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Content

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Awareness of Climate Change and Implications for Attaining the Millennium Development Goals (MDGS) in Niger Delta Region of Nigeria

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Abstract

The Niger Delta region of Nigeria is at the centre of both the economic wealth and climate change in the context of pressing national economic issues. It produces the nation's major foreign exchange earner-crude oil, has abundant fishery and marine resources- all of which are threatened by vagaries in climatic factors. The study was conducted to evaluate awareness of climate change and implications for attaining the MDGs in the Niger Delta region of Nigeria. The study made use of a multi-stage sampling technique to select three hundred and sixty respondents across three Niger Delta States (Delta, Edo, Ondo). Data for the study were collected with the aid of well-structured questionnaires assisted with interview schedules administered on the respondents. Data collected were analysed using descriptive statistics. The analysis of awareness of climate change indicated that level of awareness is low but improving. It was found, however, that the mass media has played the most significant roles in climate change awareness in the study area. The results also indicated that the respondents had been practicing some indigenous and emerging adaptive strategies to climate change for many years. This study concluded that more awareness about climate change in the Niger Delta region have implications for attaining the MDGs.

Key words

Awareness, climate change, Implications, MDGs, Niger Delta region.

Introduction

The Niger Delta region is at the heart of Nigeria's economic, environmental and geo-political significance. The Niger Delta with only more than 20% of the nation' s population is pivotal to Nigeria's economy as the area contributes over 80% of Nigeria's revenue, accounts for about 95% of the nation's foreign exchange earnings (Ejumudo, 2013). The region's enormous reserve of crude oil and gas creates ample room for foreign and local investments and its rich biodiversity in term of fauna and flora is almost incomparable to any part in the world.

Human activities have exacerbated climate change with its attendant impacts on agriculture in many communities in the Niger Delta region. Climate change also affects livelihood vulnerability (Bryceson et al., 2002, Cochrane, 2006, Ekins et al., 2003, Reed et al., 2013). Terrestrial water and carbon cycles also respond to climate change and variability through a set of coupled physical and physiological processes (Raupach, 2013), Social-ecological system collapse is also possible (Roser, 2001, Richter, 2013)

Akinro et al. (2008) reported that, the Niger Delta region of Nigeria has over 123 gas flaring sites making Nigeria one of the highest emitters of greenhouse gases in Africa. According to the World Bank (2008), Nigeria accounts for roughly one-sixth of worldwide gas flaring, flaring about 75% of her gas and all take place in the Niger Delta region. Agriculture in the Niger Delta is largely rain-dependent as irrigation is seldom practiced. Nzeadibe et al., (2011) further noted that changes in the rainfall pattern have greatly affected vegetation and agriculture in the region.

The long neglected social and infrastructural development of the region has attracted many development programmes of the international communities. These included many Millennium Development Goals (MDGs), the European Union-funded Micro Project Programmes in nine Niger Delta States (MPP9) and Niger Delta Development

Commission (NDDC). In all the nine states, there are State-development commissions fashioned after the NDDC (Ndem, Baghebo, 2012). Because the MDGs which started implementation in 2000, is expected to be wound up in the year 2015, this study is focusing on awareness of climate and implications for attaining the MDGs.

The Millennium Development Goals (MDGs) in the Niger Delta region

The Millennium Development Goals (MDG's) are a linked set of objectives – a portfolio of targets that represent a coherent assault on the problem of development (Hall, 2005). The Millennium Development Goals (MDGs) provide an international framework that builds commitment and cooperation towards poverty reduction. According to (CGIAR, 2005), the MDGs represent the shared commitment made by the Global community to fight poverty, endorsed in 2000 by 189 nations (Nigeria inclusive) as international commitment to the priorities for achieving sustainable development by the year 2015. Broadly, these goals are:

i. Eradicate extreme poverty and hunger
ii. Achieve universal primary education
iii. Promote gender equality and empower women
iv. Reduce child mortality
v. Improve maternal health
vi. Combat HIV/AIDS, malaria and other diseases
vii. Ensure environmental sustainability
viii. Develop a global Partnership for Development

With only about two years for the time limit set for the achieving the MDGs, the MDGs may be under threat by climate change. According to Nzeadibe et al., (2011), climate change is one of the most serious environmental and human threats undermining the achievement of the Millennium Development Goals (MDGs) and the international communities' efforts to reduce extreme poverty.

