earners	-0.0205††	-0.0112	-0.005	0.0032†††	0.0243†††
	(-1.9294)	(-1.1224)	(-0.6344)	(-1.9781)	(-1.6636)
R-squared	0.73	0.56	0.69	0.54	0.67
F statistic	19.12	8.89	15.91	8.72	13.4
Wald test(χ^2)	102.9251				

NB: Single, double and triple daggers (†) indicate statistical significance at 1, 5, and 10% levels respectively. Values in parentheses are the calculated t values.

Source: own processing

Table 1: Seemingly unrelated regression estimates of LA-AIDS Model.

The coefficient of household size was found to be positive and statistically significant at 5% probability level. This implies that a unit increase in household size will increase the households rice budget share by a unit of 0.0075 and this could be attributed to the increase in the number of persons to be fed in the household. The monthly income of households is positive and statistically significant ($P<0.05$). The coefficient of household income earners was found to be negative and statistically significant ($P<0.05$). This implies that a unit increase in the number of household income earners will decrease the households rice budget share by a unit of 0.0205. The price of rice was found to be statistically significant and negatively related to the households expenditure share on beans and maize but positively related to the households expenditure share on gari. Although, price of rice was found to be positively related to households expenditure share on yam, it was not significant.

Uncompensated demand elasticities of rice

The result presented in table 2 shows that the uncompensated own-price elasticity of rice (-0.8887) had the expected negative sign and was price inelastic. This implies that a unit increase in the price of rice will less than proportionately decrease the demand for rice by a unit of 0.8887 *ceteris paribus*. The uncompensated cross price elasticity of rice with respect to beans (-0.0552) and maize (-0.0824) were negative and this implies that they were complementary to rice consumption by the households with maize having a higher complementarity to rice than beans. The uncompensated cross price elasticity of rice with respect to gari (0.0446) and yam (0.2857) were positive and this implies that they were substitute to rice in the food basket of the households with yam having a higher substitutability to rice than gari.

Compensated demand elasticities of rice

The estimated compensated own price and cross price elasticities of rice as shown in table 3 are higher than the uncompensated own and cross price elasticities of rice. This finding is contrary to that of Erhabor and Ojogho (2011) who found out that the compensated elasticities of rice were higher than the uncompensated elasticities of rice. This implies that the income effect surpasses the substitution effect. The compensated own price elasticity of rice (-0.7921) was similar to the uncompensated own price elasticity in being price inelastic and negative. This implies that a unit increase in the price of rice will less than proportionately decrease the demand for rice by a magnitude of 0.7921.

Expenditure elasticity of rice

The expenditure elasticity of rice as presented in table 4 indicates that rice is a normal good and is expenditure inelastic. This implies that rice is not a luxury in the households food basket but a necessity and a unit increase in the households income will less than proportionately increase the demand

	Rice	Beans	Maize	Gari	Yam
Rice	-0.8887	-0.1696	-0.262	0.1125	0.1731
Beans	-0.0552	-0.1508	-0.3268	-0.0225	-0.78
Maize	-0.0824	-0.276	-0.0157	-0.0009	-0.36
Gari	0.0446	-0.0027	0.0027	-0.9635	-0.5933
Yam	0.2857	-0.3929	-0.3574	-0.1475	0.5333

Source: own processing

Table 2: Estimated uncompensated (marshalian) own price and cross price elasticities of rice and other food items.

	Rice	Beans	Maize	Gari	Yam
Rice	-0.7921	-0.0317	-0.134	0.2525	0.3133
Beans	-0.0136	-0.0917	-0.272	0.0375	-0.72
Maize	-0.0479	-0.2267	0.003	0.0491	-0.3
Gari	0.0721	0.0367	0.0039	-0.9225	-0.5533
Yam	0.1014	-0.3633	-0.344	-0.1175	0.58

Source: own processing

Table 3: Estimated compensated (hicksian) own price and cross price elasticities of rice and other food items within the demand system.

	Expenditure Elasticity
Rice	0.69
Beans	0.985
Maize	0.914
Gari	1
Yam	1.0004

Source: own processing

Table 4: Expenditure elasticity of rice and other food items within the demand system.

for rice by a magnitude of 0.69. This finding disagrees with that of Omonona et al. (2010) who posited that rice is an inferior good as well as an expenditure elastic food item from a households expenditure elasticity of –5.2837 for rice. The status of rice as being a necessity in the households food basket is a pointer to the growing consumer preference for rice in Nigeria. The expenditure elasticities of beans, maize, gari and yam indicates that they were also normal goods like rice in the food basket of the households with beans and maize being expenditure inelastic just as rice but with gari and yam having unitary expenditure elasticity which implies that a proportional increase in the income of households will lead to a proportional increase in the households demand for gari and yam.

Conclusion

This study have established the determinants of the demand for rice and the uncompensated as well as the compensated demand elasticities of rice in Kaduna state using household consumption data obtained from heads of households using structured questionnaire. The data were analysed using LA-AIDS model. The result of the data analysis showed that the price of rice, price of beans, price of maize, price of yam, food expenditure, age of household head, household income and number of household income earners were all significant in influencing the households demand for rice. The uncompensated and compensated own price elasticities of rice were estimated to be -0.8887 and -0.7921 respectively which implied that rice is price inelastic in the study area. The expenditure elasticity was estimated to be 0.89 and this implied that rice is not a luxury in the households food basket but a necessity. Based on the findings of the study, it is recommended that:

1. Rice should be prioritized as a core food crop in food security programmes as it was found to be a necessity in households food basket.
2. Arising from the significant influence of households demographic characteristics on rice demand, policy measures geared towards enhancing demand for rice by households should take into proper cognisance the demographic characteristics of the target households.
3. Adequate policy framework aimed at increasing supply of local rice should be pursued as this will reduce the prices of local rice brands and invariably enhance demand for local rice by households as rice was estimated to be own-price inelastic.

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References

[1] Armagan, G. Akbay, C. An econometric analysis of urban households' animal products consumption in Turkey. Applied Economics. 2008, Vol. 40, No. 15, pp. 2029 – 2036. ISSN: 0003-6846.

[2] Ayanwale, A.B. Amusan, C.A. Gender Analysis of Rice Production Efficiency in Osun State: Implication for the Agricultural Transformation Agenda. Paper presented at the 13th National Conference of the Nigerian Association of Agricultural Economists, Obafemi Owolowo University, Ile – Ife, Nigeria, September 25th – 27th. 2012.

[3] Dontsop-Nguezet, P. M., Diagne A., Okoruwa, V. O. Ojehomon, V. Impact of Improved Rice Technology on Income and Poverty among Rice Farming Household In Nigeria: A Local Average Treatment Effect (Late) Approach. Contributed paper prepared for the 25th conference of the Centre for the Studies of African Economies (CSAE). St Catherine College, University of Oxford, UK. 20-22 March, 2011. pp 1 – 31.

[4] Ekeleme, F., Kamara, A. Y., Oikeh, S. O., Omoigui, L. O., Amaza, P., Abdoulaye, T. Chikoye, D. Response of Upland Rice Cultivars to Weed Competition in the Savannas of West Africa. Crop Protection. 2009, 28, pp. 90 – 96. ISSN: 0261-2194.

[5] Erhabor, P. O. I., Ojogho, O. Demand Analysis for Rice in Nigeria. Journal of Food Technology. 2011, Vol. 9, No. 2, pp. 66 – 74. ISSN: 1684-8426.

[6] Global Agricultural Information Network. Nigeria Grain and Feed Annual Report. GAIN Report Number: NI1204. 2012.

[7] Godwin, U. Rice farm, milling plant: Sure money spinner. 2012, Available at: http://nationalmirroronline.net/new/rice-farm-milling-plant-sure-money-spinner/. Accessed 15th January 2013.

[8] Guta D.D. Application of an almost ideal demand system (AIDS) to Ethiopian rural residential energy use: Panel data evidence. Energy policy. 2012, Vol. 50, pp. 528–539. ISSN: 0301-4215.

[9] Kudi, T. M., Yakubu, R. Nasa'i d. H. Comparative Analysis of Profitability of Nerica Rice and Local Rice Varieties Production in Chukun Local Government Area of Kaduna State, Nigeria. Journal of Agriculture and Social Research. 2010, Vol. 10, No. 2, pp. 65 – 68.

[10] Mohammed, S. Economics of Rainfed and Irrigated Rice Production under Upper Benue River Basin Development Authority Scheme, Dadinkowa, Gombe state, Nigeria. Continental Journal of Agricultural Economic. Vol. 5, No.1, pp. 14 – 22.

[11] Ngui, D. Mutua, J. Osiolo, H. Aligula, E. Household energy demand in Kenya:An application of the linear approximate almost ideal demandsystem (LA-AIDS). Energy Policy. 2011, Vol. 39, pp. 7084–7094. ISSN: 0301-4215.

[12] Nigeria Rice Investment Forum. Forum Report: Creating the Enabling Environment for Increased Rice Production in Nigeria and West Africa held at Transcorp Hilton, Abuja, Nigeria, 24th – 25th November, 2008.

[13] Ojehomon, V.E.T., Adebayo, S.B., Ogundele, O.O., Okoruwa, V.O., Ajayi, O., Diagne, A. Ogunlana, O. Rice Data Systems in Nigeria: National Rice Survey. 2009.

[14] Ojogho, O. Alufohai, G. O. Impact of Price and Total Expenditure on Food Demand in South-Western Nigeria. African Journal of Food, Agriculture, Nutrition and Development. 2010, Vol. 10, No. 11, pp. 4350 – 4363. ISSN: 1684-5358.

[15] Okoruwa, V. Ogundele O. Technical Efficiency Differentials in Rice Production Technologies in Nigeria, African Economic Research Consortium, 2006, ISBN: 9966-944-81-8.

[16] Omonona, B. T., Nkang, N. M. Ajao, F. A. Household Food Demand Analysis: A Survey of Semi-Urban and Rural Households in South-West Nigeria, Global Journal of Pure and Applied Sciences. 2009, Vol. 15, No. 4, pp. 315 – 324. ISSN: 1118-057.

[17] Onoja, A. O. Herbert, B.C. Econometric evaluation of rice profitability determinants in Kogi State, Nigeria. Journal of Agricultural Extension and Rural Development. 2012, Vol. 4, No. 5, pp. 107 – 114. ISSN: 2141-2170.

[18] Saka, J. O. Lawal, B. O. Determinants of adoption and productivity of improved rice varieties in south western Nigeria. African Journal of Biotechnology. 2009, Vol. 8, No. 19, pp. 4923 – 4932. ISSN 1684–5315.

[19] Seale, J. L. Marchant, M. A. Basso, A. Imports versus Domestic Production: A Demand System Analysis of the U.S. Red Wine Market. 2003, Applied Economic Perspectives and Policy, Vol. 25, No. 1, pp. 187-202. ISSN 2040-5804.

[20] Thompson, W. Using Elasticities from an Almost Ideal Demand System? Watch Out for Group Expenditure. American Journal of Agricultural Economics. 2004, Vol. 86, No. 4, pp. 1108-1116. ISSN 1467-8276.

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Hierarchical Cluster Analysis – Various Approaches to Data Preparation

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Anotace

V rámci článku jsou řešeny dva různé přístupy přípravy dat, které předchází výskytu multikolinearity. Cílem tohoto článku je pomocí hierarchické shlukové analýzy nalézt podobnosti mezi úrovní e-komunikace ve státech EU. Původní datový soubor čtrnácti ukazatelů byl nejprve redukován na základě korelační analýzy. V případě ukazatelů s vysokou hodnotou korelačního ukazatele, byl do následné analýzy zahrnut pouze ukazatel s vyšší variabilitou. Druhý ze zvolených přístup využívá transformaci vstupních proměnných pomocí analýzy hlavních komponent, jelikož vzniklé hlavní komponenty jsou vzájemně ortogonální. Pro následující analýzu bylo vybráno pět hlavních komponent, které vysvětlují 92 % rozptylu vstupních proměnných. Hierarchická shluková analýza byla aplikována jak na redukovanou množinu proměnných, tak na komponentní skóre pěti hlavních komponent. Na základě Pseudo t^2 statistiky a Pseudo F statistiky byly zvoleny vždy tři výsledné shluky, jejichž složení se liší. Kvalita nalezených řešení byla posuzována také pomocí R-kvadrát indexu, který vykazoval zhruba o deset procent vyšší hodnotu pro řešení založené na komponentním skóre (57.8 % ve srovnání s 47 %). Lze proto konstatovat, že v případě využití komponentních skóre jako vstupních proměnných pro shlukování s dostatečně vysokým podílem vysvětlené variability (zhruba 92 % v provedené analýze), je ztráta informace nižší než u redukce dat na základě korelační analýzy.

Klíčová slova

Hierarchická shluková analýza, PCA, korelace, Pseudo t^2, Pseudo F statistika, e-komunikace, index spokojenosti s Internetem, index spokojenosti s mobilními službami.

Abstract

The article deals with two various approaches to data preparation to avoid multicollinearity. The aim of the article is to find similarities among the e-communication level of EU states using hierarchical cluster analysis. The original set of fourteen indicators was first reduced on the basis of correlation analysis while in case of high correlation indicator of higher variability was included in further analysis. Secondly the data were transformed using principal component analysis while the principal components are poorly correlated. For further analysis five principal components explaining about 92% of variance were selected. Hierarchical cluster analysis was performed both based on the reduced data set and the principal component scores. Both times three clusters were assumed following Pseudo t-Squared and Pseudo F Statistic, but the final clusters were not identical. An important characteristic to compare the two results found was to look at the proportion of variance accounted for by the clusters which was about ten percent higher for the principal component scores (57.8% compared to 47%). Therefore it can be stated, that in case of using principal component scores as an input variables for cluster analysis with explained proportion high enough (about 92% for in our analysis), the loss of information is lower compared to data reduction on the basis of correlation analysis.

Key words

Hierarchical clustering, PCA, correlation, Pseudo t^2, Pseudo F Statistic, e-communication, Internet satisfaction index, Mobile phone satisfaction index.

Introduction

Methods of exploratory analysis are often helpful in understanding the structure and nature of multivariate datasets. Part of the exploratory analysis is searching for the structure of natural grouping. The aim of the cluster analysis is to group the objects into classes in a way that two objects in one group are more similar than any pair of objects where each is from different group. "Groupings can provide an informal means for assessing dimensionality, identifying outliers, and suggesting interesting hypotheses concerning relationships." (Johnson and Wichern, 2007)

Although the cluster analysis can also be understand as a part of exploratory analysis it should not be of first steps. The data preparation should ensure that only the relevant indicators are included in the analysis. The data preparation should handle following problems:

1. missing values;
2. variables selection;
3. multicollinearity;
4. standardisation.

The article deals with various approaches to data preparation for the use of hierarchical clustering. For the purpose of hierarchical cluster analysis the variables should be selected in respect to the problem being solved and also from the statistical point of view. The statistical viewpoint is closely connected with multicollinearity. In case of collinear variables these variables have stronger weight for the cluster analysis. In such a case one should either reduce the number of indicators or use a measure which is not so sensitive to multicollineraity, e.g. mahalanobis distance (Meloun et alter, 2005). Another possibility to avoid from multicollinearity is to use principal component analysis (PCA) while principal components are weakly correlated.

The article introduces various approaches to data matrix preparation for the purpose of cluster analysis. The aim of the work is to compare various approaches used to avoid from multicollinearity and to propose a proper method of data preparation used for hierarchical clustering.

Materials and Methods

The data set consists of fourteen indicators characterizing e-communication in the European Union. The indicators were drawn from two different sources - Eurobarometer 75.1 survey and Eurostat database. The variables taken from Eurostat database are connected to 2011, the *Broadband penetration rate, E-government usage* and *Internet banking usage* were available for 2010 only. The Eurobarometer 75.1 was realized in 2011 (February - March). The survey was particularly focused on E-Communication in households: mobile phone, television and Internet. In all, Eurobarometer 75.1 interviewed 26.836 citizens in 27 countries of the European Union. All respondents were residents in the respective country, nationals and non-nationals but EU-citizens, and aged 15 and over.

The primary data set consists of fourteen variables as mentioned above. The variables are introduced in table 1.

The satisfaction indexes were taken from Eurobarometer survey. The mobile Internet satisfaction index was computed from the following questions: *mobile phone never cuts-off, it is always able to connect, user doesn't limit calls due to charges*, and user *doesn't limit mobile Internet due to charges*. The Internet satisfaction index was based on questions: *connection never breaks down, speed matches contract conditions, and the provider's support is useful*. The indicators are presented on a six point ordinal scale in the Eurobarometer survey. For the purpose of further analysis the responses of individual respondents were aggregated. The proportion of positive responses in each state was used in following computations. Also the proportions of positive responses of aggregated indicators from the Eurostat database were used.

The principal component analysis (PCA) was used for the reduction of dimensionality and multicollinearity in the model. The overall goal of principal component analysis is to reduce the dimensionality of a data set, while simultaneously retaining the information present in the data (see Lavine, 2000). By reducing a data set from a group of related variables into a smaller set of components, the PCA achieves parsimony by explaining the maximum amount of common variance using the smallest number of explanatory concepts (more in Field, 2005).

The original variables x_i, $i = 1, ..., m$, can be reduced to a smaller number of principal components y_j. The principal components are uncorrelated linear combinations of the original variables. All linear

Variable (expressed as percentage of population/households)	Data source
Having computer	Eurobarometer 75.1
Mobile Internet	
Phone calls over Internet	
Mobile phone satisfaction index	
Internet satisfaction index	
Broadband penetration rate	Eurostat database
E-government usage	
Ordering goods over Internet	
Never used the Internet	
Frequently using the Internet	
Using Internet banking	
High computer skills	
High Internet skills	
Households with Internet	

Source: own working

Table 1: Variables description and data sources.

combinations are related to other variables or to the data structure.

The principal components explaining the maximum amount of variance of the original variables (see Hebák et al., 2007, Meloun et al., 2001, or Rencher, 2002). The first principal component corresponds to the direction of maximum variance; the second principal component corresponds to the direction of maximizing the remaining variance, and so on. Each principal component corresponds to a certain amount of variance of the whole dataset.

The cluster technique was used to find the countries with similar e-communication level.

The automatic cluster detection is described as a tool for undirected knowledge discovery. The algorithms themselves are simply finding structure that exists in the data without regard to any particular target variable. The clustering algorithms search for groups of records composed of records similar to each other. The algorithms discover these similarities (see Berry and Linoff, 2004). The goal is to find an optimal grouping for which the observations or objects within each cluster are similar, but the clusters dissimilar to each other (Rencher, 2002).

We can search for clusters graphically by plotting the observations. If there are only two variables, we can do this in a scatter plot (Rencher, 2002). Even in three dimensions, picking out clusters by eye from a scatter plot cube is not too difficult. If all problems had so few dimensions, there would be no need for automatic cluster detection algorithms. As the number of dimensions (independent variables) increases, it becomes increasing difficult to visualize clusters. Our intuition about how close things are to each other also quickly breaks down with more dimensions (Berry and Linoff, 2004). For example for more dimensions it is possible to plot the data in two dimensions using principal components (Rencher, 2002).

In cluster analysis we generally wish to group the n rows into g clusters. Two common approaches to clustering the observation vectors are hierarchical clustering and partitioning. In hierarchical clustering we typically start with n observations. At each step, an observation or a cluster of observations is absorbed into another cluster (Rencher, 2002). This way is called agglomerative hierarchical approach. It is also possible to reverse this process. It is called divisive clustering and it starts with a single cluster containing all n observations and ends with n cluster of a single item each (Řezanková, 2007). In either type of hierarchical clustering, a decision must be made as to the optimal number of clusters. The results of a hierarchical clustering procedure can be displayed graphically using a tree diagram, also known as dendrogram, which shows all steps of the procedure, including distances at which clusters are merged.

To group the observations into clusters, many techniques begin with similarities between all pairs

of observations. In many cases the similarities are based on some measure of distance. A common distance function is the Euclidean distance between two vectors. Other cluster methods use a preliminary choice for cluster centers of a comparison of within - and between - cluster variability. The scale of measurement of the variables is important consideration when using the Euclidean distance measure. Changing the scale can affect the relative distances among the items. Each variable could be standardized in the usual way by subtracting the mean and dividing by the standard deviation of the variable (see Rencher, 2002, or Řezanková, 2007).

There are authors combining the principal component analysis with clustering to avoid high data-dimension and to reduce multicollinearity (e. g. Garcia-Cuesta et al., 2009; Sembiring et al., 2011 or Xu et al., 2010). There is also wide research on other alternative methods leading to dimension reduction for cluster analysis (e. g. Bharti and Singh, 2013; Shamsinejadbabki and Saraee, 2012).

Various methods for determining the number of clusters were introduced (see e. g. Collica, 2007). Apart from descriptive, graphical or exploratory methods, statistical significance test were introduced as well (for details see e. g. Bock, 1985). Milligan and Cooper (1985) and Cooper and Milligan (1988) compared thirty methods for estimating the number of population clusters using four hierarchical clustering methods. The three criteria that performed the best in these simulation studies with a high degree of error in the data were a **pseudo F statistic** developed by Calinski and Harabasz (1974), a statistic referred to as **Je(2)/Je(1)** by Duda and Hart (1973) that can be transformed into a pseudo t^2 statistic, and the **cubic clustering criterion** (CCC). The pseudo F statistic and the CCC are displayed by PROC FASTCLUS; these two statistics and the pseudo t^2 statistic, which can be applied only to hierarchical methods, are displayed by PROC CLUSTER. It may be advisable to look for consensus among the three statistics, that is, local peaks of the CCC and pseudo F statistic combined with a small value of the pseudo t^2 statistic and a larger pseudo t^2 for the next cluster fusion. It must be emphasized that these criteria are appropriate only for compact or slightly elongated clusters, preferably clusters that are roughly multivariate normal (for more information see e. g. SAS/STAT® 9.2, 2008).