Climate change awareness in the Niger Delta

The Niger Delta had benefited from non-governmental organizations (NGOs), civil society and academic and policy-oriented awareness and advocacy on climate change. These include Community Research and Development Centre (CREDC) and Environmental Rights Action (ERA) which have been creating awareness about impacts of gas flaring and its linkages with climate change and poverty in the region (Uyigue, Agho, 2009, Nzeadibe et al., 2011). Notable among researches conducted in region on climate change include environmental degradation, vulnerability and mitigation of climate change impacts (Akinro et al., 2008), coastal management and adaptation to climate change (Etuonovbe, 2008), climate change, poverty and women's socio-economic challenges (Chinweze, Abiola-Oloke, 2009). Moreover, limited researches dealt with awareness of climate change and its impacts on MDGs in the Niger Delta region of Nigeria.

According to (Mani et al., 2008), adaptation is understood to include efforts to adjust to ongoing and potential effects of climate change. Noteworthy is the fact that farmers of Niger Delta communities, knowingly or unknowingly are adapting to the changing climatic conditions using their traditional knowledge, innovations and practices (Uyigue, Agho, 2009; Etuonovbe, 2008). Despite all these, it does appear that the level of awareness of farmers in the region of climate change and its impacts leaves much to be desired. As a result, the need for more awareness-raising among stakeholders about the phenomenon cannot be over-emphasized (Nzeadibe et al., 2011). With only about two years remaining for the MDGs and the Niger Delta region still struggling with aggravated climate change impacts attributed to concentration of greenhouse gases in the atmosphere, extensive dam construction, oil spillage, natural gas flaring, unfavourable farm practices, and over exploitation of natural resources found in the area. As majority of the people living in the Niger Delta are farmers, the environmental and social consequences of climate change is putting livelihoods at serious risks. Will MDGs really attain its goals in the Niger Delta? It is against this background that a study on awareness of climate change and implications for attaining the MDGs in the Niger Delta region of Nigeria was conducted with the following objectives which include to:

i. Determine the level of awareness of farmers about impacts of climate change in the study area
ii. Identify indigenous and emerging strategies for climate change adaptation in the study area and
iii. Investigate farmers' perceived implications of climate change in attaining the MDGs

iv. Make policy recommendations for building climate change resilience in the study area and national levels in Nigeria

Materials and methods

The study area

The area of this study is the Niger Delta region of Nigeria. The Niger Delta, as defined officially by the Nigerian government, covers about 70,000 km² of marshland, creeks, tributaries and lagoons that drain the Niger River into the Atlantic at the Bight of Biafra and makes up 7.5% of Nigeria's land mass consisting of the nine states of Abia, Akwa- Ibom, Bayelsa, Cross-River, Delta, Edo, Imo, Ondo and Rivers (Mba, Ogbuagu, 2013). The region is reputed for having diverse vegetation belts: from the largest rain forests in Nigeria to mangrove swamps, savannahs, mountains and waterfalls with rare animals, including endangered species and unusual plant families, making it one of the World's richest biodiversity centres attracting scientists and tourists. The region had a population of 31.2 million people at 2006 census (NPC, 2007) with more than 40 ethnic groups including the Bini, Efik, Ibibio, Annang, Oron, Ijaw, Itsekiri, Isoko, Urhobo, Ukwuani, and Kalabari, are among the inhabitants in the Niger Delta, speaking about 250 different dialects, the bulk of which lives in rural fishing and farming communities (http://en.wikipedia.org/wiki/Niger_Delta, 2013). The region is also the headquarters of Nigeria's oil and gas industry and currently the only oil and gas producing region in Nigeria (Nzeadibe and Ajaero 2010; Bakare et al., 2013). Regrettably, activities of multinational oil companies have recently been linked to degradation of the natural environment, pollution and low agricultural productivity (Abutudu et al., 2007; Ibeanu et al, 2007) as well as insecurity of lives and property, hence, a reduction in quality of life expectations in Niger Delta communities (Nzeadibe and Ajaero 2010). The Niger Delta region is therefore central to Nigeria's economic, environmental and geo-political importance.

Sampling technique, size and data collection

A multistage sampling technique was used for this study. In the first stage three states of Delta, Edo and Ondo were randomly selected from the nine (9) states that make up the Niger Delta region in Nigeria. In the second stage, using the delineation by the three (3) states' Agricultural Development Programmes (ADPs), two (2) agricultural zones were randomly selected from each state giving a total of six (6) agricultural zones. In the third stage, from each of the selected zones, two blocks were randomly selected for study. This gave a total of twelve (12) blocks. Initially, residents from the selected blocks were invited to a community forum at which a preliminary identification of different categories of households was carried out. At the community forum, fifteen (15) rural household members made up of males, females and youths who constituted the focus group were purposively selected from the list of those identified and discussions were held with them. During the community forum, Focus Group Discussion (FGD), and Key Informant Interviews (KII) and with the help of community leaders, a sampling frame of all farmers was built up in each community. From this list, random samples of 30 respondents were selected and interviewed using semi-structured interview schedules thus making a total sum of 360 respondents from the study area.

Data collection

The data collection method of Rapid Rural Appraisal (RRA) (transect walks, identification and inspection of farm lands) was used with the aim of encouraging the respondents to describe their relationship with their natural resources. Another advantage of this method is the identification of variables of importance to the rural dwellers and in the formulation of questions that were included in the more formal semi- structured interview schedule in locally meaningful terms. Two single gender Focus Group Discussions (FGDs), one for men and another for women were held with farmers in each state with number of participants ranging from 10-20. The resultant six FGDs were very helpful in eliciting clearer information from the respondents.

Data analysis

Descriptive statistics was used in data analysis. These included means, percentages, standard deviation and frequencies, charts, graphs and tables. The use of indigenous and emerging strategies for climate change in the study was measured on a three-point Likert-type scale of "always" (3), "rarely" (2) and "not at all". Adaptation strategies with mean scores of ≥ 2.5 were regarded "highly adopted", strategies with mean responses from 1.5

to 2.49 were regarded "adequately adopted while those with mean less than 1.5 were regarded as "poorly adopted.

Results and discussion

Respondent's' level of awareness of climate change

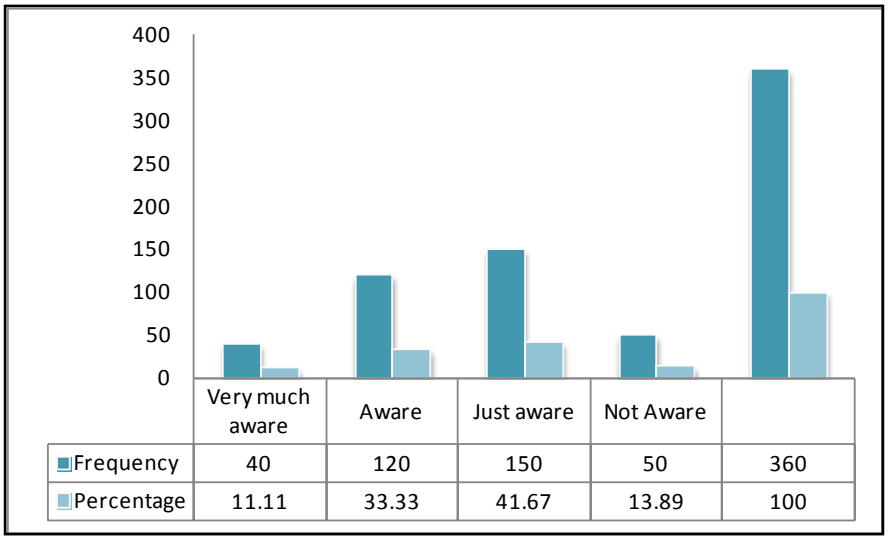
The result of respondents' level of awareness of climate change in the study area as shown in Figure 1 indicates that only 11.11% of the respondents were very much aware, 33.33% were aware, 41.67% were just aware while 13.89% were not aware at. The findings indicate that the level of awareness is still low in the study area but there is an improvement over a similar study conducted by Nzeadibe et al, (2011) who found that the level of awareness of climate change impacts was very low in the Niger Delta region of Nigeria with about 60% of respondents knowing little or nothing about climate change and its impacts.

Respondents' understanding of climate change

This study researched into respondents' understanding of climate change (Figure 2). Inquisitively, 50% of respondents indicated that they understood climate change as "change in weather". This observation is probably representative of the most basic understanding of the term "climate change". 13% related climate change to "prolonged drought" while 8% understood it as "excessive sunshine". Only 10% of respondents understood climate change as "heavy rainfall", 4% implied it to mean "poor yield" while just 3% took climate change for ozone layer depletion. The percentage of the respondents that had no idea of the concept of climate change was 12%. Those that had no idea of climate concept were as a result of non-awareness of the phenomenon.