Quality of clusters can also be evaluated using R Squared which informs about the proportion of variance accounted for by the clusters. The idea of computing R Squared is comparing the proportion of intercluster variability to the total variability (for details se e.g. Řezanková, 2007).

For the purpose of this analysis the SAS 9.3 software was used to construct the principal component and cluster analysis. The PRINCOMP Procedure was used to fit a principal component model. The CLUSTER Procedure was used to fit a cluster analysis.

Results and discussion

First application deals with data reduction on the basis of correlation coefficients. Pairs of variables with absolute value of correlation coefficient higher than 0.8 were further investigated. On the basis of coefficient of variation computed as $V = s/\bar{x}$, where s is the standard deviation and $\bar{x}$ is the arithmetic mean, variable of lower variation was excluded. For the purpose of this step, pairs of variables were sorted descending following the correlation coefficient. On the basis of correlation analysis six variables were excluded from further computations: **Households with Internet, Frequently using the Internet, E-government usage, Never used the Internet, Having computer, Broadband penetration rate.**

Therefore the following eight variables were selected for further analysis:

Mobile Internet
Phone calls over Internet
Mobile phone satisfaction index
Internet satisfaction index
Ordering goods over Internet
Using Internet banking
High computer skills
High Internet skills

The dendrogram of cluster analysis made upon the eight variables mentioned above is shown in the figure No. 1.

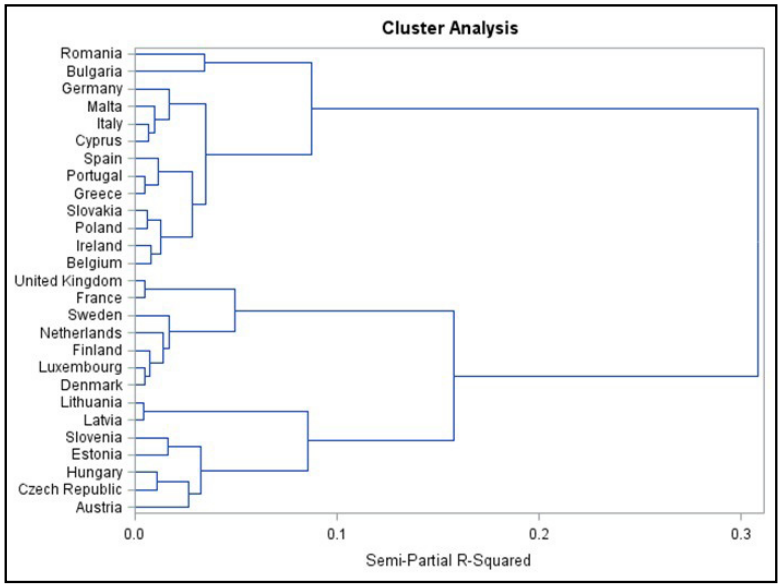
To determine the number of clusters more than one characteristic should be investigated. Figure No. 2 compares values of Pseudo t-Squared and Pseudo F Statistic. Higher values of Pseudo F Statistic provide evidence for the given number with clusters together with lower values of Pseudo t-Squared followed by larger pseudo t^2 for the next cluster fusion.

Following the Pseudo t-Squared the smallest value can be observed for four clusters. The F Statistic provides an evidence for determining three clusters

Correlation Coefficient	Variables	Coefficient of Variation (%)	Excluded Variables
-0.953	Never used the Internet	54.19	Households with Internet
	Households with Internet	18.86	
-0.946	Never used the Internet	54.19	Frequently using the Internet
	Frequently using the Internet	25.66	
0.944	Frequently using the Internet	25.66	NO
	Households with Internet	18.86	
0.928	E-government usage	48.37	NO
	Frequently using the Internet	25.66	
0.914	Frequently using the Internet	25.66	NO
	Using internet banking	58.25	
0.913	E-government usage	48.37	E-government usage
	Using internet banking	58.25	
0.911	Ordering goods over Internet	43.27	NO
	Households with Internet	18.86	
-0.897	Never used the Internet	54.19	Never used the Internet
	Using internet banking	58.25	
0.893	Having computer	17.79	Having computer
	Using internet banking	58.25	
0.88	Having computer	17.79	NO
	Broadband penetration rate	28.81	
0.88	Having computer	17.79	NO
	Households with Internet	18.86	
0.879	Using internet banking	58.25	NO
	Households with Internet	18.86	
-0.876	E-government usage	48.37	NO
	Never used the Internet	54.19	
0.876	Having computer	17.79	NO
	Frequently using the Internet	25.66	
0.874	E-government usage	48.37	NO
	Households with Internet	18.86	
0.871	Broadband penetration rate	28.81	NO
	Frequently using the Internet	25.66	
0.869	Broadband penetration rate	28.81	NO
	Households with Internet	18.86	
0.867	Having computer	17.79	NO
	E-government usage	48.37	
-0.847	Ordering goods over Internet	43.27	NO
	Never used the Internet	54.19	
0.842	Ordering goods over Internet	43.27	NO
	Frequently using the Internet	25.66	
0.84	Broadband penetration rate	28.81	Broadband penetration rate
	Ordering goods over Internet	43.27	
0.82	Broadband penetration rate	28.81	NO
	Using internet banking	58.25	
0.819	Broadband penetration rate	28.81	NO
	E-government usage	48.37	
-0.808	Broadband penetration rate	28.81	NO
	Never used the Internet	54.19	
-0.801	Having computer	17.79	NO
	Never used the Internet	54.19	

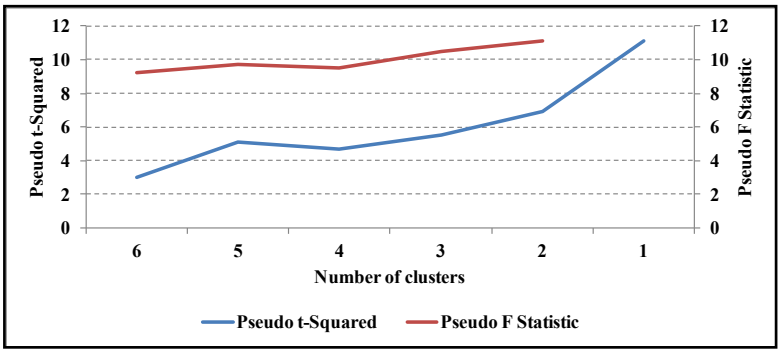
Source: own working

Table 2: Correlation coefficients and reduction of variables



Source: own working

Figure 1: Dendrogram for hierarchical cluster analysis on the basis of eight variables.



Source: own working

Figure 2: Pseudo t-Squared and Pseudo F Statistic for the first cluster analysis.

only, so there is no full agreement following these two statistics. On the other hand, the small value of Pseudo t-Squared should be followed by rapidly increasing value of t-Squared. This can also be observed for three clusters - Pseudo t-Squared is rapidly increasing for two clusters. That is why three clusters were determined as an output from the cluster analysis. Furthermore, in case of dividing the states into four clusters, one would be of two states only.

The three clusters are of seven (two times) and thirteen observations. The second cluster (following the dendrogram) consists of northern states, Netherlands, Luxembourg, France and United Kingdom is obviously of much better e-communication level. Most of the households are equipped with computer (about 82% in average) and covered by Internet – about 64% of households overall. People are frequently using Internet (74% of population in average) and they have very good computer and Internet skills. On the other hand people are the least satisfied with mobile and Internet services.

The second cluster of seven states including Czech Republic, Austria, Estonia, Hungary, Latvia, Lithuania and Slovenia is somewhat in the middle. Although the prevalence of computers and Internet is not much higher in comparison to the third clusters of thirteen states, people are of higher ability to use the Internet. Percentage of those who use e-government services or those who use Internet for ordering goods, Internet banking varies between 30 and 40%. Following the Internet and mobile phone satisfaction indices people from this

group of states are the most satisfied with services provided.

The biggest group of thirteen states covers mostly southern European states together with a group of middle-western European states such as Germany, Poland or Slovakia. These states are characterized by the lowest prevalence of both computers and Internet which is about 60, resp. 64% in average. The percentage of people with high Internet skills ranges between 5 and 13 percent only. That is why the overall Internet usage is at lower level in comparison to other clusters (except ordering goods over the Internet). On the other hand people are more or less satisfied with Internet and mobile phone services, about 70 to 75% of inhabitants are satisfied or very satisfied.

Using the principal components

Second application of cluster analysis was based on the results of principal component analysis (PCA). In PCA, we seek to maximize the variance of a linear combination of the input variables. The eigenvalues indicate that three components could provide a good summary of the data. Five components were selected for the purpose of complex analysis. These components account for almost 93% of variance of the whole dataset.

The first principal component is the linear combination with maximal variance. It explains almost 60% of the total dataset. It largely represents 10 input variables, which are logically related. The corresponding eigenvector expresses an association of input variables with the first principal component. The first principal component has high negative loadings on variables *Never used the Internet* and high positive loadings on 9 input variables related to equipment and Internet use. Therefore it is obvious that the higher component score of this component means a higher level of e-communication in the country.

The second principal component accounts for 17% of variance and it has high positive loadings on four indicators. It is correlated with indicators of the quality of services (mobile phone and Internet satisfaction index), and also with variables *Phone calls over Internet* and *High Internet skills*. It refers to the relationship between the level of the quality of services and the proportion of advanced Internet users.

The eigenvalue of the third component is 1.18 and it accounts for 8% of the total variance. It positively corresponds with *Internet satisfaction index* and negatively with *High Internet skills*.

Forth component accounts for 4% of the total variance. It positively corresponds with *Phone calls over Internet* and negatively with *High computer skills*.

Fifth component accounts for 3.6% of the total variance. It positively corresponds with High Internet skills and negatively with *Phone calls over Internet* and *Mobile Internet*.

Subsequent components contribute less than 3% of the total variance each and these will not enter into following computations.

While the first five components explain more than 90% of overall variance, components scores for the first to the fifth component were used as input variables for the cluster analysis. The use of principal components instead of original data, ensure very low correlation among the inputs.

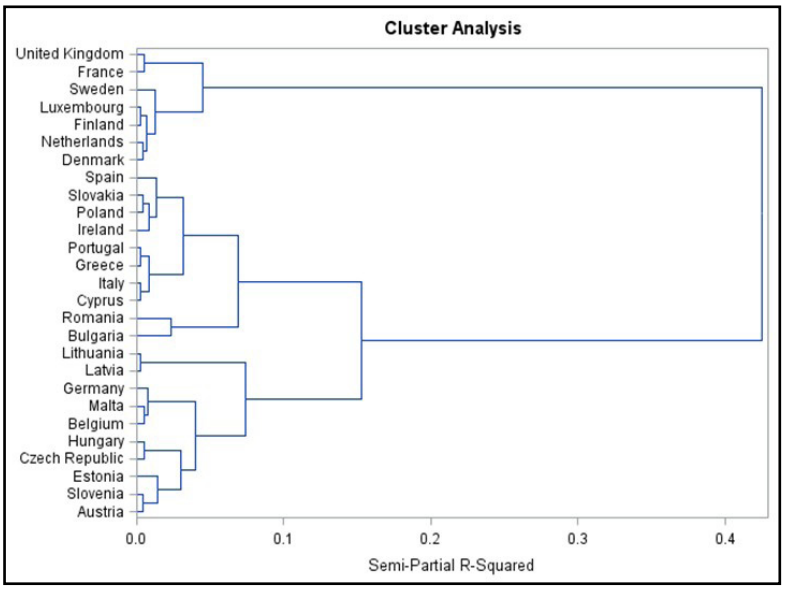
Three dominant clusters can be assumed as it is shown in figure No. 3. Distance for dividing the states into three clusters is denoted by the dashed line. The states were divided into three clusters of ten (two-times) and seven states.

Graph No. 4 shows the relation between the Pseudo t-Squared, Pseudo F Statistic and number of clusters.

Eigenvalues of the Correlation Matrix				
No.	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
1	8.3589	5.9428	0.5971	0.5971
2	2.4160	1.2362	0.1726	0.7696
3	1.1798	0.6326	0.0843	0.8539
4	0.5472	0.0421	0.0391	0.8930
5	0.5051	0.1656	0.0361	0.9291

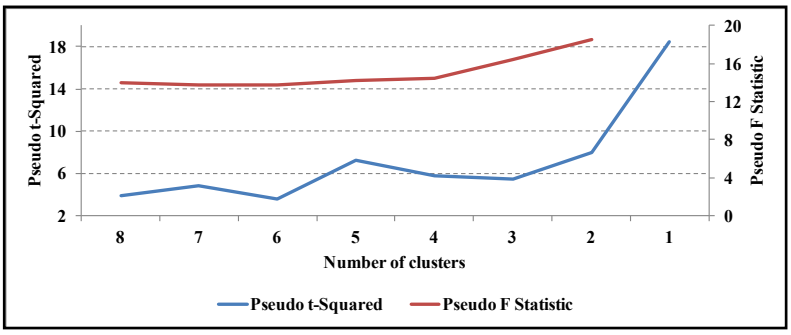
Source: own working

Table 3: First five principal components.



Source: own working

Figure 3: Dendrogram for hierarchical cluster analysis on the basis of principal components .



Source: own working

Figure 4: Pseudo t-Squared and Pseudo F Statistic for the second cluster analysis.

The minimum values of Pseudo t-Squared provide an evidence for determining six or three clusters. Following the F Statistic, there is no clear local peak, but the values of F Statistics are the highest for three and two clusters. Finally three clusters were chosen as well as in case of the previous cluster analysis.

The smallest cluster consists of northern states (Denmark, Sweden, Finland) together with Luxembourg, Netherlands, France and the UK. These states are of higher level of all indicators characterizing both the availability (Households with computer or Internet) and use (phone calls over the Internet. E-government usage, Ordering goods over the Internet, …) of e-communication services. It is obvious that Internet is commonly used in work, in everyday life and also in relation to the government. There is lower percentage of those who never used the Internet (less than 10% in average) in comparison to the other groups with average value above 20, resp. 35%. Also the percentage of those frequently using Internet is above 70% in average (74.43%), while the other groups are of averages about 40%, resp. 55%. Both the computer skills as well as the Internet skills are much better in this states and the Internet is much often used for various purposes including phone calls, ordering goods or Internet banking. The states are also more homogenous in many aspects.

On the other hand, which is maybe surprising, people are less satisfied both with the Internet and mobile phone services. Although the percentage of people who are satisfied with mobile phone

services is pretty high, it ranges between 66% and 78%, the average value is 72,7% which is more than seven percent below the average value of the first cluster. The average Internet satisfaction is about 70%, while in the other clusters it is 76, respectively 82%.

The remaining two clusters consist of ten states each. There is better situation from the view of characteristics being evaluated in the third cluster (Lithuania, Latvia, Germany, Malta, Belgium, Hungary, Czech Republic, Estonia, Slovenia and Austria). These states indicate higher prevalence of computers and Internet in households as well as higher ability to use it. People in these states are the most satisfied with Internet and mobile phone services, the average satisfaction is almost 76, resp. 80%.

The remaining cluster covers southern states such as Spain, Portugal, Greece and Italy, together with Bulgaria, Romania, Slovakia, Poland, Ireland and Cyprus. This group of states shows the lowest values of all indicators characterizing e-communication level. Less than 60% of households are equipped with computer and covered by the Internet in average, almost 40% of people have never used the Internet and only 43.8% use the Internet frequently. Computer and Internet skills are also at very low level – the average percent of citizens with high computer skills is 22% only and the average percent of those with high Internet skills is less than 10%.

Comparing results

Two various approaches to data preparation were

	Data preparation	
	Dimension reduction on the basis of correlation coefficient	**Principal component analysis**
"Cluster 1 TOP"	Denmark Finland France Luxembourg Netherlands Sweden United Kingdom	Denmark Finland France Luxembourg Netherlands Sweden United Kingdom
"Cluster 2 MIDDLE"	Austria Czech Republic Estonia Hungary Latvia Lithuania Slovenia	Austria Belgium Czech Republic Estonia Germany Hungary Latvia Lithuania Malta Slovenia
"Cluster 3 THE LOWEST"	Belgium Bulgaria Cyprus Germany Greece Ireland Italy Malta Poland Portugal Romania Slovakia Spain	Bulgaria Cyprus Greece Ireland Italy Poland Portugal Romania Slovakia Spain

Source: own working

Table 4: Comparison of the resulting clusters.

used. On the basis of results of hierarchical cluster analysis the states were divided into three clusters.

In both analysis the three clusters found grouped together the states with the highest, middle and the lowest level of e-communication. The table 4 compares the clusters found when using factor scores as input variables to the solution based on the reduced data set.

The seven states that are at the top from the view of e-communication level were grouped together when using correlation as well as principal component analysis for data preparation. There are differences between the two clusters of states with middle and low e communication level.

Germany, Malta and Belgium were included in different clusters. Considering the results of the first cluster analysis, the three states are of higher level in nine of fourteen indicators mentioned at the beginning. So in the group of the lowest thirteen states they are at the top.

Another possibility how to consider the two results is to look at the variability explained by the clusters found. When considering the first result on the basis of eight poorly correlated variables, the proportion of variance accounted for by the clusters is just under 47%.

When the states are grouped into three clusters on the basis of component scores for the first five components, the proportion of variance accounted for by the clusters is almost sixty percent (57.8%).

Therefore it can be stated, that there is higher variability among the clusters found on the basis of principal components and the input variables (component scores) are very poorly correlated as well.

Conclusion

The article introduces two possible approaches to data preparation to avoid high correlation among variables. The aim of the article was to identify states of similar e-communication level. This was realized by cluster analysis which is sensitive to collinearity. Firstly, the original data set was reduced on the basis of correlation coefficient while in case of strong correlation the variable of lower variability was eliminated. The second application of cluster analysis was based on principal components. By the use of five principal components, about 92% of variability can be explained.

In case of both applications, three clusters were assumed on the basis of two criterions: Pseudo t-Squared and Pseudo F Statistic. The group of states of the highest e-communication level has been found the same but there are differences for the rest of states. An important criterion to assess the results is to look at the proportion of variance accounted for by the clusters which is much higher for the results based on principal components.

Therefore it can be stated, that in case of using principal component scores as an input variables for cluster analysis with higher proportion of variance explained, there was lower lack of information compared to data reduction on the basis of correlation analysis.

The results of cluster analysis have confirmed the conclusions published by the authors previously, which is the top position of Nordic European states and Luxembourg together with France or United Kingdom and lower prevalence and use of e-communication tools in southern European states e.g.

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References

[1] Berry, M. J. A., Linoff, G. Data Mining Techniques For Marketing, Sales, and Customer Relationship Management. Second Edition. Indianapolis: Wiley Publishing, 2004, 643 p. ISBN: 0-471-47064-3.

[2] Bharti, K. K., Singh, P. K. A two-stage unsupervised dimension reduction method for text clustering, Advances in Intelligent Systems and Computing, 202 AISC/2, 2013, pp. 529-542, ISSN 1615-3871.

[3] Bock, H. H. On Some Significance Tests in Cluster Analysis, Journal of Classification, 1985, 2, pp. 77–108, ISSN 0176-4268.

[4] Calinski, T., Harabasz, J. A Dendrite Method for Cluster Analysis, Communications in Statistics, 1974, 3, pp. 1–27.

[5] Collica, R. S. CRM Segmentation and Clustering Using SAS Enterprise Miner. Cary, NC: SAS Institute. 2007, ISBN 978-1-59047-508-9.

[6] Cooper, M. C., Milligan, G. W. The Effect of Error on Determining the Number of Clusters in Data, Expert Knowledge and Decisions, pp. 319–328, 1988, ed. W. Gaul and M. Schrader, London: Springer-Verlag.

[7] Duda, R. O., Hart, P. E. Pattern Classification and Scene Analysis, New York: John Wiley & Sons. 1973.

[8] Field, A. Discovering Statistics Using SPSS. Second Edition. London: SAGE Publication, 2005, 779 p. ISBN: 978-0761944522.

[9] Garcia-Cuesta, E., Galvan, I. M., De Castro, A. J. Supervised clustering via principal component analysis in a retrieval application, Proceedings of the 3rd International Workshop on Knowledge Discovery from Sensor Data, SensorKDD'09 in Conjunction with the 15th ACM SIGKDD Conference on Knowledge Discovery and Data Mining, KDD-09, 28 June, 2009, Paris, France, pp. 97-104.

[10] Meloun, M., Militký, J. Kompendium statistického zpracování dat. Praha: Academia, 2006, 984 p., ISBN: 80-200-1396-2.

[11] Milligan, G. W., Cooper, M. C. An Examination of Procedures for Determining the Number of Clusters in a Data Set, Psychometrika, 1985, 50, pp. 159–179, ISSN: 0033-3123 (Print) 1860-0980 (Online).

[12] Lavine, K. B. Clustering and Classification of Analytical Data. Encyclopedia of Analytical Chemistry, John Wiley & Sons Ltd, Chichester, 2000, p. 9689-9710. ISBN: 9780470027318.