Respondents' source of information on climate change

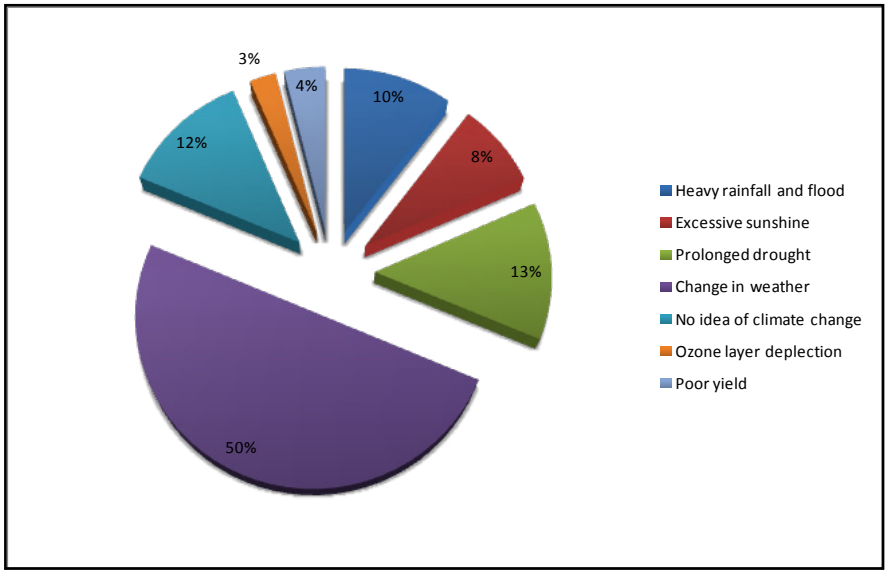
Availability and accessibility to information on climate change is a key determinant of level of awareness, understanding, and knowledge of climate change. It is crystal clear from Table 1 that the respondent received information mostly on climate change from the following three major sources; radio/television (50.83%), newspaper (25.28%), and friends (21.39%). Other sources included internet (9.72%), researchers (8.6%), extension workers (12.22%), farmers' co-operative (9.44%) and politicians (3.61%). The implication of the above is that the mass media remains that largest source of information to the respondents. The result also implies that extension workers had played little role in informing respondents on the climate change. This could be in part, due to the very small extension to farmer ratio in the country as extension services are poorly funded. Again, high incidence of poverty in country may explain why responses to newspaper were low (25.28%). More also, research is poorly funded and frequent power failure and poor communication



	Very much aware	Aware	Just aware	Not Aware	
Frequency	40	120	150	50	360
Percentage	11.11	33.33	41.67	13.89	100

Source: Computed from field survey, 2013

Figure 1: Respondents' level of awareness of climate change.



Source: Computed from field survey, 2013

Figure 2: Respondents' understanding of climate change.

Source of information*	Frequency	Percentage (%)
Extension workers	44	12.22
Friends	77	21.39
Farmers' co-operatives	34	9.44
Politicians	13	3.61
Internet	35	9.72
Newspaper	91	25.28
Radio/Television	183	50.83
Researchers	31	8.61

*Multiple response exist

Source: Computed from field survey, 2013

Table 1: Respondents' source of climate change phenomenon.

networks would have been largely responsible for low percentages to internet and researchers.

Respondents' indigenous and emerging strategies for climate change adaptation

Table 2 shows 27 indigenous and emerging strategies for climate change adaptation used by farmers in the Niger Delta region of Nigeria. This result revealed that out of the 27 adaptive strategies, 7 were "highly adopted" by the famers as reflected in their mean score values of ≥ 2.5. These strategies for climate change adaptation included the use of organic manures, planting of cover crops, planting of trees, increase in number of weeding, protection of water sheds, mulching, preservation of seeds/seedlings for planting and use of windbreaks/shelter belts. The remaining 20 strategies were "adequately adopted" given mean score values from 1.5 to 2.49. It was however noteworthy that none of the strategies was "poorly adopted". These findings corroborated (Nzeadibe et al, 2011, Ogunleye and Yekini, 2012) who concluded that the widely adopted adaptation measures of climate in the Niger Delta region were planting cover crops like melon to help conserve soil moisture, zero tillage so as not to expose the soil to loss of nutrients, regular weeding of cropped farmland, early planting with first rain especially for crops like maize and cassava, mulching and use of organic manure, preservation and selection of seeds for next planting season.

Adaptive strategies	Always (%)	Rarely (%)	Not at all (%)	Mean	Remarks
Early and late planting	58.05	26.40	15.56	2.42	A
Soil conservation and water	53.61	33.89	12.5	2.41	A
Use of organic manures	64.72	21.11	14.17	2.51	H
Use of inorganic fertilizer	57.78	25.28	16.94	2.41	A
Planting pest and disease resistant crop	56.95	24.44	18.61	2.38	A
Use of crops varieties that are well acclimated	36.94	25.28	37.78	1.99	A
Draining of wetland for crop cultivation	25.83	33.89	40.28	1.86	A
Making of contour bund around farmland	44.45	21.11	34.44	2.10	A
Planting of cover crops	66.94	20.56	12.50	2.54	H
Planting of trees	67.22	15.56	17.22	2.50	H
Minimum tillage system (zero/ minimum)	48.61	30.83	20.56	2.28	A
Use of irrigation system/water storage	27.50	34.17	38.33	1.89	A
Reforestation/ Afforestation	28.33	26.67	45.00	1.83	A
Use of chemicals like herbicide, insecticide	63.06	22.78	14.16	2.49	A
Increase in number of weeding	70.56	12.50	16.94	2.54	H
Use of early maturing crop varieties	60.28	27.22	12.50	2.48	A
Protection of water sheds and mulching	62.78	25.83	11.39	2.51	H
Preservation of seeds/seedlings for planting	66.11	18.33	15.56	2.51	H
Use of weather-resistant variety	42.22	26.94	30.83	2.11	A
Reducing access to eroded/erosion prone area	72.22	15.56	12.22	2.60	A
Mixed farming practices	49.17	26.11	24.72	2.24	A
Use of recommended planting distance	53.61	28.33	18.06	2.36	A
Changing the timing of land preparation	53.61	25.56	20.83	2.33	A
Changing harvesting dates	49.17	28.33	22.50	2.27	A
Out migration from climate risk areas	66.39	15.00	18.61	2.48	A
Use of windbreaks/shelter belts	72.22	18.61	9.167	2.63	H
Reclamation of wetlands/ river valleys	57.78	22.50	19.72	2.38	A

Source: Computed from field survey, 2013

Table 2: Respondents' indigenous and emerging strategies for climate change adaptation.

MDGs*	Yes (%)	No (%)	Rank
Eradicate extreme poverty and hunger	53.33	46.67	3rd
Achieve universal primary education	30.27	69.73	6th
Promote gender equality and empower women	39.72	60.28	5th
Reduce child mortality	27.22	72.78	8th
Improve maternal health	49.44	50.56	4th
Combat HIV/AIDS, malaria and other diseases	30.28	69.72	7th
Ensure environmental sustainability	61.67	38.33	1st
Develop a global Partnership for Development	56.94	43.056	2nd

* Multiple response exist

Source: Computed from field survey, 2013

Table 3: Climate change implications on attaining the MDGs.

Climate change implications on attaining the MDGs

The respondents were precise in responding "yes" or "no" to the question of whether climate change had implications on achieving the MDGs (Table 3). As shown by the percentage of responses to each MDGs, ensure environmental sustainability, develop

a global partnership for development, eradicate extreme poverty and hunger were the three MDGs according to the respondents may not be attained ranking 1st, 2nd and 3rd respectively citing extreme impacts of climate on them in the Niger Delta region. However, MDGs of reducing child mortality and combating HIV/AIDS, malaria and diseases were the least affected by climate change.

Conclusion

The study was conducted to determine awareness of climate change and implications for attaining the MDGs in the Niger Delta region of Nigeria. The study specifically revealed that the level of awareness of farmers about impacts of climate change in the study area as 11.11% of the respondents were very much aware, 33.33% were aware, 41.67% were just aware while 13.89% were not aware at all. The sum of the percentages of farmers that were aware i.e. much aware, aware and just aware was 86.11%. This level of awareness is an improvement over the result of Nzeadibe et al, (2011) who found that 60% of farmers in Niger Delta region of Nigeria knew little or nothing about climate change and its impacts. The study also found that this improvement was due mostly to the advocacy created by the mass media.

The study also identified 27 indigenous and emerging strategies for climate change adaptation used by the farmers. The study revealed that out of the 27 adaptive strategies, 7 were "highly adopted" by the famers, 20 strategies were "adequately adopted" while none was "poorly adopted". The 7 "highly adopted" strategies included the use of organic manures, planting of cover crops, planting of trees, increase in number of weeding, protection of water sheds, mulching, preservation of seeds/seedlings for planting and use of windbreaks/shelter belts.