[13] Rencher, A. Methods of Multivariate Analysis. Second Edition. New York: Wiley Publishing, 2002, 738 p., ISBN 978-0471418894.

[14] Řezanková, H., Húsek, D., Snášel, V. Shluková analýza dat. Příbram: Professional Publishing, 2007, 220 p., ISBN 978-80-86946-26-9.

[15] SAS/STAT® 9.2 User's Guide, The CLUSTER Procedure, 2008. Cary, NC: SAS Institute.

[16] Sembiring, R. W., Mohamad Zain, J., Embong, A. Alternative model for extracting multidimensional data based-on comparative dimension reduction, 2nd International Conference on Software Engineering and Computer Systems, ICSECS 2011, 2011, 27 – 29 June, Kuantan, Malaysia, pp. 28-42.

[17] Shamsinejadbabki, P., Saraee, M., A new unsupervised feature selection method for text clustering based on genetic algorithms, Journal of Intelligent Information Systems, 2012, 38/3, pp. 669-684, ISSN: 0925-9902 (Print) 1573-7675 (Online).

[18] Xu, Z. J., Zheng, J. J., Zhang, J., Ma, Q. Application of cluster analysis and factor analysis to evaluation of loess collapsibility, Yantu Lixue/Rock and Soil Mechanics, 2010, 31, pp. 407-411. ISSN: 10007598.

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Development of Market Prices of Agricultural Land within the Conditions of the EU

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Anotace

Tržní ceny zemědělské půdy ve světě v posledních letech výrazně vzrostly. Důležitými faktory tohoto trendu je nejen to, že půda je základním, nenahraditelným zdrojem produkce potravin a přírodního bohatství každé země, ale i to, že je obecně chápána jako výhodný tezaurus kapitálu, nepodléhající vlivu inflace. Tržní ceny zemědělské půdy a výše nájemného jsou v jednotlivých členských zemích EU ovlivněny historickým vývojem, velikostní strukturou zemědělských podniků, legislativou, regulací trhu s půdou, přírodními podmínkami a intenzitou zemědělské výroby (např. Nizozemsko). Tržní ceny zemědělské půdy v ČR sledují Český statistický úřad (ČSÚ), Ústav zemědělské ekonomiky a informací (UZEI) a Ministerstvo zemědělství (Mze), ale výstup z datové základny není srovnatelný v časové řadě 1993-2012, neboť instituce pracují s odlišnou metodikou. Na základě deskripce cen zemědělské půdy a regresní analýzy nebylo potvrzeno, že tržní cena zemědělské půdy pro zemědělské využití v ČR je ovlivněna zejména její bonitou. Úřední (administrativní) cena je pro stanovení tržní ceny jen orientačním a podpůrným nástrojem. Rozvoj trhu se zemědělskou půdou v ČR ovlivnila privatizace půdy po roce 2000. Dle odhadu (autorky) mohou po skončení privatizace, i vzhledem ke změnám v daňové politice, poklesnout ceny půdy pro zemědělské využití do roku 2014 až o 30 %, zároveň bude výrazně klesat i podíl obchodované státní půdy. Je pravděpodobné, že poptávka bude orientována na obchody s půdou pro spekulativní a investiční účely, neboť dle světových trendů je průměrné zhodnocení investice do půdy v době ekonomické krize vyšší (6-7% p. a.) v porovnání s investicemi do akciových trhů (1,8-2,2%).

Článek byl zpracován v rámci VZ MSM 6046070906 „Ekonomika zdrojů českého zemědělství a jejich efektivní využívání v rámci multifunkčních zemědělskopotravinářských systémů“.

Klíčová slova

Zemědělská půda, orná půda, tržní cena zemědělské půdy, úřední cena zemědělské půdy, bonita půdy, dotace, pacht.

Abstract

Market prices of agricultural land in the world have increased significantly in recent years. Important factors in regard to this trend are not only the fact that land is a basic, irreplaceable resource for the production of food and natural resources of each country, but also the fact that it is generally perceived as a favorable holder of capital, not succumbing to the effects of inflation. Market prices of agricultural land and the rent level in individual EU member countries are affected by historical development, the size structure of agricultural businesses, legislation, regulation of the land market, natural conditions and the intensity of agricultural production (e.g. the Netherlands). Market prices of agricultural land in the Czech Republic are monitored by the Czech Statistical Office (CSO), Institute for Agricultural Economics and Information (IAEI) and Ministry of Agriculture (MoA), but output of the data base is not comparable within a time series 1993-2012, as institutions work with differing methodology. On the basis of the description of prices of agricultural land and regression analysis, the hypothesis that the market price of agricultural land for agricultural use in the Czech Republic is affected primarily by its quality was not confirmed. The official (administrative) price is only an orientational and subsidiary tool for the determination of the market price. The development of the agricultural land market in the Czech Republic was affected by the privatization of land after 2000. According to an estimate (of the author), after the completion of privatization, and also in view of changes in tax policy, the prices of transacted land for agricultural use can decline within 3 years (2014) by up

to 30%. It is probable that the demand will be focused on transactions with land for speculative and investment purposes, as, according to world trends, the average increase in value of investments in land in a time of economic crisis is higher (6-7% p.a.) as compared to investments in stock markets (1.8-2.2%).

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Key words

Agricultural land, arable land, market price of agricultural land, official price of agricultural land, quality of land, subsidies, tenure.

Introduction

Main objective: To analyze the development of market prices of agricultural land in terms of the transformation of agriculture, quality and the effect of privatization of land on the development of the market within the years 1993-2012 in the Czech Republic.

The main objective is fulfilled on the basis of partial objectives:

- Quantification of market prices of agricultural land in terms of production capability and the purpose of utilization for the period of 1993-2012 according to available databases in the Czech Republic;
- Statistical analysis, assessing the correlation of the selected factor (land quality) on the market price of agricultural land.

Land plot markets act as a medium for the transfer of agricultural land from passive farmers to active farmers, or, more generally, from less effective farming to more productive agricultural producers (Deininger et al., 2004).

Factors that potentially affect the prices of agricultural land in the Czech Republic are: size, accessibility and natural fertility of a land plot. The conclusions of the work of authors further show a significant effect of projects for land adjustments and zone planning on the price of agricultural land. A significant role is also played by zone planning. That protects agricultural land from runaway proliferation of urban development (Sklenicka et al., 2013).

According to an analysis of market prices of agricultural land in the Czech Republic on the basis of a regression model, it was ascertained that relevant determinants of market prices in 2008-2009 were: type and quality of land, location of the district, the nature of the acquirer (agricultural or non-agricultural entity), the area of the land plot, distance from the district seat. An analysis in 5 selected districts in the Czech Republic (monitoring approximately 450 purchase agreements) did not confirm a significant effect of conducted land adjustments within the cadastral area on market prices of agricultural land (Medonos et al., 2011). Vopravil et al. (2011) focus on the current manner of valuating land in the Czech Republic. It is based on quality-rated land-ecological units (BPEJ) and represents a unique system on a global scale. The quality-rating was based on a comprehensive study of land, which took place in the 1960's, and was conducted on the entire territory of Czechoslovakia. The quality-rating of the agricultural land fund is understood to mean the classification and valuation of land for tax and pricing purposes and for the purposes of the exchange of land plots (in the case of land adjustments). The existing system of quality-rating is based on the conditions of the socialist manner of farming on land. The authors propose an innovation of the system as a tool for the protection of agricultural land.

Rent for agricultural land is a significant factor in the valuation of agricultural land and costs of production. That is given by the fact that rented land comprises a significant proportion in the Czech Republic (86%), and 54% in the EU (Střeleček et al., 2011).

In the future it is expected that the market price of agricultural land will be the basis for calculating taxes and replacing the official prices. The assumption is , however, developing land market and the corresponding market prices (Rejfek et al., 1990).

Three significant causes of the inflexibility of the land plot market in Slovakia: (1) the effect of taxes, which are determined for non-agricultural use of land, (2) laws complicate foreign ownership relations in regard to land, and (3) administrative price of transacted agricultural land that is used for the calculation of property taxes, instead

of market prices. The agricultural land market is at a low level and market prices of land are undervalued. For example, the interest rate on savings exceeds the rate of return on agricultural land. That leads to a low demand for agricultural land and it is very difficult to use agricultural land to secure an investment loan. That makes financial investments for the purchase of agricultural land ineffective (Duke at al., 2004). The agricultural land market in Poland has its specifics. Among farmers, there are accepted internal rules regarding how to conduct a market exchange of land plots with the goal of preventing the sale of agricultural land to foreigners. A second objective is to protect farmers from an explosion of land plot prices, which would exclude many local buyers from participating in transactions regarding land plots (negotiations only within the local group or without any negotiations at all). The market price is understood to be the price that was paid for land plots of a similar quality or in a recent transaction in the given area (Hurrelmann, 2008). The price of agricultural land in Great Britain has a tendency to reflect 1) the profitability of raising animals, growing cultured crops, and 2) the effect of production subsidies and support of agricultural income. Factors that play a significant role here are a limited supply of land plots for sale (usually less than 0.2 percent of the total area each year), a strong demand for small land plots, and tax advantages of land ownership. In 2008, an increase in the number of purchases of land plots adjacent to family farms was seen, with the purpose of retaining savings from economies of scale and taking advantage of the exemption of agricultural land from inheritance tax. Prices of land plots will develop according to changes in the utilization of the area in the future. The main question is how to deal with arising conflict regarding the utilization of agricultural land for food, fuel and ecosystem services (Angus et al., 2009). The most significant factor in spatial fluctuation of agricultural land prices in Bulgaria is the proximity of land plots to settlements. In such cases, there is a significant increase in the prices of agricultural land up to approximately 100 m. from the edge of built-up areas. The highest prices are paid by purchasers for agricultural land plots directly adjacent to built-up areas. The willingness of farmers themselves to pay higher prices for agricultural land is also growing in cases where they themselves own agricultural land adjacent to transacted land plots. That then leads to a consolidation of land plots owned by one owner and to a decrease in the fragmentation of ownership relations. The fragmentation of land ownership is a negative factor that leads to decreases in agricultural profitability (Falco et al., 2010). Authors Lloyd et al. (1991) analyze land in terms of agricultural utilization. The most common factors (determinants) determining the price level of agricultural land are: land quality, availability of water on the land or in its vicinity, the option of lease and rent, the location of land plots, the size of the farm interested in land, the size of agricultural subsidies. Skaloš (2010) states that the spatial variability of prices of agricultural land is given by factors that reflect agricultural utilization, and also specific characteristics that are significant for the conversion of agricultural land to non-agricultural purposes. Despite the fact that motives for the acquisition of agricultural land for non-agricultural or speculative purposes are immense, non-agricultural utilization of agricultural land is usually a less significant driving force for the growth of prices of agricultural land.

A significant portion of agricultural businesses in the monitored regions are truly interested in the expansion of their business. The authors provide the following factors that affect transactions in agricultural land: (1) The number of potential tenants, i.e. the number of company and agrarian farms, (2) the quality of the agricultural land, (3) the physical accessibility and affordability of agricultural land in the region. The developing public registry of plans and maps is nevertheless creating a number of procedural obstacles that complicate transactions in land plots. Real estate agents do not have real access to information on market prices (Lerman, Shagaida, 2007). The main difference of Czech agriculture as compared to the EU 15 is a higher average area of businesses, non-family type farms, a high proportion of tenure, approximately half the intensity of agricultural production, and a significantly higher proportion of intermediate consumption. The competitive advantage is the size of the business and the lower price of land (Baška, 2010). Authors Buday et al., (2011) evaluate the development of the agricultural land market within the period of 2001-2009 in selected regions of Slovakia (12 districts). The analysis of market prices shows that land plots with small area sizes were sold for the highest prices, and the average market price falls with increasing area. More than 85% of farmed land is rented. Agreements on rent are entered into for 5-10 years. The largest area of agricultural land in Slovakia is farmed

by business companies and cooperatives. In an analysis of the factors affecting market prices of agricultural land in Slovakia (Buday, Bradáčová (2010), it was ascertained that the greatest effect is had by the size and location of a land plot, the manner of utilization and the amount of provided aid. A smaller effect on the amount of the market price is had by the quality of the land and the expended investments. In an analysis of the impact of CAP (Common agricultural policy) on the price of agricultural land and rent in EU states, the conclusion was formulated that the Single payment scheme has a greater effect on rent than on the price of agricultural land (Ciaian et al., 2010).

Materials and methods

1. The article was processed on the basis of the following materials

- Research reports and studies of the Institute of Agricultural Economics and Information (IAEI) in the area of statistical evaluation of the state of the agricultural land fund within the period of 1990-2011.
- Final annual and situational reports of the Ministry of Agriculture of the Czech Republic (MoA) from the years 1999, 2003, 2009, 2011, 2012.
- FAOSTAT-Agriculture database (FAO, 2013).
- Němec et al. "Analysis of the Evaluation of Agricultural Land Market up to the Year 2006". Editorially adjusted final report for the year 2007. Project NAZV QF 3081. Praha:IAEI, 2008.
- Vilhelm V. et al., Report on results of thematic assignment TÚ 22 (4233) "Development of the Agricultural Land Market and Identification of Factors Affecting the Development of Prices of Agricultural Land in the Conditions of the Czech Republic", Prague, December 2012, IAEI.

2. Utilized correlations, methods and procedures

- The basic methods of research are utilized in the article, such as the method of secondary data collection, analysis and synthesis of documents, comparison, qualified estimate.
- The article utilizes the Microsoft Excel 2007 software program and Statistica version 10. On the basis of the work with those programs, regression and correlation analysis is conducted, which proves or disproves the effect of factors affecting the price of agricultural land according to the specified hypotheses. As part of the regression analysis, the t-test is conducted, which tests the statistical significance of the absolute element and the beta coefficient of the function at a significance level of $\alpha = 0.05$. If the achieved significance is $p < 0.05$ for both elements, then the entire model is statistically significant. The zero hypothesis, representing a zero correlation between the analyzed variables, is ruled out. In the case of $p > 0.05$, it is possible to leave out from the analyzed values such values that show the greatest variances from the average analyzed values.
- Creation of prognoses according to the Statistika program, version 10.

Results and Discussion

1. Factors Affecting Market Prices of Agricultural Land in the World

Decrease of Agricultural Land

Market prices of agricultural land are growing all over the world in recent years. The decisive factors of this trend are the decrease in agricultural land per capita globally and, at the same time, the exponential demographic development. The decline in the state of agricultural land in the world within the past 19 years (the period of 1993-2011) is approximately 1.847 mil. ha. (FAO, 2013). The deterioration of agricultural land is occurring as a result of climatic changes, urbanization, growth in petroleum prices, the production of first generation biofuels, etc. On the other hand, the growth in demand for agricultural products may double by the year 2050 (Alterová, 2009). Such increase will have to be ensured with the current state of disposable resources of agricultural land or even with declining areas of arable land and a lack of water resources. This issue also relates to the level of the world population living in poverty – 1 billion people with an income of USD 1.25/per capita and day (Ravallion at al., 2009). The number of undernourished people is estimated to be at 870 mil. (UN, 2012). The factors of poverty will affect the growth of demand for food in the poorest countries of the world and thereby also the global demand for food. Growth of global prices of agricultural commodities within recent years was not affected only by the global recession,

but such prices grew even despite the record harvest of grains in 2009 (FAO, 2013). The growth in prices of agricultural commodities in 2007 and 2008 (FAO, 2013) brought about distrust on the part of grain importers in regard to global markets and thereby also the demand for agricultural land, or lease of agricultural land abroad for the purpose of ensuring their own food self-sufficiency. Research is showing that growth in the use of biomass, and primarily biofuels, leads to the growth of demands for agricultural land, primarily in tropical areas. In view of the growing global demand for food and other agricultural products, the demand for the use of arable land for the production of biofuels should also decline. (Bringezu, 2009)

The European Union also subscribes to such opinion, and proposes a fundamental change, pertaining to the restriction and utilization of first generation biofuels and the complete elimination of state subsidies for their production. However, current EU legislation does not allow this change until 2020. (Cabinet of the Czech Republic, 2012).

On the basis of regression analysis and FAOSTAT-Agriculture data on the area of agricultural land in the period of 1993-2011, a prognosis was conducted for the period until the year 2050 (Table 1).

Regression no. 1: The correlation that expresses the development of the state of agricultural land in the world in time. The years 1993-2011 correspond to the values of the independent variable $x \subset (1\text{-}19)$. The values of the independent variable of time $x \subset (20\text{-}58)$, correspond to the prognosticated years 2012-2050, which were subsequently inserted into the regression function $y = 4{,}931604.10^{9}\text{-}1{,}304737.10^{6}x$. In this way, the extent of agricultural land from the year 2012 until the year 2050 was prognosticated. Table no. 1 shows the example of the year 2012 (x = 20) with the prognosticated value of 4 905 509.415 thousand ha of agricultural land (Y_{20}) along with the possible variance value of 5% thousand ha.

The Examples of selected observed values of agricultural land (y)

Year: 2011: 4 911 622 650 ha

Year: 2012: 4 905 509 415 ha (y_{20})

Year: 2020: 4 895 071 517 ha (y_{28})

Year: 2050: 4 855 929 400 ha (y_{58})

According to a prognosis of the UN (FAO, 2013), the number of people on Earth will increase to 9.3 billion people by the year 2050. The development of agricultural land per capita globally in the years 1993-2011 (methodology 2.2.par.3,4) is set out in graph no. 1. While in 1993, there was 0.88 ha. per capita, in 2009 it was 0.72 ha., 0.70 in 2011, and in 2050 it may only be 0.52 ha.

An indicator of the growth of demand for agricultural land, as a result of the worldwide decrease of agricultural land per capita and its degradation, is, for example, the development of the index of prices of agricultural land (NCREIF Farmland Index). The average return on investment in land is estimated to be at 6-7 % annually (NCREIF, 2012). For the past 10 years, this Index has exceeded the return on investments in stock markets S&P 500. Dividend yield ranged from 1.8 - 2.2 % in 2007-2012 (Standard & Poor´s, 2013)

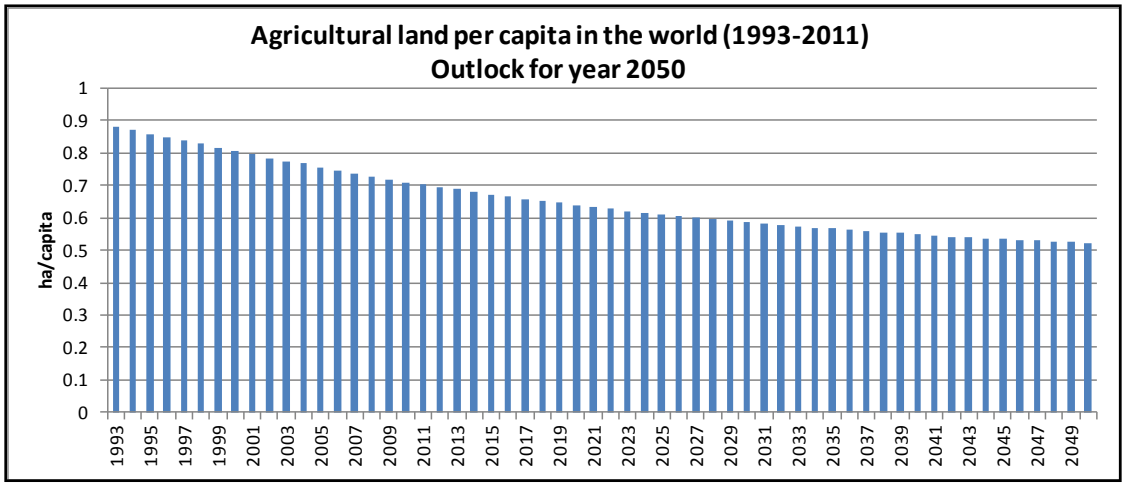
Note: *"The **NCREIF index** of prices of agricultural land is ascertained from quarterly time data and informs of the return on investments, is a measure of the performance of a large set of agricultural land plots acquired on the private market for investment purposes"(NCREIF, 2012).*

*The **S & P 500 Index** covers 75% of stocks in leading sectors of companies with a high level*

	in absolute terms	the regression coefficient (beta)	p-value of absolute member	p-value independent variable	
N=19	4.931604*109	(-)1.304737*106	0.0000000	0.008893	
	The regression function:		Agricultural land:	-0,95	0,95
X=20	y20= 4.931604*109-1.304737*106x		4 905 509 415	4 894 882 620	4 916 136 209

Legend:
y1 = dependent variable: the area of agricultural land in the world
x = independent variable: time (years 1993-2011).
N = number of values of the sample (1993-2011)
Results of t-test: p-value <0.05 is demonstrated a statistically significant model
Source: Statistica 10 software, data: database FAOSTAT-Agriculture (FAO, 2013)

Table 1: The Basic statistical characteristics of the development of the acreage of agricultural land in the world (hectares).



Source: Authors by Statistica 10 software, MS Exel, database FAOSTAT-Agriculture (2013), Methodology: 2.2 paragraph 3)

Graph 1: Agricultural land per capita in the world (1993-2011), outlock for year 2050 .