The investigated farmers' perceived implications of climate change in attaining the MDGs revealed that ensuring environmental sustainability, developing a global partnership for development; eradicating extreme poverty and hunger were the three MDGs which may not be attained ranking 1st, 2nd and 3rd respectively. If these MDGs are therefore to be attained, then there is need for more inclusive collaboration among stakeholders for evolving innovative approaches and adaptive strategies for the climate change adaptation in the Niger Delta region.

Based on the above findings, the following recommendations are made:

i. Farmers and policy makers should tap into the vast potential of the media to disseminate climate change information and create more awareness about causes, and consequences of climate change as well as strategies for climate change adaptation in the Niger Delta.

ii. Extension workers, the media, researchers and civil society groups should build on the existing information apparatus in the Niger Delta region to diffuse the adaptive strategies for widespread adoption in other communities.

iii. Adequate investment in research and capacity building should be made on the identified indigenous and emerging strategies to climate change adaption in the Niger Delta region.

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Accessibility of the Regional Information Based on the Regional Information Structure Framework

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Anotace

Příspěvek se zabývá dlouhodobě aktuální problematikou efektivní implementace informačních a komunikačních technologií ve venkovských regionech, především pak dostupností regionálních informací a velkých kolekcí dat vztahujících se k území.

Prezentované výstupy vycházejí z dlouhodobé výzkumné činnosti na Katedře informačních technologií PEF ČZU v Praze v oblasti regionální informatiky, problematiky digitální propasti a jsou v souladu se strategickými cíli Digital Agenda 2020. Jsou zde popsány a definovány prvky obecného modelu dostupnosti regionálních informací - Regionální informační struktura (RIS) a Regionální informační vazba (RIV).

Klíčová slova

Dostupnost informací, region, venkov, framework, Regionální informační struktura, Regionální informační vazba, Digital Agenda 2020, podpora podnikání, kvalita života.

Abstract

The paper addresses the issue of effective implementation of the information and communication technologies in rural areas with the special focus on the accessibility of regional information and big collections of data related to the location.

Presented results comes from long term research at the Department of Information Technologies FEM CULS in Prague in the areas of regional informatics and digital divide, and are compliant with strategic goals of Digital Agenda for Europe: A Europe 2020 Initiative. Description and definition of the general framework of the accessibility of regional information – Regional Information Structure (RIS) and Regional Information Relation (RIR) is introduced in the paper.

Key words

Information accessibility, region, rural areas, framework, Regional Information Structure, Regional Information Relation, Digital Agenda 2020, support of business, quality of life.

Introduction

One of the principles that the European civilization is built upon is the equal access of its inhabitants to resources, services and generally to all results of human activity. There are number of places and groups that do not have access to them, such as national minorities, women and men, young and elderly persons, people living in rural and urban areas, etc. It is needed to use findings from various scientific disciplines to find solutions to remove inequalities (Kloudová, 2013).

The imbalance of economic and social relationships between cities and rural areas is generally accepted and caused with many historical, geographical, political and economical phenomena. One of the key tools for rural development and exploitation of its potential is the use of the information and communication technologies (Taušová, 2013).

In general terms, it can be stated that the contribution for the countryside is in better accessibility of information, quality communication, accessibility of services and education, etc. It is needed to say that these general facts cannot bring required results by themselves without development of mutual relations and participation of all relevant regional subjects.

The line connecting all directions of rural development is represented by the information and communication technologies (sometimes called with all-embracing term the Internet). Benefits need to be found in activities that are conducted more effectively so that they bring an economic profit (Lönnqvist, 2013), (Shelomentseva, 2013). Three areas where ICT has a potential for growth and development in rural areas are such as (Viturka, 2011):

Support of business

That includes the set of activities and processes that are already conducted in rural areas but their effectiveness might be multiplied by the information and communication technologies in the way that was not realisable before (Leitão, 2011).

» Region presentation is one of the basic marketing tools for regional development where numerous potential areas could be presented (Vaněk, 2012) such as:
  - Services for hobbies (leisure time activities) are most mentioned and implemented area including traveling, accommodation, sports, culture, products, etc. (Min, 2011);
  - Investment opportunities for the investors are welcomed in all regions, but introductory information about the region is necessary;
  - Regional products and services that are specialties and have specific features of the region.
» Accessibility of information as the main contribution for the development can be seen in its economic appreciation;
» Education – higher accessibility of education in regions is a fundamental building block of human resources development and the use of modern technologies, eg. (Feng, 2013).
» Accessibility of services – that makes the business easier and more effective, namely eGovernment, electronic banking, electronic communication, eConsultancy, etc.

Starting own business

New business opportunities that were not possible without the information and communication technologies such as:

» Homeworking – there is a large potential for employment of rural inhabitants without any geographical limits;
» Information technology services - participation in huge and dynamically developing market of immaterial information and communication technologies (software development, design, services, etc.);
» Business - electronic commerce with material and immaterial commodities.

Improvement of quality of life

The term "quality of life" is rather relative and very disputable. We will deal with the quality of life in terms of the communication and information accessibility in this paper (Salmelin, 2005):

» Social cohesion in places where is a strong community aspect. Even if the people live in isolated locations, they need to be included in various communities that relate to their social background, hobbies, other interests, etc. The social media play a significant role in it.
» Entertainment and consumer behaviour can bring better quality of life through access to the high-speed Internet. The interactive content is customized for entertainment and professional purposes no matter of the location of consumers. We can include for example interactive TV programmes, new forms of content in all media and so on. Collaborative games as another example demand good level of Internet connection as well.
» Education and training in distant and rural areas can be guaranteed only if new eLearning technologies are used. This represents not only technical connection and creation of content but also the redesign of pedagogical systems is required so that they correspond with needs of skills acquisition and lifelong learning. Education and training are important for social inclusion, for mitigation of differences in training opportunities in rural and urban areas, and for the emergence of new opportunities.
» Public services represent an important factor for service providers (local, regional or national administration) and for social inclusion. The use of modern infrastructure and services will assure availability and access to the public services, and the quality of life and security for people living and coming to rural areas.

It is fundamental to make the rural and distant areas more attractive, to lower their isolation, and to reach higher productivity by means of the innovative use of modern technologies of the knowledge society. Systematic innovations with concurrence of policy, technology and social implementation are demanded to reach these goals.

The goal of the information and communication technologies development in rural areas should be to reach higher quality of life and sustainable development, but not only the implementation of ICT. Technologies provide necessary infrastructure for data and information management (Jelonek, 2013). The tool for rural development is the accessibility and transfer of the information and the development of services based on the network technologies and the net economy (Liu, 2013). Information is needed for decision making while services are needed for creation of economic assets. As the information management in enterprises is described theoretically and practically, the similar structures for information management in regions need to be found.

Materials and methods

Presented results comes from long term research at the Department of Information Technologies FEM CULS in Prague in the areas of regional informatics and digital divide, and are compliant with strategic goals of Digital Agenda for Europe: A Europe 2020 Initiative. Case Study Method (CSM) according the Robert K Yin (Yin, 2009) was used for. CSM is, as Yin states, "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". Further, the CSM "copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result, relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result, benefits from the prior development of theoretical propositions to guide data collection and analysis.

Research material includes a set of data publicly accessible through web services with geographical (regional) identification. Basic location unit that was examined is regional unit called NUTS 3, regions of the Czech Republic respectively. The goal of the paper is to present a general framework of the accessibility of regional information.

Results and discussion

When it comes to investigation of data and information transfer within a region, it is needed to set a certain structure, or types of structures, that can serve for both quantitative and qualitative evaluation of data and information transfer. All subjects located in particular region are involved in data production. The subjects are state and local administration bodies, companies, businesses, interest groups, regional and professional associations and others. Their structure totally differs in terms of legal, competencies and organisation. The common characteristic is that all of them produce particular data (based on business, ethic, legal or other purposes) which they publish online through Internet web services with the aim to address specific target group (such as customers, citizens, investors, etc.).

It is not possible to use existing connections and structures with subjects that have such large divergence among them. It is needed to perceive even various legal and institutional systems in countries. Based on these reasons, there has to be a virtual structure of subjects defined that is founded with existing and potentially available information flows and services – an information structure of regional subjects (Regional Information Structure).

Particular subjects can be organized in layers of the pyramid structure. According to the information content and position in the region the subjects can be divided in five basic layers (Figure 1).

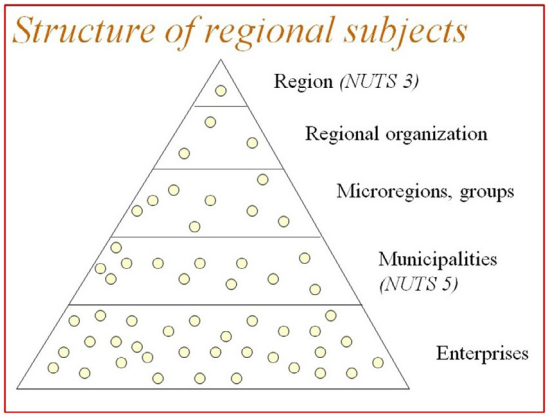

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Figure 1: Information structure of regional subjects (Regional Information Structure).