Selected states of the European Union	Slovakia	Czech Republic	Bulgaria	France	Belgium	Germany	Poland	EU average (25)
Leased land (% of the agricultural land fund)	90.9	83.8	83.0	75.1	67.9	63.3	22.VII	46.0

Source: Vilhelm at al. (2012)

Table 2: The proportion of leased agricultural land in the selected EU countries in the year 2007.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Netherlands	35713	37150	40150	34160	31432	30235	31276	35 969	40 916	47 051	-
Denmark	10330	12211	12920	14669	15995	18787	22791	27 112	31 652	25 919	-
Germany	9081	9427	9465	9184	9233	8692	8909	9 205	9955	10 908	11 854
Spain	7292	7553	8026	8553	9024	9714	10402	11 070	10 974	10 465	-
France[2)]	3590	3710	3860	3970	4110	4260	4370	4 900	5 160	5 130	5 230
Sweden	1989	1988	2019	2126	2455	3351	3706	3 957	4 181	3 748	-
Czech Republic > 5 ha	1611	1275	986	1121	1176	1245	1275	1 867	2 375	2 250	2 230
Slovakia	895	878	888	912	946	981	1017	1 121	1 211	1 256	-
Lithuania	294	321	468	390	406	536	734	831	1 075	971	-

[1)] conversion to the corresponding to the average rate for the years
[2)] in 2006, the prices of arable land
Source: MoA (2009b)

Table 3: The average price of farmland in the selected EU countries 27 (€/ha from LA)[1)].

of market capitalization (at least USD 4 billion) listed on United States stock markets.

2. Factors Affecting Market Prices of Agricultural Land in the EU

Market prices of agricultural land and the level of rent are, to a great extent, affected by historical development, size structure of agricultural land plots, location, traditions, legislation, etc. in the individual EU states. For such reasons, the comparison of the development of prices provided by Eurostat is very difficult. Statistical data on prices of agricultural land provided by Eurostat are acquired on the principle of optionality from individual EU member states, without there being a uniform methodology for the monitoring of such data, and thus their validity in terms of comparability is limited. In terms of the structure of agricultural land plots and the high proportion of leased land, prices in the Czech Republic are comparable to Slovakia, the new federal lands of Germany, and the other new EU member states (Tab. 2, 3). Common for all of the EU states is the fact that the proportion of leased land is

lower among small farms and higher among large agricultural businesses (Vilhelm, 2012).

The average annual rate of growth of prices in selected EU countries ranged from 4-8%, with the exception of Denmark and Lithuania (20-26%). Greater interest on the part of investors in purchasing agricultural land, as a favorable investment, was seen as a result of the economic crisis primarily in countries with higher economic performance, e.g. in Germany.

2.1. Czech Republic

Market prices of agricultural land were undervalued on a long-term basis, and it was therefore anticipated that they would grow not only because of their gradual balancing out with adjacent states, but also as a result of the worldwide trend. The Czech agricultural land market is, in terms of the structure and other conditions, unattractive for large investors. Foreigners who purchased agricultural land for the purpose of doing business in agriculture in the Czech Republic made such purchases prior to the termination of the moratorium (2011) by way of legal entities. In 2010, there were 378 farms with foreign participation within the territory of the Czech Republic, which farmed on (not owned) 230 thousand ha. of agricultural land (i.e. approximately 6.5% of the total farmed area of agricultural land). The area of agricultural land and the numbers of owners with permanent residence abroad for the year 2012 were ascertained on the basis of data for a selected set of owners (Table 4). That represents approximately 6% of all owners of all agricultural land and approximately 14% of the area of agricultural land in the Czech Republic according to the cadastral records (in 5 districts: Prague – east (Praha – východ), Klatovy, Havlíčkův Brod, Znojmo, Olomouc). The purchase of agricultural land by foreigners was not considered to be significant in any of the 5 selected districts in terms of the development of prices of agricultural land. (MoA, 2012)

Economic Factors

The lesser interest of farmers in expanding their farms in the period of 1990-2004 was affected mainly by the following economic factors: a lack of capital and its low rate of return in agriculture (2-3% p.a.), unclear and unstable agricultural policy, an excess of the supply of agricultural commodities over demand within the EU, the state of land adjustments and lower subsidies as compared to the EU-15 countries. Land adjustments have a significant effect on increases in the market price of agricultural land plots, primarily because of the specification of ownership of land plots in regard to area and location, the option of integration of land plots, real division of co-ownership, increased access to land plots, creation of a network of field roads, execution of new lease agreements and thereby an increase in the effectiveness of doing business in agriculture. As of 31 December 2010, the status of completed comprehensive land plot adjustments (i.e. the comprehensive resolution of an entire cadastral area) in the Czech Republic was 505 744.87 ha. of agricultural land (MoA, 2011b). The agriculture land market was suppressed by a low rent price, determined by large business companies, which thereby also influenced the price of agricultural land plots.

Effect of Official Price on the Level of Market Prices of Agricultural Land

The institute of the official price of agricultural land was introduced in the Czech Republic in 1990, primarily for the purposes of settling restitution claims and for tax purposes. Official prices express the production capability of lands (quality) and were calculated by way of the yield method. They are regulated by Act No. 151/1997 Coll., on appraisal of property including implementary Ministry of Finance Decree No. 364/2010 Coll. and Ministry of Agriculture Decree No. 412/2012 Coll., on the setting of a list of cadastral areas with assigned average basic prices of agricultural

	The quantity	%
The total quantity of owners of agricultural land	172 396	100
- which of the number of owners with permanent residency in the foreign countries	1 443	0.84
Total agricultural land area (ha)	592 089	100
-of which area of the LA owner residing abroad (ha)	2 725.28	0.46

Source: MoA (2012)

Table 4: Number of farms and acreage owners residing abroad (2012).

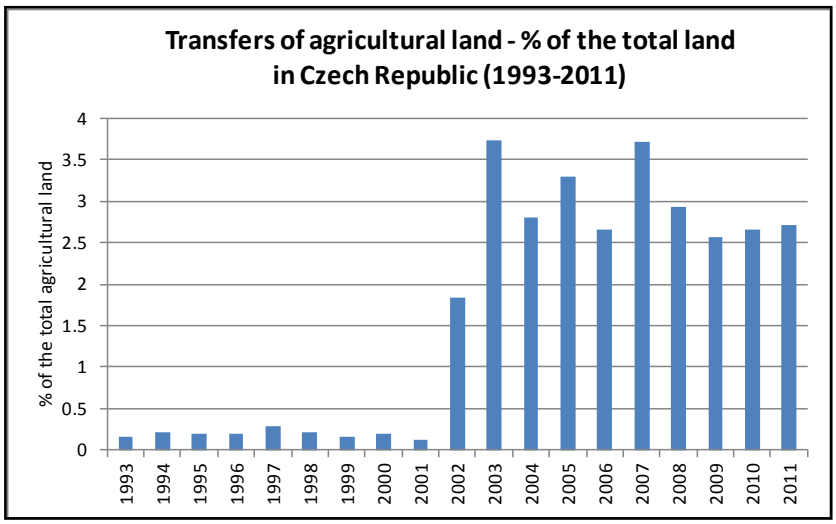
land plots, as amended. The existence of official prices of agricultural land affected, to a great extent, the level of market prices (primarily among land plots of over 5 ha.) because of the low level of the agricultural land market. The absence of experience on the part of owners in regard to doing business pertaining to agricultural real estate often led to unilaterally very unfavorable business transactions. The basis of market prices up to the year 2000 was, to a great extent, official prices, and in the size category of over 5 ha. (for agricultural use) they fluctuated below the threshold of the official price. For example, in the year 2000, the average market price of land plots in the Czech Republic, purchased for agricultural use (CZK 3.04/m2), was at 60% of the average official price.

Transformation of Agriculture, Privatization of Land

In the period of 1990-2000, the agricultural land market was, to a great extent, affected by restitutions, the privatization of land, and the transformation of cooperatives. The transformation process brought about a high level of fragmentation in the ownership of the agricultural land fund – approximately 2.5 mil. owners (MoA, 2001) and thereby also an excess of the supply of agricultural land over demand. The most purchased were land plots with an area of up to 0.10 ha. with the option of transformation into a building plot, and least purchased were those with an area of over 5 ha, primarily for agricultural market use (MoA, 1999). The low area size of land plots being sold (e.g. 0.72 ha. in 1999; MoA, 2001) negatively affected the amount of the market price. The above factors affected the low level of the agricultural land market in that period and thereby also the market price. Market prices of land plots were significantly higher for land plots of up to 1 ha., as much as a hundred-fold, up to 5 ha. as much as ten-fold as compared to the average market price of agricultural land plots. The average market price of land for agricultural use (1993-2003) was CZK 4.59/ m2, the average market price of land plots being sold overall (1993-2003) was CZK 24.36/m^2 (MoA, 2003).

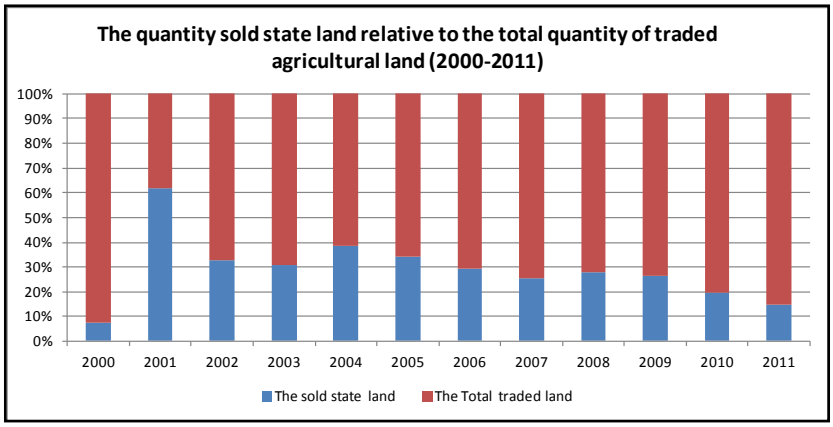
The period of 2001-2011 explains price changes on the agricultural land market after the introduction of the law on the sale of state land into practice (1999) and after the accession of the Czech Republic to the European Union. The sale of government land played a significant role share in the development of the agricultural land market for agricultural use in the Czech Republic. The development of the proportion of transactions out of the whole agricultural land fund (% of the agricultural land fund) is shown in graph 2,3.

For the comparison of market prices in the government and private sector (graph 4), various sources of information on market prices were utilized, i.e. the Czech Statistical Office, UZEI, and the Ministry of Agriculture. The development of market prices in the period of 2004-2011 shows that the support



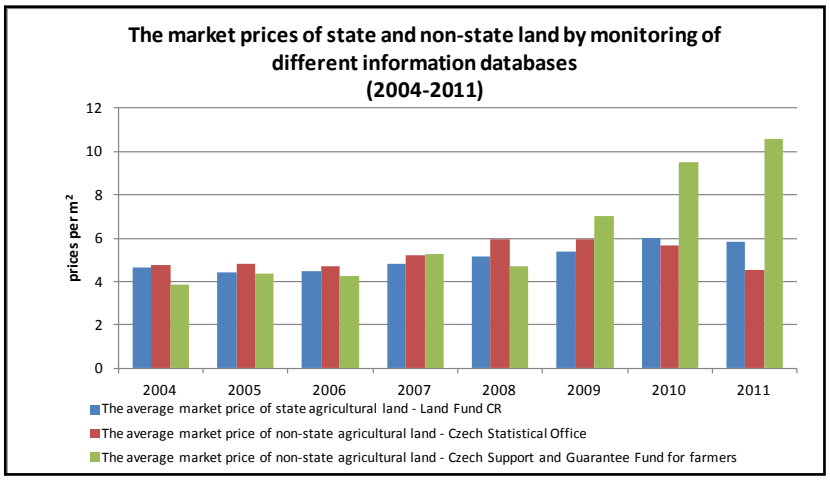
Source: Authors by Němec at al. (2008), MoA (2012)

Graph 2: Transfers of agricultural land - % of the total land in Czech Republic (1993-2011).



Source: Authors by Němec at al. (2008), MoA (2012), LF CR (2012)

Graph 3: The quantity sold state land relative to the total quantity of traded agricultural land (2000-2011).



Source: Authors by MoA (2012), LF CR (2012)

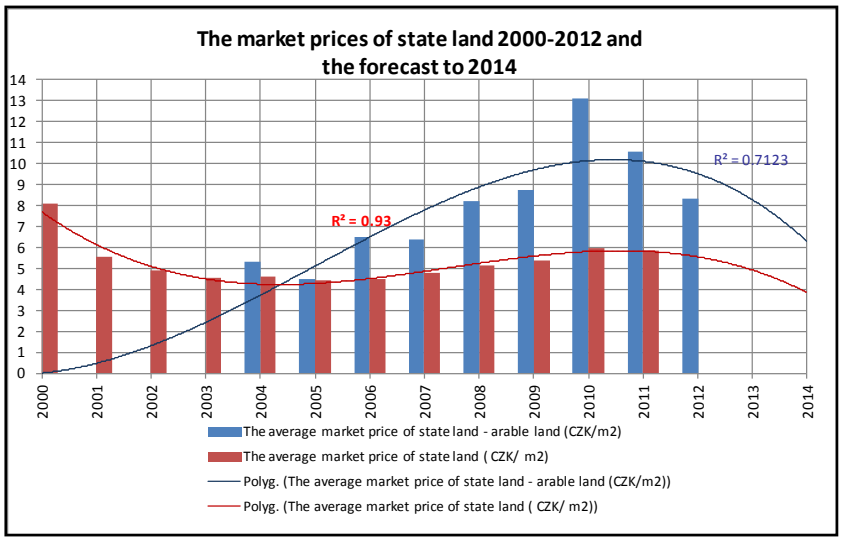
Graph 4: The market prices of state and non-state land by monitoring of different information databases (2004-2011).

of the purchase of land in the private sector by way of the Supporting and Guarantee Agricultural and Forestry Fund (SGAFF) affected the demand for agricultural land for business in agriculture and, overall, through the effect of subsidies, lowered the market price for the buyer and provided better availability of loans for the purchase of land.

There is little access to quality sources of information on prices of agricultural land in the Czech Republic. There is no database containing complete information on business relationships (price of land, size, purpose of use, type of business person, etc. …). Price development is monitored by the Czech Statistical Office, UZEI and the Ministry of Agriculture with different results (graph no. 4).

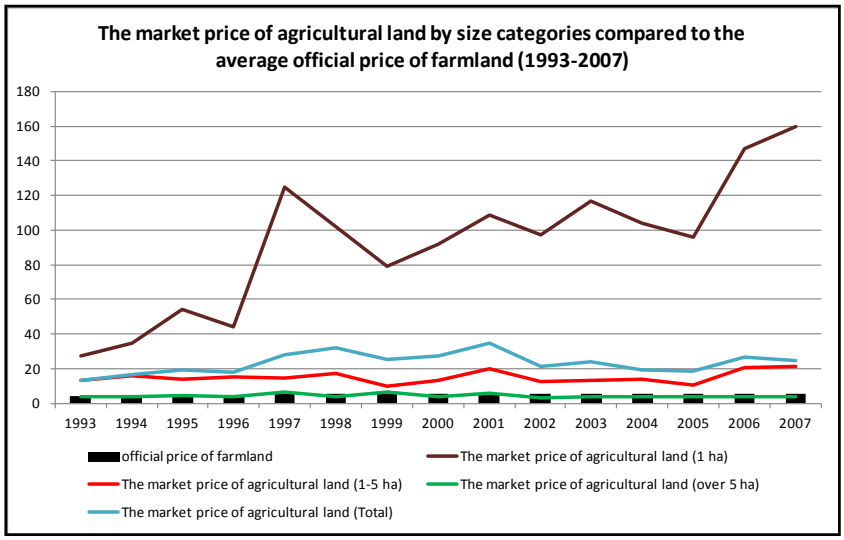
From the year 2000 until 2012, approximately 90% (out of 600 thousand ha.) of state agricultural land (MoA, 2011a), intended for agricultural use, was sold. Currently, prices of privatized land are stagnating, as the remaining portion of the land being offered is of worse quality and thus less appropriate for agricultural use. The price of state land, they will be falling by approximately 30% within the period of the next 3 years (to 2014) (graph no. 5), while the prices of agricultural land for non-agricultural use will grow (graph no. 6).

When evaluating the development of the agricultural land market is necessary to take into account the effect of Act No. 503/2012 Coll. The State Land Office, Section 15th *„To ensure the unpaid purchase price*



Source: Authors by LF CR (2012), Vilhelm at al. (2012)

Graph 5: The market prices of state land 2000-2012 and the forecast to 2014.



Source: Authors by MoA (2009b)

Graph 6: The market price of agricultural land by size categories compared to the average official price of farmland (1993-2007).

of agricultural land or part of the state will have a lien on the transferred agricultural land at the time of transfer of land,, (§ 15, article 1). „The pre-emption right of the State ceases payment of the purchase price of the land, but not before the expiry of 5 years from the date of deposit of title to land in the real estate in favor of the acquirer (§ 15, article 2).“ At this legislation expected many purchasers of state land to live out their land for favorable pricing terms to sell at current market prices . Another important factor is the attitude of the Church and the question of what to do having been restored to agricultural land acquired under the restitution of church property pursuant to Act No. 428/2012 Coll .

It is likely that in the period of economic crisis as well as in view of the situation on global stock markets, investors will be seeking a commodity that will ensure a stable and long-term return. A proposal of how to support the development of the agricultural land market primarily for agricultural use in the Czech Republic in terms of tax savings is published by the authors in their work (Gebeltová, Pletichová, 2012).

Bonita of Land

In the period of 1993-2007, the market price of agricultural land with an area of over 5 ha. ranged within the interval of values of CZK 3.4/m2 (2002) to CZK 6.57/m2 (1999). As prices in this size specification represent land for agricultural use, they are compared with the average official price of the same period (an interval of CZK 4.49/m2, 1993 to CZK 5.33/m2, 2007). The value of the average official price is, for the past eleven years of monitoring (1997-2007), in the same amount CZK 5.33/m2. The price decree in the Czech Republic is updated every year, but, nevertheless, the BPEJ appendix with assigned official prices remained in an unchanged form.

According to IAEI (MoA, 2012), the main factor that affects the average market price of agricultural land, regardless of size differences, is the quality of the land (yield rent). Qualitative evaluation of land is expressed by way of the BPEJ code. If the BPEJ has not changed in eleven years and nevertheless the average market price of agricultural land is increasing (graph 6), it means that:

a) If the IAEI statement applies, that the average price of agricultural land is determined primarily by quality, then the official price does not plausibly reflect the production capability of agricultural land (the authors) or:

b) The correlation between the market price and the official price is insignificant and there are still other, more significant factors that affect prices. For example, the size of the land plot, the location of the land plot in regard to an urban agglomeration, subsidies, etc. (Vilhelm et al. 2012, the authors).

The results of regression (the correlation of the average official price of agricultural land and the average market price of agricultural land):

The required significance $p < 0.05$ (methodology 2 par. 2) was not achieved for any one of the elements of the regression function (p-value of the absolute element: 0.9168, p-value of the regression coefficient: 0.4517). A zero correlation (effect) between the analyzed variables was confirmed.

Because of identical values of the official price of land in the course of eleven years, it was not possible to conduct even the statistical correlation between average official prices and the average market price of state land.

In view of the fact that privatized land is intended for business in agriculture, the prices of land plots in the size category of over 5 ha. were used for the analysis, which represent the purchase of land plots for agricultural use. Land plots in this size category mirror the development of the average official price (graph no. 6). Through analysis, it was confirmed that the official price affects the market price of state land.

Conclusion

It took 20 years for the agricultural land market in the Czech Republic to get to the level that is normal within the EU. In 2011, approximately 2.72% of agricultural land was transacted in the Czech Republic out of the total agricultural land fund. (MoA, 2011a). The average market prices of agricultural land regardless of its utilization increased from **CZK 13.90/m²** in 1993 (MoA, 1999) to **CZK 24.58/m²** in 2007 (MoA, 2009b).

The effect of quality on the market price of agricultural land was proven only in the case of the sale of state land, which is significant in terms of the purpose of its use. For the average market price of agricultural land, a correlation to the quality of the land for agricultural use was not established, which may show that the official price does not objectively express the production capability of land because of the absence of the gradual objective reflection of the effect of economic factors in the official price.

The analysis shows that the development of the market and the market price of agricultural land were significantly affected by the privatization of agricultural land (graph 2,3).

Despite the fact that market prices of agricultural land in the Czech Republic were deformed by state intervention and subsidies provided for agricultural land from EU funds and the PGRLF more than in the 1990's, the decision regarding the privatization of land in 1999 was correct. The proportion of transacted agricultural land in 1993 was 0.17%, and in 2003 3.74% of the total land fund (Němec at al., 2008, MoA, 2009b). An important fact is that the demand increased primarily for land for agricultural use, which is a priority in terms of the protection of the agricultural land fund and the efficiency of agriculture.

In the Czech Republic, market prices of agricultural land for agricultural use fluctuate within

the interval of CZK 7-15/m^2 (RSA, 2012).

A negative factor for the analysis of market prices of agricultural land in the Czech Republic is an absent information system regarding the agricultural land market. There is little access to quality sources of information on prices of agricultural land in the Czech Republic. There is no database containing complete information on business relationships (price of land, size, purpose of use, type of business person, etc.…) Price development is monitored by the Czech Statistical Office, UZEI and the Ministry of Agriculture with different results. The authors of the article suggest the creation of a central database of market prices, the size of land being sold, quality and anticipated manner of use of land plots. Such information could be monitored by cadastral offices along with registration of land plots in the real estate register for individual cadastral areas. It is useful for the above information to be publicly available for potential owners of agricultural land, leaseholders, researchers, the banking sector and government administration.

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References

[1] Alterová, L. Volání po potravinové bezpečnosti, Zemědělec: special and professional weekly, 2009, 17, No. 5, p. 4, ISSN: 1211-3816.

[2] Angus, A., Burgess, P. J., Morris, J., Lingard, J. Agriculture and land use: Demand for and supply of agricultural commodities, characteristics of the farming and food industries, and implications for land use in the UK, Land Use Policy, Supplement 1, December 2009, Vol. 26, pp. 230 - 242, ISSN: 0264-8377.

[3] Bringerzu, S., Schütz, H., Arnold, K., Merten, F., Kabasci, S., Borelbach, P., Michels, C., Reinhardt, G.A., Rettenmaier, N. Global implications of biomass and biofuel use in Germany – Recent trends and future scenarios for domestic and foreign agricultural land use and resulting GHG emissions, Journal of Cleaner Production, Supplement 1, November 2009, Vol. 17, pp. 57- 68, ISSN: 0959-6526.

[4] Buday Š., Bradáčová K. Faktory vplývajúce na rozvoj trhu s pôdou na Slovensku. Collection of papers from seminar Vliv zemědělské politiky EU na využívání půdního fondu a rozvoj venkova. Špindlerův Mlýn, CR. VUZE Prague, 2007, p. 57-63. ISBN 978-80-86671-73-7.

[5] Buday, Š., Krausová,G., Rybár,V. Tendencia rozvoja trhu s pôdou a hospodárenie na pôde v podmienkach EÚ, in Land in 21st century: evaluation and appraisal of agricultural land in the context of natural ressource conservation, Collection of papers of international seminar, 1. -2. 11. 2011, IAEI, Prague, 2011, pp. 13 - 23, ISBN 978-80-86671-85-7.

[6] Ciaian, P., Kancs, D., Swinnen, J. F. M. EU land markets and the Common agricultural policy. Centre for European policy studies. Brussels. 2010. p. 343. ISBN 978-92-9079-963-4.

[7] Deininger, K., Sarris A., Savastano, S., Rural land markets in transition: evidence from six Eastern European Countries, Quarterly Journal of International Agriculture, 2004, 43 (4), Pages 361–390, ISSN: 00498599.

[8] Duke, J., M., Marisová, E., Bandlerová, A., Slovinska, J. Price repression in the Slovak agricultural land market, Land Use Policy, January 2004, 21, 1, pp. 59 - 69, ISSN: 0264-8377.

[9] FAO (2013), FAOSTAT – Agriculture, available: http://faostat.fao.org/site/291/default.aspx, online: April 2013.

[10] Government CZ (2012), available: https://www.euroskop.cz/8961/21269/clanek/komisari-potvrdili-budouci-omezeni-spotreby-biopaliv/, online: February 2012.

[11] Gebeltová, Z, Pletichová, D: Proposal of the Creation of Resources for the Maintenance of the Production Capability of the Agricultural Land Fund by Way of Tax Savings. Agris on-line, 2012, No 4 - special, p. 37-48, ISSN 1804-1930.

[12] Hurrelmann, A., Analysing agricultural land markets as organisations: An empirical study in Poland, Journal of Economic Behavior & Organization, July 2008, Vol. 67, 1, pp. 338-349, ISSN: 0167-2681.

[13] Lerman, Z., Shagaida, N., Land policies and agricultural land markets in Russia, Land Use Policy, January 2007, Vol. 24, 1, pp. 14-23, ISSN: 0264-8377.

[14] LF CR. The Land Fund of the Czech Republic, available: www.eagri.cz, online: December 2012.

[15] Lloyd, T. A. , Rayner, A. J., Orme, C. D. Present value model of land prices in England and Wales, European Review of Agricultural Economics, 1991, Vol. 18, 2, pp. 141-166, ISSN: 01651587

[16] Medonos, T., Vilhelm V., Hruška, M., Jelínek, L. Faktory ovlivňující vývoj cen zemědělské půdy v České republice – regionální pohled, in Land in 21st century: evaluation and appraisal of agricultural land in the context of natural ressource conservation, Collection of papers of international seminar, 1. -2. 11. 2011, IAEI, Prague, 2011, pp. 78 - 87, ISBN 978-80-86671-85-7.

[17] MoA. Ministry of Agriculture, Prague, 1999, Situation and Outlook report – Land, ISBN 80-7084-800-5.

[18] MoA. Ministry of Agriculture, Prague, 2003, ISBN 978-80-7434-005-5.

[19] MoA (2009a). Ministry of Agriculture, Prague, 2009, ISBN 978-80-7434-005-5.

[20] MoA (2009b). Ministry of Agriculture, Prague 2009, Situation and Outlook report – Land, ISBN 80-7084-800-5.

[21] MoA (2011a), Ministry of Agriculture, Prague, 2011, ISBN 978-80-7434-005-5.

[22] MoA (2011b). Pozemkové úpravy, 2. updated issue, MoA CR, 2011, ISBN 978-80-7084-944-6.

[23] MoA. Ministry of Agriculture, Prague 2012, Situation and Outlook report – Land, ISBN 80-7084-800-5.

[24] Němec, J. Bonitace a oceňování zemědělské půdy ČR, VUZE Prague, 2001, ISBN 80-85898-90-X.

[25] Němec, J. et al. Analýza hodnocení trhu se zemědělskou půdou do roku 2006. Editorially adjusted final report 2007. Project NAZV QF 3081. VUZE, Prague: 2008.

[26] NCREIF, 2012. The National Council of Real Estate Investment Fiduciaries, available: https://www.ncreif.org/farmland-returns.aspx, online: January 2013.

[27] Rejfek, F. et al. Bonitace čs. zemědělských půd a směry jejich využití: Stanovení úředních cen zemědělské půdy – Vol. 5., MoA CR, Prague, 1990.

[28] Skalos J., Engstova B. Methodology for mapping non-forest wood elements using historic cadastral maps and aerial photographs as a basis for management, 2010, Journal of Environmental Management, 91, 4, pp. 831 - 843, ISSN: 0301-4797.

[29] Sklenicka, P., Molnarova, K., Pixova, K., C., Salek, M., E. Factors affecting farmland prices in the Czech Republic, Land Use Policy, January 2013, Vol. 30, 1, pp. 130 - 136, ISSN: 0264-8377.

[30] Standard & Poor`s. available: http://www.standardandpoors.com/indices/sp-500/en/us/?indexId=spusa-500-usduf--p-us-l--, online: May, 2013.

[31] Střeleček, F., Lososová, J., Zdeněk, R. Výše pachtovného v závislosti na struktuře výroby, in Land in 21st century: evaluation and appraisal of agricultural land in the context of natural ressource conservation, Collection of papers of international seminar, 1. -2. 11. 2011, IAEI, Prague, 2011, pp. 67 - 77, ISBN 978-80-86671-85-7.

[32] Ravallion, M., Chen S., Sangraula, P. Dollar a day, The World Bank Economic Review, 2009, pp. 163-184, Online ISSN 1564-698X, Print ISSN 0258-6770.

[33] RSA. Real estate agency, available: www.farmy.cz, online: October 2012.

[34] TP fund (2011). Traxis Partners hedge fund, available: www.HedgeLists.com, online: January 2012

[35] UN. The State of Food Insecurity in the World 2012, Food and Agriculture Organization of the United Nations, 2012, ISBN 978-92-5-107316-2.

[36] Vilhelm V. et al. Vývoj trhu se zemědělskou půdou a identifikace faktorů ovlivňujících vývoj cen zemědělské půdy v podmínkách ČR". Topical task 22 (4233), December 2012, IAEI, Prague.

[37] Vopravil, J. et al. Systém bonitovaných půdně ekologických jednotek – současnost a jejich Budoucnost, in Land in 21st century: evaluation and appraisal of agricultural land in the context of natural ressource conservation, Collection of papers of international seminar, 1.- 2. 11. 2011, IAEI, Prague, 2011, pp. 93 - 100, ISBN 978-80-86671-85-7.

[38] Zákon č. 503/2012 Sb. o Státním pozemkovém úřadu, available: http://www.sbirka.cz/POSL4TYD/NOVE/12-503.htm, online: May 2013

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The Importance of Congress Tourism for Regional Development

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Anotace

Kongresová turistika je jedním z nejrychleji se rozvíjejícím a nejvíce ziskovým odvětvím cestovního ruchu v dnešní době. Tento dokument vytvoří kvalitativní a kvantitativní analýzu tohoto odvětví v Bulharsku a v České republice na základě provedeného pozorování a získaných dat ze spolehlivých zdrojů na národní a mezinárodní úrovni. Obecně lze konstatovat, že tendence rostoucího počtu setkání - kongresy, konference – lze získat v obou zemích a mnohem vyšší hodnoty jsou pro Českou republiku, v porovnání s Bulharskem. Vyrovnání se v obou zemích pro následujících 5-10 let neočekává. Při současné ekonomické situaci lze očekávat v obou zemích stagnaci na současném stavu. Rozvoj kongresové turistiky významně ovlivňuje také kvalita website ve sledovaných zemích. Stav kongresové turistiky v České republice je ovlivněn také poskytovanými informacemi na website.

Klíčová slova

Kongresová turistika, porovnání, Bulharsko, Česká republika, počet setkání, kvalita website.

Abstract

Congress tourism is one of the fastest developing and most profitable industries in the tourism sector nowadays. This document creates a qualitative and quantitative analysis of the sector in Bulgaria and the Czech Republic on the basis of observations and data obtained from reliable sources at national and international level. In general, the tendency of increasing the number of meetings - congresses, conferences - can be obtained in both countries and much higher values for the Czech Republic in comparison with Bulgaria. Equalization in both countries for the next 5-10 years is not expected. Under the current economic situation it can be expected to remain in the state of stagnation in both countries. Development of congress tourism significantly affects the quality of website in the countries. Status of congress tourism in the Czech Republic is also influenced by the information provided on the website.

Key words

Congress tourism, comparison, Bulgaria, the Czech Republic, number of meetings, quality website.

Introduction

Congress tourism is one of the fastest developing and most profitable industries in the tourism sector nowadays. According to the statistics of the World Tourism Organization (WTO) the share of congress tourism represents 10-12% of the overall number of business trips, whilst the research on behalf of the Meetings and Conventions Magazine 2003 states that congress industry only generates about 16 billion dollars attracting 12.5 million people (Ford, Pepeer, 2007). For the last few years a tendency of increasing the intensity of congress tourism within member countries of the European Union (EU) has also been observed. The considerably higher revenues attracted by this sector determines its priority on national and international scale. This is mainly due to the high budgets which corporative and other well-off clients spend on business meeting attendances. This paper focuses on the particular development of the sector in Bulgaria and the Czech Republic as two comparable examples following the same rising trend. The aim of this work is to present comparative characteristics for both countries based on analysis of data from national and global sources, to compare the websites of both countries

presenting congress tourism, to assess their quality and possibilities for expanding the influence of congress tourism in regional development in both countries.

Tracing back the process of congress tourism development as far as 2007, when Bulgaria became a member of the EU, the data for both countries show similar characteristics. The approaches used in this study are the qualitative and quantitative approaches. The analysis is based on thorough observations and statistics taken from reliable sources such as the Institute of Analysis and Assessment in Tourism (Bulgaria), the International Congress and Convention Association (ICCA), the Czech Statistical Office (CZSO). Additional data are obtained via information bulletins, revues of relevant papers, articles and web sites. It will also compare the quality of the websites that attract congress tourism in both countries. Social program will be used for conferences with a view to intensifying the region‘s competitiveness, improve its image, increase tourism and more. The development of congress tourism and its impact on regional development mainly describes Oppermann.

„Web interface, transaction services, security, administration and personalisation - tools of his kind belong to the so-called portal core services. The aim of which is to ensure correct access to other services in the required quality and according to these of individual users“ writes Havlíček. Štědroň characterized by then for disclosure of information for the development of individual regions also associated with the development of tourism. Problems connected with congress tourism, congress tourism website evaluation and rural development are also discussed in the works of Hennyeyová, Brožová, Zalatev. „The creation, operation and mainten and information system destination depends primarily on formation needs and demands of users who use the system. The creation and mainten and CEO use information strategy that represents a functional strategy destination“ writes Palatková.

Material and methods

The methods of deduction and comparative analysis have been used aiming at the formulation of models appraising congress tourism competitiveness. To assess the quality of a website will be used indicators of search sites, web accessibility and user interface (intuitiveness, graphics).

The main objective of the present paper is to analyze congress tourism potential in the targeted countries. The integration of common problems and their solving will lead to improving the present state of the sector in question. On the other hand, this study will spread already existing information and insure its wider circulation among stakeholders.

The geographical situation of Bulgaria being the only European Balkan country bordering the Black sea to the east and the Danube River to the North, defines its strategic position in the region and contributes to the development of tourism as a whole. Moreover, the financial aspect for both conference events organizers and attendees is quite appealing because of the lower package rates compared to those of West European countries.

The congress tourism in Bulgaria has been developing in modern venues which foster its successful realization on the Bulgarian market. The great number of expo and congress centers adds a lot to this issue, so do the conference halls, expo initiatives and festivals.

Exhibitions and events with international participation take place annually. Among these the following can be mentioned: “Banks, Investments and Money”, “Agriculture and Everything about It”, “Protection and Security”, The “Eneco” Energy and Ecology Expo, “World of Furniture”, the Plovdiv International Technical Fair, “Aquatex” – Technology and Water Management Expo, “Eltex” – Electronics and Electro-technology, “Infotex” – Informational Technology, “Web Expo”, etc.

At the same time the Czech Republic enjoys the major advantage of its ideal position in the heart of Europe. The country is aware of the importance of congress industry; it is one of the most dynamically developing economic activities worldwide. Dozens of international flights are scheduled to Prague every day, and the capital city has also become a major destination for budget airlines. Coming to the Czech Republic is fast, inexpensive and convenient. Modern hotels have been built, offering a wide range of conference facilities and modern service facilities. The Prague Congress Centre has been extensively modernized, and the international airport has also been expanded and has extended its services.

Compared to the annual events taking place in Bulgaria, the most significant events defining the Czech Republic as one of the top congress destinations in Europe are: the Annual Meeting

of the International Monetary Fund and the World Bank in September 2000, the NATO Summit held in autumn 2002, the meeting of the International Olympic Committee in June and July 2003, the Microsoft Security Summit in 2004, the 16th Annual Euro Meeting of the Drug Information Association held in March 2004, or the 14th European Congress of Clinical Microbiology and Infectious Diseases.

Results and discussion

Analysis based on national databases

As presented in Table 1, a total number of 11850 events related to congress and conference tourism were held in 2011 in Bulgaria, which forms a growth of 13% compared to 2010. It is expected that the number of events for 2012 should be 11604 which makes a decrease of about 2% compared to 2011. Table 1 reveals that the number of events was highest for 2009. This was due to the fact that parliament elections took place in Bulgaria in that year. The data for 2009 and 2010 presenting the number of conferences have a striking difference – while the number of events for 2009 was 2340, that for 2010 was 105. Another reason for the peak figures for 2009 was the sustenance of the PHARE Program for Bulgaria along with 12 other EU Programs related to regional conferences on competitiveness, etc.

Table 2 presents the number of meetings and participants in conferences held in the Czech Republic for the same period of time. The data has been taken from the Czech Statistical Office. There is an obvious tendency of increasing the number of conferences – from 2831/2008 to 10601/2011. The numbers show an approximate 3,7-fold increase.

After comparing the data from tables 1 and 2 a conclusion has been drawn that for the past 4 years there has been a strong tendency for increasing the number of conferences. At the same time it has to be considered that the figures for 2008 and 2009 for Bulgaria do not represent the realistic situation for reasons mentioned before.

The analysis of the number of conferences for both countries for 2010 and 2011 shows a similar up-growing trend. For Bulgaria the figure for 2011 is 70,5% higher than that for 2010. While for the Czech Republic the increase for the same period equals to 4,5%. The great difference of the level in the development of congress tourism in the Czech Republic and Bulgaria is due to the fact that the Czech sector is already highly developed while Bulgarian congress tourism is still paving its way and it is done at a higher speed.

Table 3 refers to the number of participants for Bulgaria in 2011. Their number varies according to the nature of the event. The table represents the total number of participants in the presented events along with detailed average number of participants in each event.

The comparison of figures in tables 2 and 3 referring to the average number of participants in conferences for 2011 shows that for the Czech Republic it is

Event	2008	2009	2010	2011	2012*
Congresses	158	296	147	195	148
Conferences	1,230	2,340	105	179	128
Forums	26	34	29	41	39
Seminars	3,240	3,508	3,720	4201	4,232
Panels	33	42	124	232	252
Institutions	317	347	402	433	524
Exhibitions	2,240	1,890	2,145	2750	2,340
Halls	9	12	15	15	15
Fairs	17	11	14	16	17
Exchange	12	10	7	7	12
Meetings	3,860	3,440	3,560	3780	3,897
Total	11,142	11,930	10,268	11,850	11,604

Source: Data from Institute of Analysis and Assessment in Tourism
* Expected

Table 1: Number of congress and conferment events in Bulgaria 2008-2012.

Year	Number of conferences	Number of participants
2008	2831	761,901
2009	9411	1,192,909
2010	10,146	1,295,287
2011	10,601	1,350,459

Source: Data from the Czech Statistical Office

Table 2: Number of meetings and participants in the Czech Republic 2008-2011.

Event	Total Number of participants	Avarage number of participants
Congresses	17,750	119
Conferences	8,448	66
Forums	1,755	45
Seminars	50,784	12
Panels	14,112	56
Institutions	39,824	76
Exhibitions	84,240	36
Halls	480	32
Fairs	1,717	101
Exchange	276	23
Meetings	300,069	77
Total	519,455	-

Source: Data from Institute of Analysis and Assessment in Tourism

Table 3: Number of participants in 2011.

127 while for Bulgaria it amounts to 66. Some of the main reasons for these results are the following:

- Conferences in the Czech Republic are on grater scale (more participants per event);
- The Czech conference centers as a whole have had a longer tradition and are more popular among organizers and participants;
- Fewer Bulgarian conference centers may host a great number of participants.

Analysis based on the International Congress and Convention Association

In accordance with ICCA's data base for the period 2000-2009, Bulgaria occupies the 70th position in the World Ranking for number of meetings. Fluctuation of meetings number is observed through the years whilst the number of participants for 2009 decreases sharply. This tendency is not surprising for the fact that most European countries also show the same trend (Spain, UK, Belgium, Portugal, the Czech Republic, etc.). According to ICCA, the latter can be partially explained with a decrease of popularity of European destinations for holding meetings and congresses and increase of interest towards venues in Asia, Africa and South America.

In 2010 and 2011 there is an increase as refers to the number of meetings for Bulgaria although it is ranked 7 positions lower in the World Ranking – from position 60th to 67th. The European Ranking reports the same tendency for Bulgaria during the last couple of years but this time it is only one position lower – from position 30th (2010) to position 31st (2011).

The same analysis for the Czech Republic shows that the country occupies 28th position in the World Ranking for the period 2000-2009. The year with highest number of meetings held is 2006 – 119th . On European level, the Czech Republic ranks 18th for 2010 and 30th on world level. The situation is slightly changed for 2011 when the country ranks 31st on world level and 19th according to the European level.

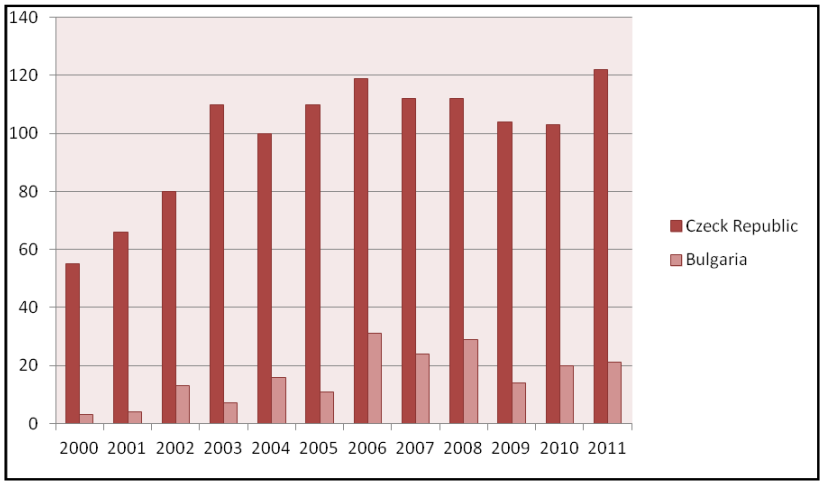
The comparison of the number of meetings for Bulgaria and the Czech Republic

for the period 2000-2011 is clearly displayed on graph 1. In general, the tendency of growing and decreasing the number of meetings is preserved for both countries although the values are much higher for the Czech Republic compared to those for Bulgaria.

Effect of congress tourism on regional development

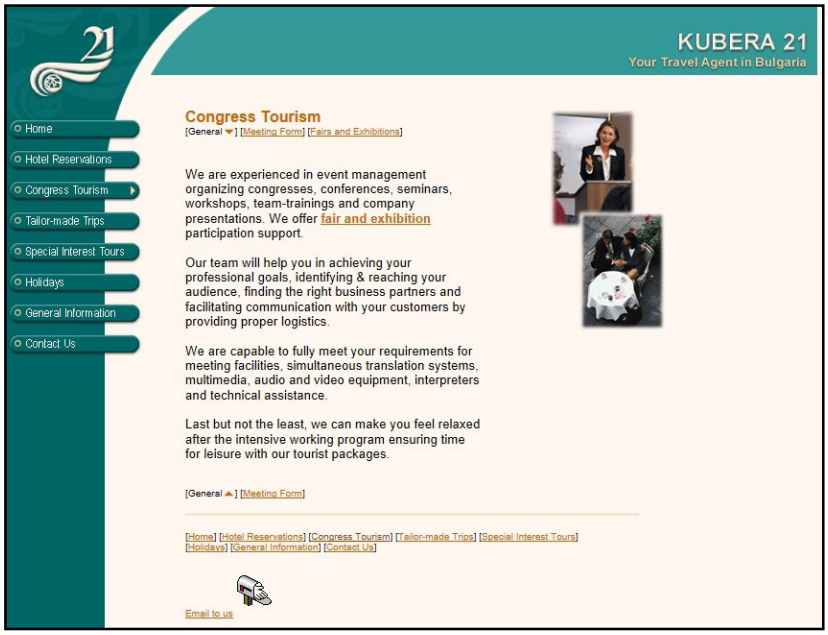
Congress tourism has become increasingly important for the development of individual countries and in particular their regions. For faster development of congress tourism, will be required very sophisticated marketing presentation of the target groups on the Web - regions, cities, organizations and companies. In search of websites focused on congress tourism in both countries have been evaluated by the following indicators:

1. References found in the top ten
2. Created in different regions of the country
3. Topics
4. User Interface - intuitive, graphical interface.



Source: Data from ICC

Graf 1: Number of meetings for Bulgaria and the Czech Republic 2000-2011.



Source: http://www.kuberatravel.com/bulgaria_congress_tourism.htm

Figure 1: Congress tourism in Bulgaria.

Source: http://www.czech.cz/cz/Podnikani/Ekonomicka-fakta/Kongresova-turistika

Figure 2: Congress tourism in the Czech Republic.

Monitored country	Location in the search	Presentation of the Regions (number)	Location of regions in search
Bulgaria	2	0	0
Czech Republic	1	4	to 20th place

Source: own survey

Table 4: Web search results.

To search in both countries were used the Google search engine. When entering the same query to find a presentation of congress tourism in the country, the links were almost the same place. In the Czech Republic the link was in the first place, in Bulgaria in second place (tab. 4).

The difference arises when watching the links in each region. The Czech Republic is among the top twenty links appear presentation of congress tourism in four regions - such as North Moravia region, western Bohemia. In Bulgaria, the region does not appear in the slideshow, you can assume that it is not created. Displays only the presentation of objects directly offer congress tourism - hotels, guest houses

Presentation of other regions related to conference tourism is not found even among other references, it can be assumed that there are. Link to conference tourism in the Czech Republic through the creation of a central site www.czech.cz (Fig. 2), in Bulgaria this link via www.kuberatravel.com (Fig. 1).

The content characteristics has been evaluated as the quality of the information provided. Quality of information have been assessed by the following indicators - information about the subject, location information - availability to find the page.

Pages on Bulgaria congress tourism provide general information, links to the organizers of the congress tourism and a list of all events in Sofia and Plovdiv. Link to conference tourism is part of the website, which also offers other tourist activities - general information about Bulgaria, accommodation, attractions in tourism. Presentation of congress tourism in the Czech Republic is part of the transparent provision of all activities - such as tourism, business, education. Information about the given topic are arranged as follows: first provides information about the importance of congress tourism, associated in particular with Prague. The next section provides basic information about Prague Congress Tourism Association, which covers the entire congress

tourism in the Czech Republic. Information about other places suitable for congress tourism are listed on the regional website.

The user interface is so intuitive and relatively well with the published searches.

Conclusion

As a whole, the results from the analysis carried out show a tendency for increasing the number of conference events. However, there is a difference detected in growth rates for both countries which can be explained in the following way:

For Bulgaria:

- This country has just started developing in the area congress tourism;
- Bulgaria has been changing into a desired destination because of its favourable geographic location, modern facilities and competitive prices;
- A tendency has been observed for gradual overcoming the economic crisis and for organizing a larger number of congress and conference events.

For the Czech Republic:

- There is a tendency of increasing the number of conferences but at a lower rate;
- It is a top destination for holding conference events with rich traditions in this particular aspect;
- The country keeps permanent high number of organized congresses and conference events and has an important role on European and global level.

Although Bulgaria has shown a clear progress with respect to the organization and holding of conferences, this country still lacks the capacity intrinsic to other European countries such as the Czech Republic. The lack of varied data for this tourism sector on Bulgarian part is strongly contrasted to the profuse information on the same issue concerning the Czech Republic. On one hand this shows a not well-structured system for data collecting and processing for statics purposes and tourism analysis, and on the other – lack of motivation among organizers of similar events to present such information to the public.

On global level, both countries are extremely unequal as refers to number of organized meetings per year. Provided the development rate for congress tourism in Bulgaria and the Czech Republic remains the same, equation of values cannot be expected for the next 5-10 years.

The decline of congress tourism in the first half of 2013 in the Czech Republic was about 15%. The causes must be sought in the austerity of companies and public administration, among other things the floods in June and governmental crisis. A similar situation also occurred in Bulgaria. The increase congress tourism development can be expected to ending the financial crisis.

Great influence on the development of congress tourism marketing has conducted a very essential part of the marketing presentation on the Web. The Czech Republic congress tourism ranked among the most important activities that it offers to its official website. Bulgarian tourism presents a travel agency that can affect the quality of the information provided. For further development of congress tourism, which positively affects the economy of both countries are decisive quality website, their intuitiveness, the quantity and quality of published information. For further development of congress tourism, it is necessary to create global solutions to support the development of the whole country.

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References

[1] Andersson, T. D., Lundberg., E. Commensurability and sustainability: Triple impact assessments of a tourism event, Tourism Management, 2013, No. 37, p. 99 – 109, ISSN 0261-5177.

[2] Brožová, I., Vaněk, J. Assessment of economic efficiency of conventional and organic agricultural enterprises in a chosen region. Acta Universitatis Agriculturae at Silviculturae Mendelianae Brunensis, 2013, Vol. LXI, No. 2, pp. 297 – 307, ISSN 1211-8516.

[3] Business Tourism Briefing. Business Tourism Partnership, Great Britain, 2007.

[4] Davidson, R., Cope, B. Business Travel: Conferences, Incentive Travel, Exhibitions, Corporate Hospitality and Corporate Travel. Edinburgh: Pearson Education Limited., 2003, ISBN 10 0-582-40444-4.

[5] Ford, R., Peeper, W. The Past as Prologue: Predicting the Future of the Convention and Visitor Bureau Industry on the Basis of Its History. Tourism Management. 2007, No. 28, p. 1104-1114, ISSN 0261-5177.

[6] Havlíček, Z., Vaněk, J. ICT and cooperative work. Plant, Agricultural Economics, 2005, Vol. 51, No. 10, p. 469 – 474, ISSN 0139 – 570X.

[7] Hennyeyová, K. Selected aspects of e-business development, Agricultural Economics, 2006. Vol 52, p. 385 – 388. ISSN 0139 – 570.

[8] ICCA (2010), ICCA Statistics Report, The-25-3 International Association Meetings Market 2000-2009, available at: www.iccaworld.com.

[9] Ministry of Economy, Energy and Tourism of the Republic of Bulgaria, Informational Brochures, available at: www.mi.government.bg.

[10] Oppermann, M. Convention Destination Images: Analysis of Association Meeting Planners' Perceptions, Tourism Management, 1996, Vol. 17, No.3, p. 175–182, ISSN 0261-5177.

[11] Oppermann, M., Chon, K. S. Convention Participation Decision-making Process, Annals of Tourism Research, 1997, Vol. 24, No.1, p. 178-191, ISSN 0160738.

[12] Palatková, M. Marketingový management destinací, Grada, 208 p., 2011, ISBN 978-80-247-374.

[13] Štědroň, B. Úvod do eGovermentu, Úřad vlády České republiky, 172 p., 2007, ISBN 978-80—87-041.

[14] Zlatev, V., Filipov, G., Lozanov, D., Markov, I., Ivanova, Y., Doichev, P., Rakadzhiiska, S., Aleksieva, S., Ivanov, S., Marinov, S., Tonchev. T. Bulgarian Tourism Management and Efficiency, 2005, ISBN 954-579-503-4.

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The Ways of Fuzzy Control Algorithms Using for Harvesting Machines Tracking

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Abstract

This contribution is oriented to ways of a fuzzy regulation using for machine tracking of the harvest machines. The main aim of this work was to practice verify and evaluate of functionality of control fuzzy algorithms for an Ackerman's chassis which are generally used in agriculture machines for the crops harvesting. Design of the fuzzy control algorithm was focused to the wall following algorithm and obstacle avoidance. To achieve of the reliable results was made the real model of vehicle with Ackerman's chassis type, which was controlled by PC with using development board Stellaris LM3S8962 based on ARM processor. Fuzzy control algorithms were developed in LabView application. Deviations were up to 0.2 m, which can be reduced to 0.1 m by hardware changing.

Key words

Fuzzy control, algorithm, Ackerman, tracking automation, harvest.

Introduction

The important aspect of agricultural crops harvesting is speed and accuracy. With higher motion speed of the agricultural machine, the result productivity and work efficiency will be higher. Higher rate disproportionately increases the mental load of worker that may adversely affects to total concentration. Increasing the speed of harvesting, and decreasing mental work of the worker at the same time, could be workable with using automation tracking control. Psychical load reducing extends work time, time to exhaustion and inattention of the worker. Steering person will have more free time that he can uses for setting of the cutting deck and optimizing acquisition parameters during driving. The driver's work is simplified in poor visibility too and the harvesting machine performance remains stable. Parameters such as tolerance, scale and agility utilized in data sampling for using in precision agriculture required an expressive number of researches and development of techniques and instruments for automation (Tabile, 2011). New technologies and devices for real-time data acquisition and actuation have been released to equip agricultural machinery to support and automate these practices (Stone et al., 2008). What is more, higher safety of the autonomous driving of the agricultural machine is needed as Murakami et al. (2008) developed and described. However, since the agricultural environment is complex and loosely structured fundamental technologies must be developed to solve difficult problems such as: mobile operation in tree-dimensional continuously changing track random location of targets which are difficult to detect and reach (hidden leaves and positioned among branches) variability in fruit size and shape delicate products and hostile environmental conditions like dust, dirt and extreme temperature and humidity (Edan, 1995).

Materials and methods

Agriculture areas contain obstacles. Usually, masts, poles and various objects, which are essential to the safe operation unwanted. These barriers is necessary avoid and keep minimum distance for maximum harvest. Area is changing dynamically from the aspect of the harvesting device. Mathematical description of the regulatory (control) system for such an environment is very difficult, sometimes impracticable.

Chassis mobility is another key factor in the agriculture machinery control. It specifies the number of differential degrees of freedom of a chassis (DDOF). Agricultural machines are

generally designed on the Ackerman's chassis type with one of degree of freedom and one rotation axis with a limited range of angles. It follows that is not able to rotate around its axis. Control algorithm for smooth system control and Ackerman's chassis is more complex.

A sufficient sensor count is necessary to provide a suitable basis for input information base. These sensors will be used to obtain primary input data for control process of autonomous system and for avoiding obstacles. Measurements obtained from various sensors are analogue values (not precisely defined), so there is difficult to make decision during control process. In contrast, output actuators' values of driven system must be precisely defined (called as sharp control values). In case of information feedback of control process, it is possible to use the advantages of inertial navigation, because the information about the position could be obtained through the acceleration and gyro data from accelerometers and gyroscopes (Cviklovič, Hrubý, 2011).

The above description is a summary of the requirements, which can be fulfilled by an appropriate control algorithm. One of the ways is using fuzzy control algorithm. Fuzzy control is qualitative control based on qualitative description of real systems. We do not need to know the exact equation of control system. One of main benefits of fuzzy logic system is intuitiveness of design, that allows control system designing too, where isn't available a mathematical model of the system or it is hardly determinable (Hrubý, 2007). The advantage of fuzzy control versus conventional methods is the ability to synchronous control of multiple independent physical variables (Cviklovič, 2011).

Characteristic feature of fuzzy control is the possibility of immediate use posteriori knowledge about human controlled process, which we refer to as base of data. Base of data consist information about the invariant states and the intervals where input and output variables with their limits move. The most important segments of base of data are verbally defined control rules by which are written up the complex control algorithm of the system.

The fuzzy controller's block diagram consists of fuzzyfication module where all input values are normalized. Next, normalized values are assigned to fuzzy sets of membership functions through input membership functions. These membership functions determine the degree how the measured value belongs to the fuzzy set. Memberships (u_i) can take values from 0 (element is not in set) to 1 (element belongs set).

Fuzzy sets are described by linguistic variables that could be any expression of any language. For example, a fuzzy set "distance from obstacle" contains the linguistic variables *{Near (N), Middle (M), Far (F)}*. Implemented verbal quantification of distance from obstacle (e.g. "Near") that refers to diffused fuzzy set defined by the characteristic function of membership. Examples of three input fuzzy membership functions that are represented by linguistic variables are shown in Figure 2.

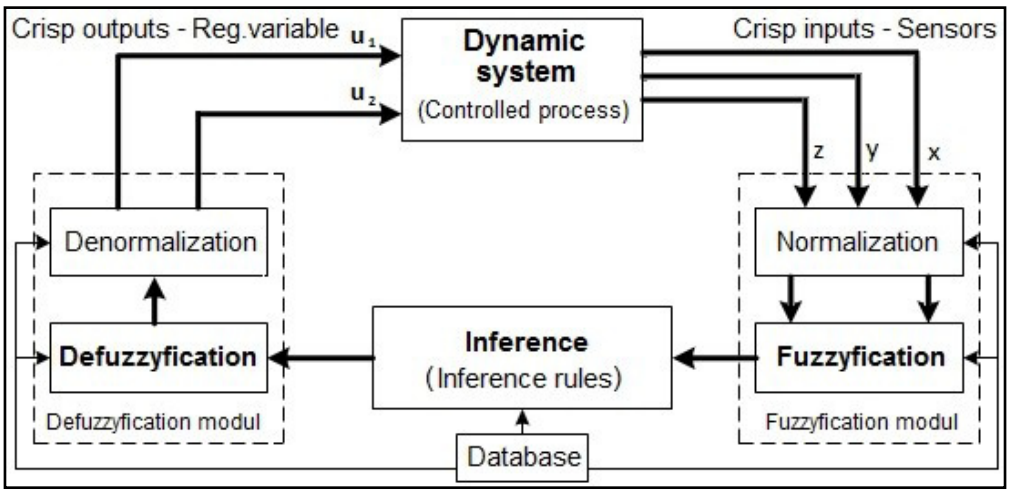

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Figure 1: Block diagram of fuzzy regulation process for three input variables and two output actuators.

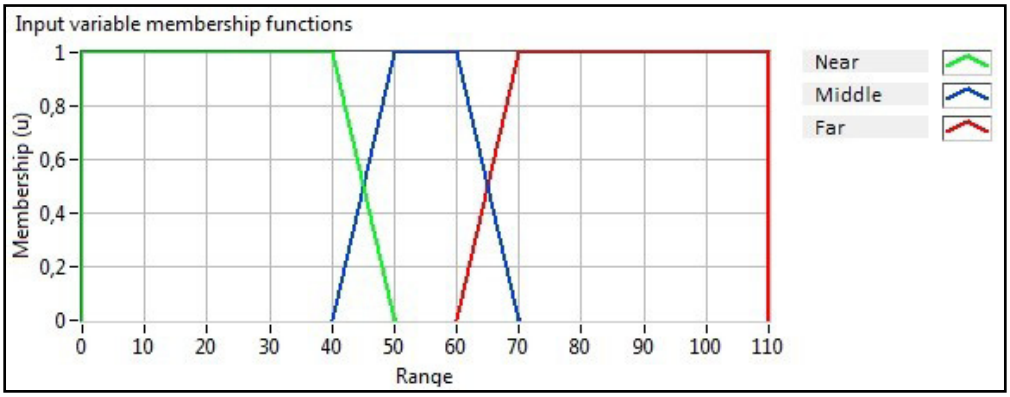

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Figure 2: Input functions of membership for input variable "x" is represented by linguistic variables "Near" (N), "Middle" (M) and "Far" (F).

In the block of inference is realized inference mechanism which uses the knowledge base of decision rules (interference rules) and fuzzyficated values. Output fuzzy sets are created of them. For automated control of agricultural machinery, fuzzy algorithm controls three input variables x, y, z for two actuating variables u_1, u_2. That is characterized by a number of fuzzy sets, which are represented by linguistic variables. The method of obtaining input fuzzy sets is as follow (Modrlák, 2002):

$$\alpha_1 = m_N(x) \wedge m_N(y) \wedge m_N(z) = \min\{m_N(x), m_N(y), m_N(z)\} \quad (1)$$

$$\alpha_2 = m_M(x) \wedge m_M(y) \wedge m_M(z) = \min\{m_M(x), m_M(y), m_M(z)\} \quad (2)$$

where:

α_1 is degree of membership function $m_N(u_1)$ of linguistic variable *N* of actuating variable u_1

α_2 is degree of membership function $m_M(u_2)$ of linguistic variable *M* of actuating variable u_1

$m_N(x)$ is membership function of linguistic variable *N* of input variable *x*

$m_N(y)$ is membership function of linguistic variable *N* of input variable *y*

$m_N(z)$ is membership function of linguistic variable N of input variable *z*

$m_M(x)$ is membership function of linguistic variable *M* of input variable *x*

$m_M(y)$ is membership function of linguistic variable M of input variable *y*

$m_M(z)$ is membership function of linguistic variable *M* of input variable *z*

Fuzzy sets of actuating variables u_1 and u_2 can be determined by cutting of output function of membership according to Mamdani implication:

$$*m_N(u_1) = \alpha_1 \wedge m_N(u_1) = \min\{\alpha_1, m_N(u_1)\} \quad (3)$$

$$*m_M(u_1) = \alpha_2 \wedge m_M(u_1) = \min\{\alpha_2, m_M(u_1)\} \quad (4)$$

$$*m_N(u_2) = \alpha_1 \wedge m_N(u_2) = \min\{\alpha_1, m_N(u_2)\} \quad (5)$$

$$*m_M(u_2) = \alpha_2 \wedge m_M(u_2) = \min\{\alpha_2, m_M(u_2)\} \quad (6)$$

where:

$m_N(u_1)$ is membership function of linguistic variable *N* of actuating variable u_1

$m_M(u_1)$ is membership function of linguistic variable *M* of actuating variable u_1

$m_N(u_2)$ is membership function of linguistic variable *N* of actuating variable u_2

$m_M(u_2)$ is membership function of linguistic variable *M* of actuating variable u_2

$*m_N(u_1)$ is fuzzy set of membership function $m_N(u_1)$

$*m_M(u_1)$ is fuzzy set of membership function $m_M(u_1)$

$*m_N(u_2)$ is fuzzy set of membership function $m_N(u_2)$

$*m_M(u_2)$ is fuzzy set of membership function $m_M(u_2)$

Result fuzzy sets for two outputs $m_{CELK}(u_1)$ and $m_{CELK}(u_2)$ can be determined as:

$$m_{CELK}(u_1) = \max\{*m_N(u_1), *m_M(u_1)\} \quad (7)$$

$$m_{CELK}(u_2) = \max\{*m_N(u_2), *m_M(u_2)\} \quad (8)$$

In the case when some of the measurements x, y, z spans multiple fuzzy sets we get more value degree of membership, which cut of output fuzzy

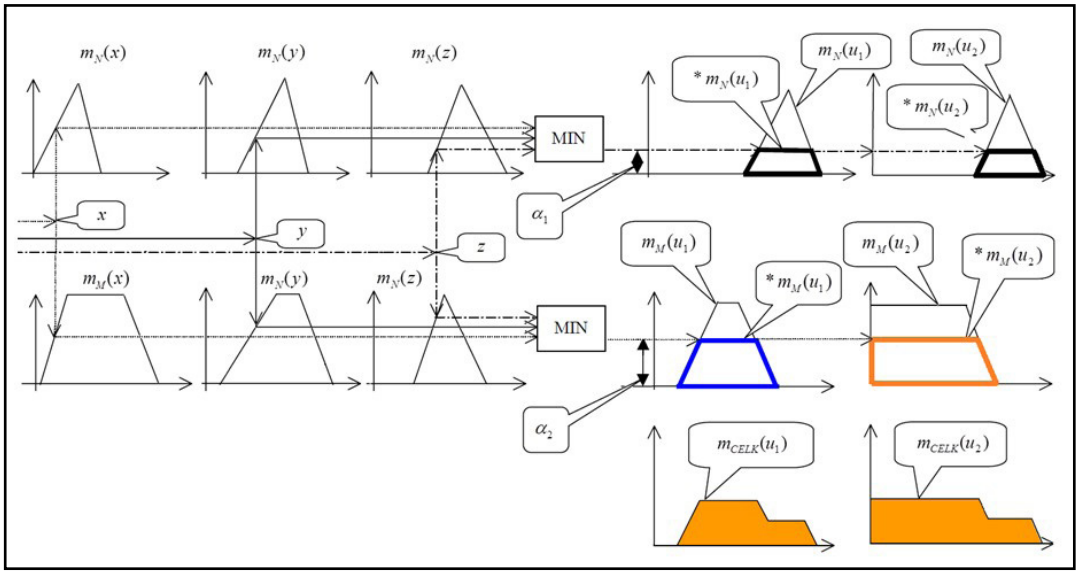

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Figure 3: Graphical representation finding method of output sets $m_{CELK}(u_1)$ a $m_{CELK}(u_2)$

sets $*m_N(u_1)$ and $*m_N(u_2)$. The resulting fuzzy sets of output variables $m_{CELK}(u_1)$ and $m_{CELK}(u_2)$ is given by unification of cutting fuzzy sets. In Figure 3 is shown the way to identify output sets $m_{CELK}(u_1)$ and $m_{CELK}(u_2)$ intervention in the two inference rules with three input variables x, y, z.

The relationships between input and output fuzzy set which are represented by linguistic variables determines the inference rules in the base of rules. Practically it is a simple logical operation that applies quantitatively formulated experience including verbally defined management strategy. With them it is possible to generate the actuating variable.

Decision rules represent body of experiences, knowledge and key information of fuzzy control algorithm. Example of decision rules has the following form:

IF (*x* belongs to *Near*) **AND** (*y* belongs to *Near*) **AND** (*z* belongs to *Near*) **THEN** (u_1 belongs to *Near*) **ALSO** (u_2 belongs to *Near*)

IF (*x* belongs to *Middle*) **AND** (*y* belongs to *Near*) **AND** (*z* belongs to *Near*) **THEN** (u_1 belongs to *Middle*) **ALSO** (u_2 belongs to *Middle*)

The resulting number of decision rules in the base of rules is multiple of input fuzzy sets count. We can write:

$$P = \prod_{i=1}^{n} X_i \qquad (9)$$

where:

P is a number interference rules in base of rules,

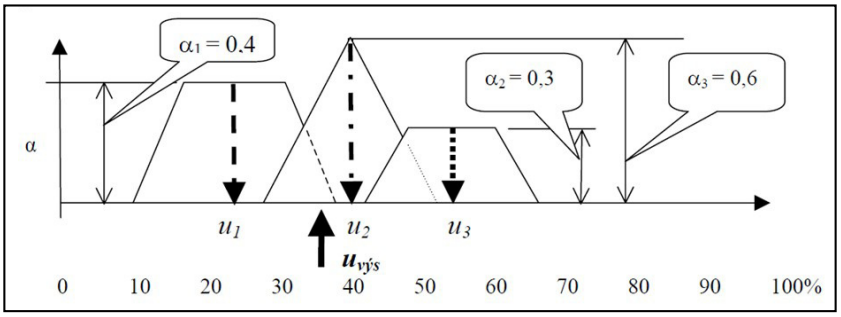
X_i is a number of linguistic values in i-th input variables

n is linguistic variables count.

The output of the interference mechanism is a fuzzy set, but many applications require of sharp value for regulation respectively action hit. The last task of the fuzzy controller performs defuzzyfication module where output fuzzy sets $m_{CELK}(u_1)$ and $m_{CELK}(u_2)$ are assigned to sharp actuating values u_1, u_2. This assignment process is called defuzzyfication.

There are the group of defuzzyfication methods which are based, for example on the method of determining the centre of gravity or method of determining the maximum. Peak search methods are based on determining of most important left (LoM), right (RoM) or in the middle (MoM) of located maximum of the resulting fuzzy sets. These methods "search for maximum" are characterized by high computing performance. On the other hand, the disadvantage is the possibility of discontinuous changes in the output values (Modrlák, 2002).

At the method of determining centre of gravity, the resulting value of action hit is determined as coordinate of the resulting centroid of fuzzy set either as "gravity centre of singletons" (CoM) or as "gravity of surface" (CoG). A centre of maximum method replaces the functional dependence of each



Source: Modrlák, 2002

Figure 4: Calculation of action value using method of determining Centre of Maximum.

sub-output fuzzy set of the typical maximum value (u_i) and sharp output variable ($u_{výs}$) determined as the centre of gravity each fragment values (u_i). Illustration of finding sharp output values $U_{výs}$ according to the method of gravity centre by singletons is shown in Figure 4.

Mathematical equation (10) for finding of the resulting value ($u_{výs}$) of output variable by the "centre of maximum method" is (Modrlák, 2002):

$$u_{výs} = \frac{\sum_{k=1}^{r} \alpha_k * u_k}{\sum_{k=1}^{r} \alpha_k} \qquad (10)$$

where:

$u_{výs}$ is the output value of the output variable

α_k is a value of membership function of the k-th fuzzy set

u_k is a coordinate of the output value of the k-th fuzzy set

The identified sharp values of the output variables after defuzzyfication operation are needed to convert to suitable physical dimension of actuating variable. This operation is named as denormalization.

Result and discussion

Automation homing of agriculture machine requires a good understanding of control mechanism of the chassis. Machinery chassis for harvesting of agriculture crops are generally designed with using Ackerman's principle. Using the Ackerman geometry to trace the front steering angle allows the vehicle to correctly perform a given manoeuvre preserving the minimum level of stability and manoeuvrability (Borrero, 2012). Alignment and keeping the machine at the border of two different height plants (Figure 5b), in conception with Ackerman's chassis, require sophistic solution in terms of control member. In parallel, there is necessary to receive a sufficient number of new information from controlled process, determine and finally transmit the sharp output values to the actuators by the created algorithm. In our case, input information sources were three ultrasound sensors (S1, S2, S3) developed by Maxbotix MaxSonarLV1 placed on real model, as shown in Figure 5a, with two actuators (DC motors). Ultrasound sensors' analogue values discretization, ultrasound sensors synchronization and triggering were realized by ARM microprocessor LM3S8962 with algorithm. DC motors were driven by microprocessor's PWM. Data were transferred to PC via RS232 wireless module. All measurements were processed and analysed using Labview 2010.

Basic requirements that are needed to be implemented in the control algorithm are required distance and parallelism between the longitudinal axis of the agricultural machine and the boundary of two different height plants. This means, the angle between the wall (higher plant in our case) and the longitudinal axis of the machine must be always approach to 0°, respectively, the sums of angles α and β are must be approach to 180° as shown in Figure 5a. This state is achieved when the distance is equal as distance b. Distances between sensor S1 and S2 will be desired value of distance from the wall (Figure 5). Using fuzzy input membership functions were set distance from the wall a = b = 0.55 m and set linguistic value was "Middle" (setpoint distance) in range from 0.5 m to 0.6 m of input linguistic variable as shown in Figure 2.

Instead of the vegetable border crop, in the practical test, a slightly curved wall was used with smaller disparities. There is a presumption to a more

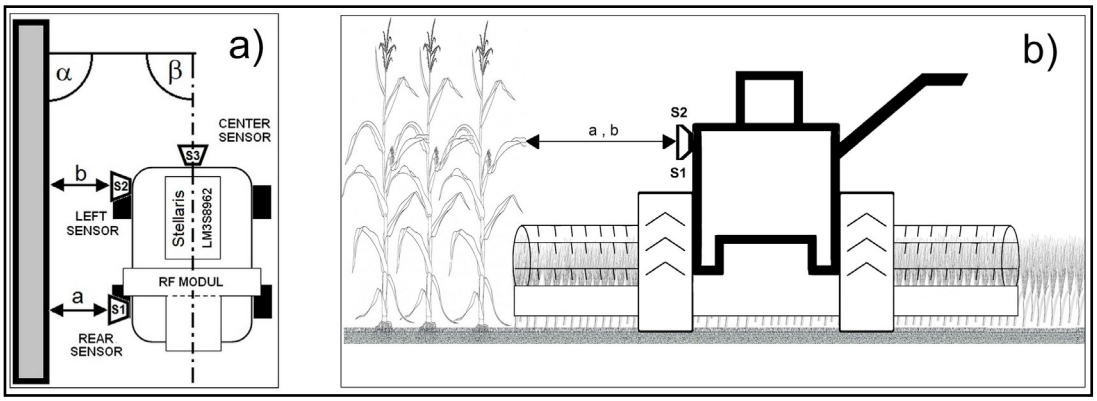


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Figure 5 Illustration of the characteristic parameters for navigate: a) vehicle model beside the wall, b) an agricultural machine at the border crop (e.g. maize).

complex evaluation of the distance measurement from boundary of the adjacent vegetation in an agricultural terrain, due to the indented and not always perfect surfaces (e.g. withered maize leaves). With an additional algorithm focused on random and sudden changes of the measured distances, incorrectly measured distances could be corrected. Accuracy of corrected input values could be increased with establishing a temporary memory, statistical estimation of the measured values and with prediction of these values. Before agricultural machine employment starts in real agriculture terrain, would be necessary to set the threshold sensitivity of abrupt changes of the measured distances for a type of vegetation forming the virtual border.

Distance measuring from obstacles in front of mobile vehicle was provided by ultrasound sensor S3. Distance of manoeuvre start to circumventing obstacles is conditioned with turning radius of the vehicle model. In our case radius was r = 1 m. The limit distance from an obstacle equals to sum of vehicle model rotation radius and desired distance from the wall. This limit was set to fuzzy control algorithm by input membership function for every specified sensor.

The resulting cut of fuzzy sets was created from obtained degrees of membership of input fuzzy set by the Mamdani's implication together with implemented decision rules. Individual rules are set by empirical knowledge, experience and logical reasoning. Sharp values of actuating variables of both outputs were calculated by method of gravity - centre of maximum (CoM).

Action hits in control process was performed by two the electric motors. Output membership functions were chosen in the range from -100 to +100. These numbers represented output (for PWM) power of electric motor in the percentages. Sign means direction of rotation. Fuzzy control surfaces were created on the base of fuzzy control algorithm. The most significant are shown in Figure 6.

Regulatory surfaces determine basic control strategy (Olejár, 2009), which the results are direction changing of vehicle. Horizontal planar surface of yellow square, that is shown in Figure 6a, is defining the required state and steady regulation values on the output. Smaller area means a more precise control and more changes of actuating variable in time. During the practical testing of fuzzy control algorithm for the real model distances were measured by sensor S2 and calculated distances from the wall were saved in the diagram graph 1.

The total straight travelled distance of the vehicle model along the wall was 43 m. Size of deviations was smaller as ± 0.2 m. Such a relatively large variation is caused by delayed mechanical response of control mechanism (mechanical clearances). Real agricultural machines are equipped by hydraulic power steering with electronically controlled hydraulic valves, which would be possible continuous control of the steering mechanism without delay. For example the CAN protocol provides an efficient platform that can be applied for data connection and distributed control of agricultural mobile robots meeting the requirements for an accurate robot movement and an acceptable response time for control commands and supervision (Godoy, 2010). What is more, in real environment the distance measurement by ultrasound sensors can be less precise due

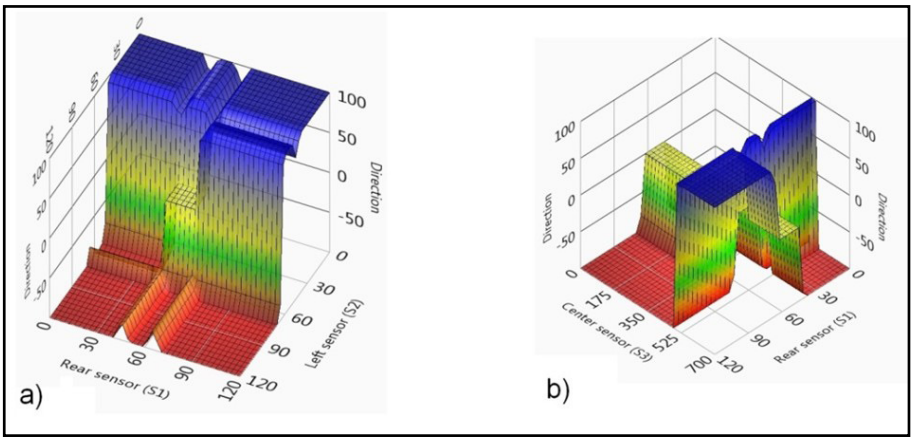

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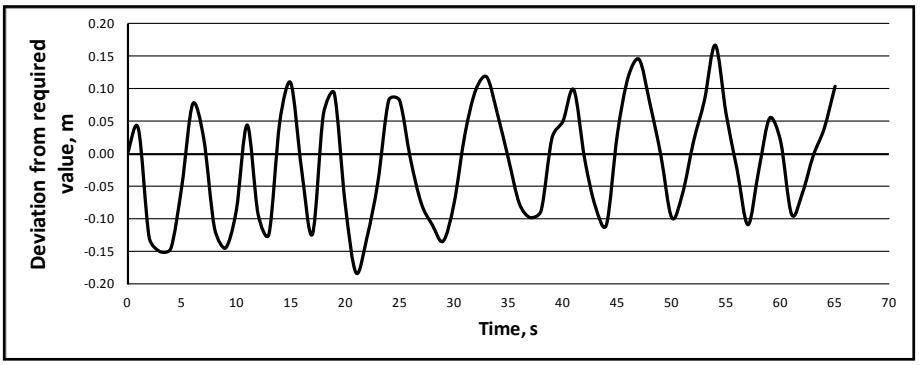
Figure 6: Control surfaces of fuzzy regulator. a) for input variables S1, S2 and output variable "Direction", b) for input variable S1, S3 and output variable "Direction".



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Graph 1: Dependence of deviation from the required value in time.

to the characteristics of air such as its temperature, humidity, turbulence and pressure (Kanzel, 2006). Therefore, to increase the steering direction's accuracy of the harvesting device, an additional gyroscopic sensor can be used with the Cviklovič's (2012) method of calibration to achieve tolerance of ±0.5 degree.

Fuzzy controller was able to provide responsive reactions up to speed 8m/s. The speed was limited by ultrasound sensors sequential triggering which braked the measuring speed and not sufficient new information were exchanged for fuzzyfication input module.

Defuzzyfication processes are possible speed up and stabilize by using faster methods of distance measuring. The deployment of fuzzy control algorithm to harvesting machines is possible from mechanical as well as electronic point of view. In our case is not usable PID regulator, which principles are better applicable to the one parameter systems (Nagy, 2011, 2012).

Conclusion

The paper describes the knowledge of control sphere and navigation of agricultural machines, which is based on the Ackerman's chassis type. Using fuzzy control algorithm can streamline works at harvest of agriculture crops of two high different plants. Precision of guidance of the agricultural machine depends equally on the precision of sensors, of the spacing between sensors and of the setting of the input fuzzy membership functions. In our case, the input function of membership was set for linguistic value to "Middle" (i.e. target distance from wall) in range from 0.5m to 0.6m. Using the created fuzzy control algorithm were achieved variations along the guidance of the vehicle model in front of the wall in range ±0.2m, where control mechanism of prototype vehicle model had significant impact. Smaller

range of variations could be achieved by using better actuators.

Practical deployment of fuzzy controller, respectively control system, can be in automated management areas with more agricultural machinery, where could be performed parallel activities such as tillage, harvesting beet or spray application. It is also possible to use fuzzy control algorithms together with camera sensors, and create the bases for autonomous lawnmowers, for processing and sorting of agricultural products according to visual properties.

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References

[1] Borrero, G. H., Becker, M., Archila, J. F., Bonito, R. Fuzzy control strategy for the adjustment of the front steering angle of a 4WSD agricultural mobile robot, 7th Colombian Computing Congress, CCC 2012 - Conference Proceedings. 2012, ISBN: 978-146731476-3.

[2] Cviklovič, V. Alternatívne spôsoby navigácie autonómnych mobilných robotov v poľnohospodárstve. (Alternative ways of navigation of autonomous mobile robots in agriculture). SUA in Nitra, 2011. Dissertation work.

[3] Cviklovič, V., Hrubý, D., Olejár, M., Lukáč, O. Comparison of numerical integration methods in strapdown inertial navigation algorithm, In: Research in Agricultural Engineering, 2011, vol. 57, no. SPEC. ISSUE, pp. S30-S34. ISSN: 1212-9151.

[4] Cviklovič, V., Hrubý, D., Olejár, M., Priatková, L. Gyroscope calibration with the method of simulated identification, In: Research in Agricultural Engineering, 2012, vol. 47. 2012. ISSN 1212-9151.

[5] Edan, Y. Design of an autonomous agricultural robot, Applied Intelligence, 1995, vol. 5, no. 1, pp. 41-50. ISSN: 0924-669X.

[6] Godoy, E. P., Tabile, R. A., Pereira, R. R. D., Tangerino, G. T., Porto, A. J. V., Inamasu, R. Y. Design and implementation of an electronic architecture for an agricultural mobile robot, Revista Brasileira de Engenharia Agricola e Ambiental, 2010, vol. 14, no. 11, pp. 1240-1247. ISSN: 1415-4366.

[7] Hrubý, D., Amrich, M. Automatic fuzzy logic control of vehicle motion, In: Acta technologica agriculturae, 2007, vol.10, no.1, p. 14-17. ISSN 1335-2555

[8] Kanzel, J., Jurišica, L. Comparison of mapmaking methods for mobile robots, Journal of Electrical Engineering, 2006, vol. 57, no. 5, pp. 276-284. ISSN: 1335-3632.

[9] Modrlák, O. Fuzzy řízení a regulace. 2003, [Online]. Available: http://www.kirp.chtf.stuba.sk/~bakosova/wwwRTP/tar2fuz.pdf.

[10] Murakami, N., Ito, A., Will, J. D., Steffenb, M., Inoue, K., Kita, K., Miyaura, S. Development of a teleoperation system for agricultural vehicles. Computers and Electronics in Agriculture, 2008, Vol. 63, pp.81-88. ISSN: 0168-1699.

[11] Nagy, Ľ., Palková, Z., et al. Identification of model lightening system and design of PID controllers for the purpose of energy savings by using of MATLAB and their functionality in LabVIEW. In: Rocznik Ochrona Środowiska. 2010, Vol. 14 (2012), pp. 247-261. ISSN 1506-218X.

[12] Nagy, Ľ., Palková, Z., 2011. Measuring the photosynthetically active radiation of illumination sources and global sun radiaton using the Matlab program.In: Scientific papers. 2011, Vol. 11, 1, pp. 127-131. ISSN 2247-3527.

[13] Nagy, Ľ., Palková, Z., Kovač, P., 2011. Matlab algorithms for the lighting control on the constant value. In: Journal of Production Engineering. 2011, Vol. 14, 1, pp. 47-50. ISSN 1821-4932.

[14] Olejár, M., Hrubý, D. , Lukáč, O. Metódy riadenia mikroklimatických podmienok v uzavretých priestoroch a ich vplyv na úsporu elektrickej energie. Monograph. Nitra: SPU, 2009. p. 146, ISBN 978-80-552-0316.

[15] Stone, M. L., Benneweis, R. K., Van Bergeijk, J. Evolution of electronics for mobile agricultural equipment, Transactions of the ASABE, 2008, Vol. 51, 2, pp. 385-390. ISSN: 0001-2351.

[16] Tabile, R. A., Godoy, E. P., Pereira, R. R. D., Tangerino, G. T., Porto, A. J. V., Inamasu, R. Y. Design and development of the architecture of an agricultural mobile robot, Engenharia Agricola, 2011, vol. 31, no. 1, pp. 130-142. ISSN: 1809-4430.

[17] Viorel S., Mircea I. Robot Control by Fuzzy Logic, Frontiers in Robotics, Automation and Control, Alexander Zemliak (Ed.), InTech, 2008, ISBN: 978-953-7619-17-6.

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Information Support of Regions – Organic Farming

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Anotace

Příspěvek prezentuje možnosti informační podpory regionů prostřednictvím mapového výstupu v prostředí www aplikace. Představuje aktuální stav řešení mapového portálu s využitím datové základny ekologických farem v ČR. Mapové výstupy jsou zobrazovány pomocí nové verze systému MPRR 2.0 (Mapový portál pro rozvoj regionů verze 2.0) a pilotně zpracovány pro ekofarmy na území Jihočeského kraje. Výsledky řešení představují výchozí data s platností pro rok 2012 (evidence MZe ČR k 31. 12. 2011), která byla validována a zanesena do databáze. Z celkového počtu 516 ekofarem bylo možné ověřit a mapově lokalizovat 472 subjektů.

Klíčová slova

Ekologické zemědělství, www, rozvoj regionů, Google Maps, mapový výstup.

Abstract

The paper strives to introduce opportunities for information support of regions by means of a map output within www application. It presents a recent solution of a map portal using a database of organic farms in the Czech Republic. The map outputs are visualized by means of a new version of the MPPR 2.0 system (Map Portal for Regional Development – version 2.0) and have been processed for the South Bohemian Region organic farms in the pilot stage. The results account for initial data from 2012 (organic farms in the records of the Ministry of Agriculture as at 31st December 2011) that have been verified and recorded in the database. Out of the total number of 516 organic farms in the region, it was feasible to verify, localize and position 472 entities.

Key words

Organic farming, www, regional development, Google Maps, map output.

Introduction

For several decades now, organic farming has constituted a worldwide strategy leading to both sustainable development and environment protection. As a result, it has been endorsed by public. Within the framework of the EU, organic farming has become an integral part of the Common Agricultural Policy and has been systematically subsidized.

The Czech Republic is also dedicated to the development of the organic farming sector. Organic farming contributes to the production of environment-friendly, healthy and nutritious quality foodstuff thanks to its production processes and practices. Moreover, its production is primarily focused on local markets. Selling organic products in their place of origin also encourages regional development as it involves employment opportunities, direct selling (cash circulation in local economy) and other activities provided by organic farms (visits or stays at farms, excursions and tours, various courses and lectures aimed at promoting healthy lifestyle etc.). The above also raises general attractiveness of regions.

Recently, the importance of presenting organic farming has been growing. Individual farmers and organizations or bodies involved in the field strive to promote the products and services while consumers and tourists on the other hand search for information (organic products purchase, eco-agrotourism services etc.).

The development and spread of the Internet and Internet technologies has been bringing the abundance of web presentations entailing a lot

of information and outputs for their users.

However, the quality of the fore-mentioned outputs is quite diverse. Some resources might be eye-catching and attractive but comprise just partial information on the entity (often also inaccurate) or fail to provide sufficient terminological explanation which may lead to confusing consumers‘ confusion.

Another problem might lie in the availability of up-to-date official information required by the public. If the information needed is not available or its quality is insufficient, a room for other entities involved or in the sector remains open. Many factors then influence the quality and relevance of the respective outputs.

Having in mind that map resources (outputs) in the form of web portals are far from being common in both organic farming and agriculture in general, we can observe a lack of information resources related to the issue in question. This speaks for originality of the solution presented in this paper.

The above-mentioned fact might be caused by a lack of appropriate data resources (this argument does not really work for the CR and also other EU countries), by underestimating or not mastering the technologies, often together with the data volume, or, as the case may be, also by a lack of good will or interest to present information in this way.

In global-scale, there exists e.g. an output in the form of a world map „World Map of Organic Agriculture“[9] which can stand for a certain synthetic output for 2011 (Density Equalizing Map). Beyond all doubt, it would be beneficial to animate the individual map components, provide them with a commentary, display the presentation on the web portal etc. Generally speaking, this is the case of a wide range of „static“ outputs. While talking about organic farming, we can mention for instance [2] or [8].

Geographic Information Systems (GIS) or GIS combined with a web portal also offer interesting opportunities related to our issue. However, GIS applications are recently more aimed at collecting spatial data from sensors etc. [4], [12], often as an integral part of web solutions [3].

Materials and methods

Organic farming represents a typical sector where transparent and well-arranged official information should be available since it is strongly subsidised, the farms are run in accordance with Law no. 344/2011 Coll. (Law on organic farming) and are listed on the official list comprising organically farming entities. The farms in question have to comply with continuous inspections and supervision carried out by the Ministry of Agriculture (compliance with Law 344/2011 Coll.) through authorised control bodies. These bodies ensure all the respective checks and certifications.

Therefore, the above list offers a database that is to provide comprehensive official outputs. These outputs should be then optimised for the sake of different users/user groups and subsequently presented in an appropriate way. Unfortunately, just this presentation is completely missing.

The database itself is available on the eAGRI portal only in the form of an .xls grid (The grid can be found as „Celkový seznam osob podnikajících v EZ_201x“.). In the past years, these data served as the basis for the creation and verification of the database. However, the last version published has a different data structure that does not correspond to the original one. On the other hand, a new resource is now available on the eAGRI – Register of Organic Farmers. The register entails an up-to-date survey (continuously updated) and contains also with other properties. Nevertheless, the access is through searching. [7]

If a subject of interest is bound to a concrete area or location, it is very effective to save information in the database of a map portal and present it by means of a map output – in this particular case, a map of organic farms in the Czech Republic.

Organic farming – recent situation

In the Czech Republic, organic farming has been developing since the beginning of the 90‘s and its progress has been determined by the volume of financial means invested in the sector. While monitoring the spread of organic farms, a rather uneven distribution on the territory can be observed. Most organic farms are concentrated to less favourable montane and submontane areas of the Czech Republic. This has a direct impact on their activity and focus. We can therefore observe the predominance of permanent grassland over arable land and other cultures that represent an incomparably lower share in the land resource structure. The South Bohemian region has been chosen as a typical representative of the above attributes and therefore a suitable example to meet the objectives of the present

paper. It has the biggest area of organically farmed land (14.4% of the total organically farmed land in the Czech Republic - as at 31st December 2011[6]) and at the same time the highest number of organic farms (13.4% of all organic farms in the Czech Republic – as at 31st December 2011 [6]). Taking into account the above-mentioned factors, the pilot solution is on purpose validated on the database of the South Bohemian region.

Technical solution – MPRR Map Portal

In order to solve the above-mentioned problem, a universal software solution MPRR (Map Portal for Regional Development) has been created and used. The MPRR is a general solution enabling to work with virtually any database (universal applicability). It can be parameterised to different output forms following the analysis of the issue given or user requirements. The latter features guarantee its wide applicability.

The original MPRR 1.0 solution offered standard basic functions such as e.g. visualizing objects on the map, visualizing basic or more detailed information on the object marked, map-scale change (zoom) etc.

Apart from the above features, the MPRR entails other significant functionalities such as e.g. filtering and sorting the objects visualised according to different criteria, dynamic change in the number of visualised objects etc. While changing the map scale, dynamic change means aggregation of individual objects into cluster groups (zoom out) on one hand, and declustering into smaller subgroups or individual objects (zoom in) on the other hand. This leads to a significantly better clarity of the output – standard map outputs where objects are visualized only on one level often look like a jumble of points in a map. Aggregate object clusters are indicated by the zoom icon with a numeric indication of the exact number of objects included (see Fig. 2 and 3).

In order to realize an up-to-date map output, a new version of a complex SW solution related to geographical object presentation within the World Wide Web has been developed – Regional Development Map Portal version 2.0 (MPRR 2.0).

Results and discussion

As at 31st December 2011, 516 South Bohemian organic farms were registered in the database of the Czech Ministry of Agriculture [6]. This number accounts for almost 13.4% of all organic farms in the Czech Republic while these farms farm approximately 14.4% of the whole organically farmed area in the Czech Republic.

Primary mapping data were generated from this database. The database is compiled by control bodies and organizations while registering and controlling organic farms in the course of the year. Organic farms located in the South Bohemian region according to the database were first checked against the ARES system (Administrative register of economic entities) in order to verify if their economic activities comply with organic farming. Individual farms were then localized in the Google Maps by means of GPS coordinates (6 decimal place accuracy). Out of the total number of 516 organic farms, approximately 9.3% could not have been traced by their address. This was caused mostly by the lack of farm number (i.e. manual localization was not possible too), identical address of the place of business and farm (densely populated built-up area where organic farming is not possible). Unfortunately, specifying data concerning those farms was not possible even after own survey (local inquiry, telephone survey). The remaining 90.7% organic farms (i.e. 472 entities) were successfully localized, used for the map development and depicted (see Fig. 2).

Table 1 and Fig. 1 below can be used for illustrating one of the trends in the organic farms‘ focus, i.e. orientation to permanent grassland. The situation is connected to the pilot stage in the South Bohemian region.

Within the framework of new data collection, a new version MPRR 2.0 (Map Portal for Regional Development version 2) has been developed. The original environment and libraries were retained since their long-term functionality and reliability has been proven and can be taken for granted. MPRR 2.0 therefore runs within the Apache Web Server, MySQL 5 database, Google Maps API version 3, JavaScript, JQuery framework, jQuery plugin bMap 1.3, MarketCluster Library for Google Maps API, JSON technology, PHP Nette Framework, Dibi database layer and Google Maps Icons. Further details can be found e.g. in [11]. Technological aspects of these solutions are provided e.g. in [5], [12], [14].

Furthermore, the database structure has been optimised for a more effective search and classification. Based on the trials, testing and users‘ feedback, the user environment (GUI) has been

innovated too, for instance, visualization of multiple entities on one single address/place of business, speed of visualization etc. Last but not least, the new version offers also enhanced functionality on mobile devices. An example can be seen in Fig. 4.

The final solution displayed in the portal stems from the maximum effort to validate, assemble and complete all data resources, including efforts to find a precise organic farm location and subsequently to position it in the map (data validity and map location accuracy). The map output includes as well a detailed methodology available within the framework of the application.

The new version of the portal (data related to organic farms in 2012, as at 31st December 2011) is freely available on **http://mapy.agris.cz/2012/ekologicke-farmy/mapove-podklady.**

District	"Organically farmed land share [%]"	"Permanent grassland share in organic farming [%]"	"Arable land share in organic farming [%]"	"Permanent cultures share in organic farming [%]"
České Budějovice	11.38	**31.68**	4.19	15.47
Český Krumlov	45.27	**66.94**	4.36	1.29
Jindřichův Hradec	10.61	**27.63**	3.16	8.34
Písek	3.60	**13.19**	0.92	0.06
Prachatice	33.16	**49.06**	3.43	0.83
Strakonice	6.02	**18.67**	0.93	0.04
Tábor	2.17	**8.25**	0.38	0.32

Source: processed on the basis of [1, 6]

Table 1: South Bohemian region – district data as at 31st December 2011 (valid for 2012).

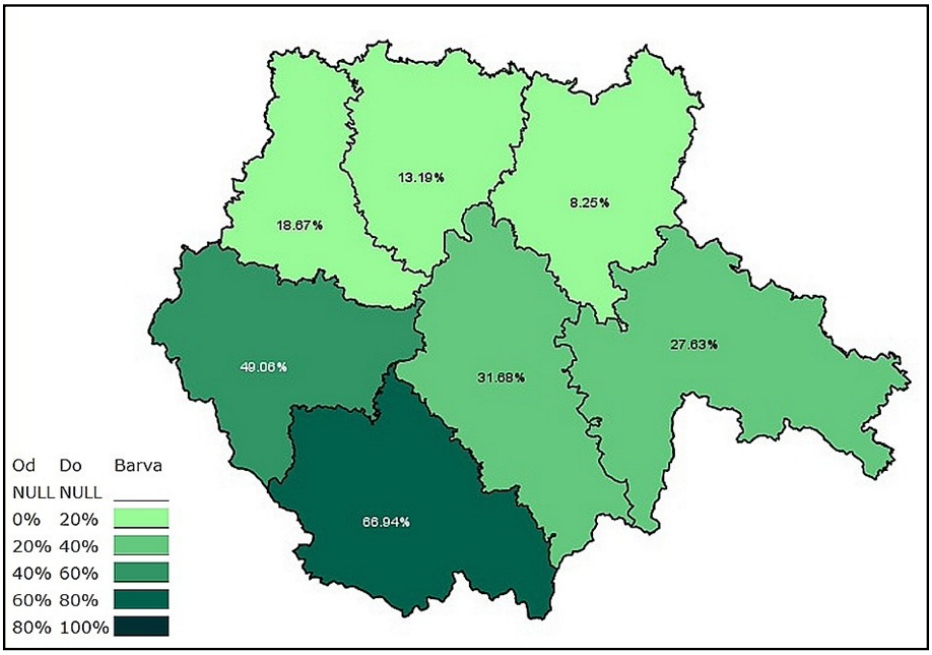
Table 1 – commentary:

Organically farmed land share – share of organically farmed land in the total area of farmed land in the district.

Permanent grassland share in organic farming – share of organically farmed permanent grassland in the total permanent grassland area for the district.

Arable land share in organic farming - share of organically farmed arable land in the total arable land area for the district.

Permanent cultures share in organic farming - share of organically farmed permanent cultures (hop gardens, vineyards, orchards) in the total permanent cultures area for the district.

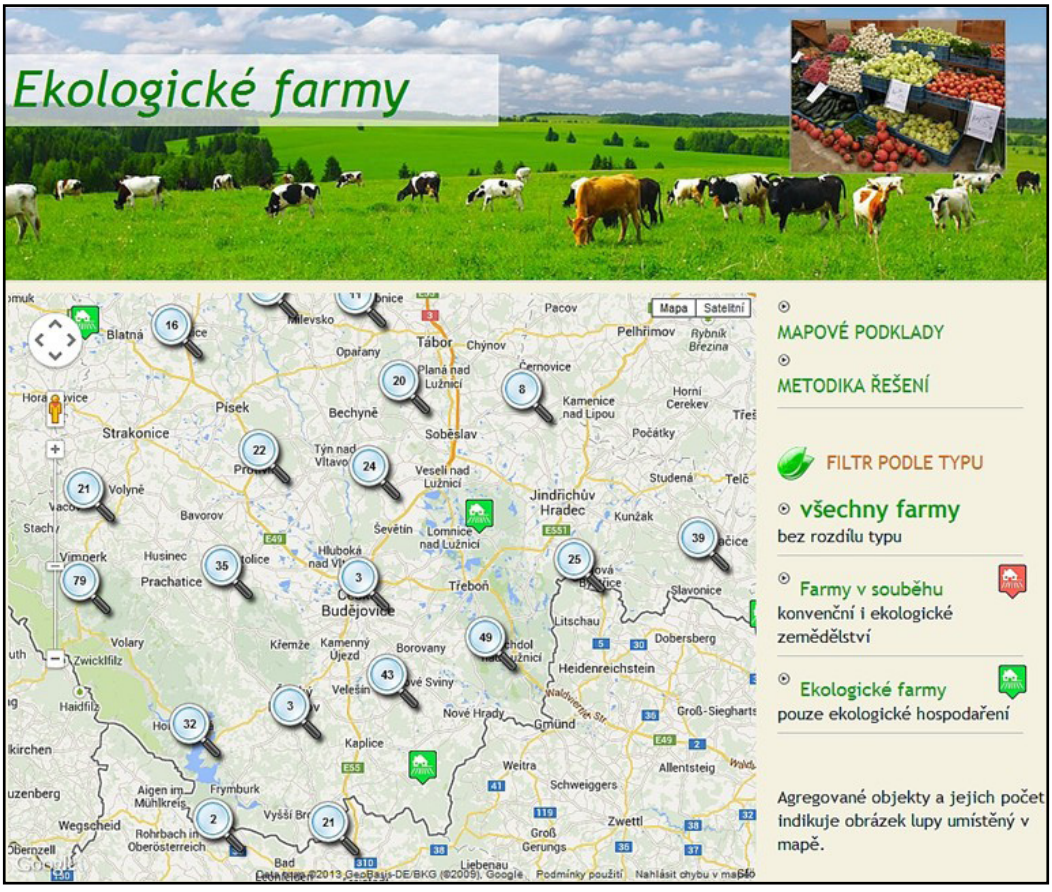


Source: own processing

Figure 1: Permanent grassland share in organic farming (South Bohemian region - districts).

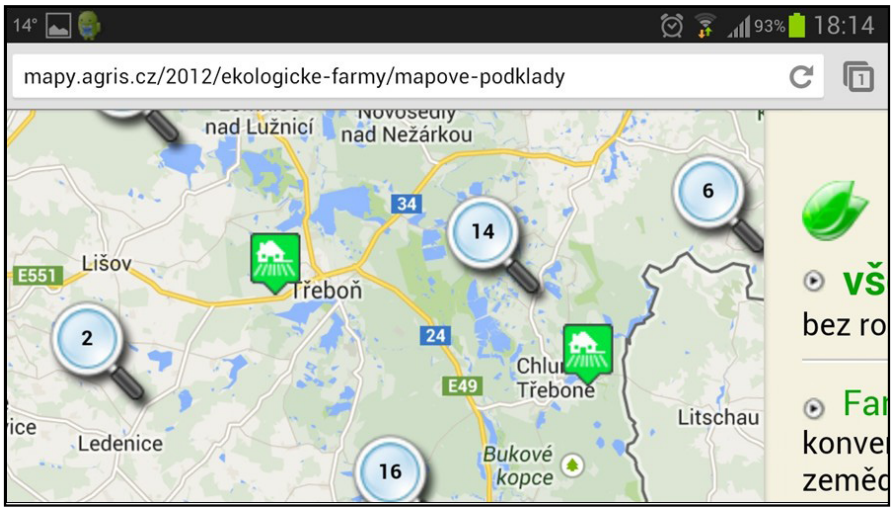
Source: own processing

Figure 2: Overall view of the pilot solution - South Bohemian Region (total number of farms in the database – verified and localised farms).



Source: own processing

Figure 3: Implicit preview of the map portal (Homepage) – South Bohemian Region.



Source: own processing

Figure 4: Detail on a mobile device (Samsung Galaxy S III smartphone, Google Chrome browser).

Conclusions

The presented universal software solution (Map Portal for Regional Development version 2.0) allows users to work with virtually any database and can be parameterised into different outputs following the analysis of an issue given or user requirements. These features among others guarantee its very wide applicability.

While developing the MPRR database, 472 organic farms out of the total number of 516 entities registered at the Ministry of Agriculture have been verified and saved. In other words, 9% of subjects could not have been verified properly (sometimes not even by a local inquiry). It can be therefore estimated that a relatively big group of entities comply formally with the registration requirement and are eligible for subsidies but their organic farming activities are only formal. This issue is most often related to permanent grassland (likewise orchards for instance). It of course does not imply that all subjects registered as meadows, pastures or orchards fall in the aforementioned category.

Taking into account the development dynamics, it would be appropriate to update the database on a yearly basis (or even better continuously). Resources related to newly registered subjects have to be verified, complemented and positioned in the map. At the same time, it is vital to eliminate those subjects that stopped their operation or lost relevant certifications.

When the first original solution was designed and put into practice, there actually existed no map output related to organic farms. That is basically why the solution is supposed to have a great user potential. The portal is intended to be widely used especially by the state administration, professionals in the field (detailed characteristics of the production base), producers - farmers (promoting products and services) and last but not least also by consumers as such (purchasing organic products, exploiting services provided by the farms – accommodation, training etc.). The information and databases can be also made available to control and certification bodies by means of a secured access (login, password). The system could then provide not only detailed information on the individual enterprises but in the extended version also controls/certifications register, their results etc. Another room for use can be found for instance within professional organizations and associations. As we can see, the potential of MPRR is really huge.

For completeness sake, it has to be stated that a relatively interesting web presentation of the PRO-BIO association is now available using similar principles as the MPRR 1.0 for the list of members. It is likely that the solution has been derived from the MPRR 1.0. Nevertheless, the scale is much lower comprising only 51 subjects (members) in the South Bohemian region and the map output is not used to provide an overview of farmers, manufacturers and sellers, which would be undoubtedly more interesting (it provides a mere directory with extended activity description). [10]

Beyond all doubt, the map output over a valid database represents a very promising and comprehensive presenting tool for all information

that would otherwise be hard to share or to find. The MPRR solution can significantly contribute to an effective informational support of regions, i.e. it can support many different kinds of regional activities, including the organic farming sector.

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References

[1] ČÚZK. Souhrnné přehledy o půdním fondu z údajů katastru nemovitostí České republiky, ČÚZK, Praha 2012, ISBN 978-80-86918-65-5, ISSN 1804-2422.

[2] Forschungsinstitut für biologischen Landbau FiBL [on-line] available: http://www.fibl.org/de/startseite.html.

[3] Horák, P., Charvát, K., Vlk, M. Web Tools for Geospatial Data Management. Information Systems Development. 2010, p. 793-800. ISBN: 978-0-387-84809-9.

[4] Kubicek, P., Kozel, J., Stampach, R., Lukas, V. Prototyping the visualization of geographic and sensor data for agriculture. Computers and Electronics in Agriculture. 2013, Vol. 97, p. 83-91. ISBN: 0168-1699.

[5] Li, J., Peng, C. JQuery-based Ajax general interactive architecture. ICSESS 2012 - Proceedings of 2012 IEEE 3rd International Conference on Software Engineering and Service Science, 2012, p. 304-306, ISBN: 978-146732005-4.

[6] MZe ČR. Celkový seznam ekologických podnikatelů platný k 31. 12. 2011. 2012. [on-line] available: http://eagri.cz/public/web/mze/zemedelstvi/ekologicke-zemedelstvi/seznamy-podnikatelu/celkovy-seznam-podnikatelu/.

[7] MZe ČR. Registr ekologických podnikatelů. 2013. [on-line] available: http://eagri.cz/public/app/eagriapp/EKO/Prehled/.

[8] Organic-World.net Data collection on organic agriculture world-wide [on-line] available: http://www.organic-world.net/statistics-data-collection.html.

[9] Paull, J., Hennig, B. A. World Map of Organic Agriculture. European Journal of Social Sciences. 2011. Vol. 24, No 3, p. 360-36. ISSN: 1450-2267.

[10] PRO-BIO. Webová prezentace svazu. [on-line] available: http://pro-bio.cz/mapa-clenu/.

[11] Vaněk, J., Brožová, I., Šimek, P., Jarolímek, J., Vogeltanzová, T. Organic Farms in the Czech Republic – Map Portal Presentation Opportunities, Plant, Soil and Environment, 2011, vol. 57, No. 12, p. 565-570. ISSN: 1214-1178.

[12] Wang, G. Improving data transmission in web applications via the translation between XML and JSON. CMC 2011 - Proceedings of 3rd International Conference on Communications and Mobile Computing, 2011, p. 182-185, ISBN: 978-076954357-4.

[13] Yane, D. Research and Analysis about System of Digital Agriculture Based on a Network Platform. IFIP Advances in Information and Communication Technology. 2011. Vol. 345, p. 274-282, ISBN: 978-3-642-18336-2, [on-line] available: http://link.springer.com/book/10.1007/978-3-642-18336-2/page/1.

[14] Zhang, H., Li, M., Chen, Z., Bao, Z., Huang, Q., Cai, D. Land use information release system based on Google Maps API and XML. Geoinformatics 2010 - Proceedings of 18th International Conference on Geoinformatics, ISBN: 978-142447302-1.

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