» Enterprises (organizations) are economic tools for regional development and the cornerstone that includes all

entrepreneurial subjects despite legal form that offer their products and services. Local associations and groups, budgetary and semi-budgetary organizations such as schools, hospitals and others, can be included in this category because they fulfil similar functions.

» Municipality is a smallest administrative division (corresponding with NUTS 5 level) that is naturally superior to the enterprise layer in the region and provides its own large information services.

» Micro region is a group of municipalities and enterprises with common area of interest (tourism, culture, ecology, services, etc.). This division is used for legal purposes and for directives for drawing of structural funds. It is often not a sole subject (legal entity), but the superior unit might be for example a common project.

» Regional organizations are subjects that have significant position (business, interest, social, etc.) in the region. They could represent regional branches of national organizations and institutions (such as CzechInvest, Czech Chamber of Commerce and others), units established by the regional office to ensure development of certain sphere (eg. tourism), but also the subjects originated from different foundations having significance in the whole region.

» Region is a higher-level territorial administrative unit in the Czech Republic that is represented by the regional office and belongs to NUTS 3 level. It is a body with distinctive competencies in regional development and is a significant information resource that operates its own large information service.

Data transfers are not limited only to region borders. Each region is a part of other larger territorial units such as national states and the European Union in the European context:

» State organizations and institutions are similar to "regional organizations" but at the countrywide level they comprise subjects having significant and uniting position in some areas (such as business, interest, social, etc.) in the state (that is at the NUTS 1 level). They could be represented by countrywide organisations and institutions (eg. CzechInvest, Czech Chamber of Commerce and others), resort ministries, companies (eg. banks), but also by subjects established from other purposes and significant at whole state scope. Some web portals could be also included in this category such as The Portal of Public Administration (2014).

» Pan-European organisations and institutions that include organisations, institutions, projects, associations and further bodies that have some degree of importance in transfer of data and information such as Eurostat, visiteurope.com, etc.

» State and the European Union represent logical links in the information structure, but their role is rather covering and legislative. Regarding the number of interest areas, they delegate competencies on specialized resort organisations and institutions that cover the given interest area (see State organizations and institutions and Pan-European organizations and institutions).

We suppose that each subject that publishes data on the Internet is concerned with the maximum number of visitor on the website that will use their information and services. The most used ways of online information promotion is registration in the subject directory (such as Seznam.cz, Yahoo! Directory or Google Directory) or making it available for full-text search engines (eg. Google.com) by means of Search Engine Optimization (SEO) and Internet marketing methods. Further choice is to place backlinks on affiliated web sites. Very often used method is to make the promotion of web sites in non-electronic media. Connections among particular web pages established from the initiative and knowledge of individuals can be called as Regional Information Relation - Individual. Individual relations within information structure are depicted on the Figure 2. Subjects outside the pyramid are supposed to be supranational search engines.

Individual information relations belong among first level of Internet development that is dominant in these days. Main tool for information search on the Internet is the search engine that seems to keep its importance globally. However, search engines cannot ensure the information accessibility of full regional information and development of services of the information society. This is due to large number and differences of regional subjects participating in information base of the region. Regional information relations need to be created on this level so that they ensure

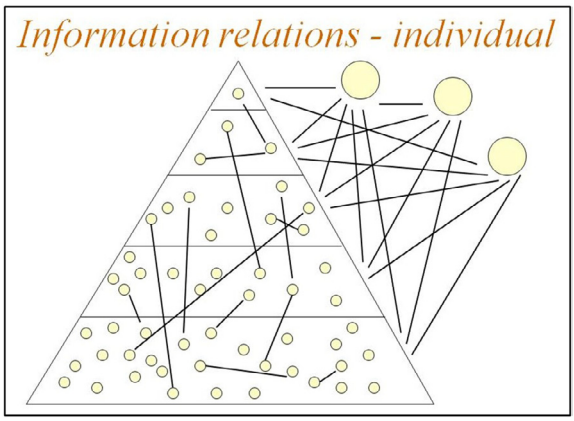

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Figure 2: Regional Information Relations – Individual.

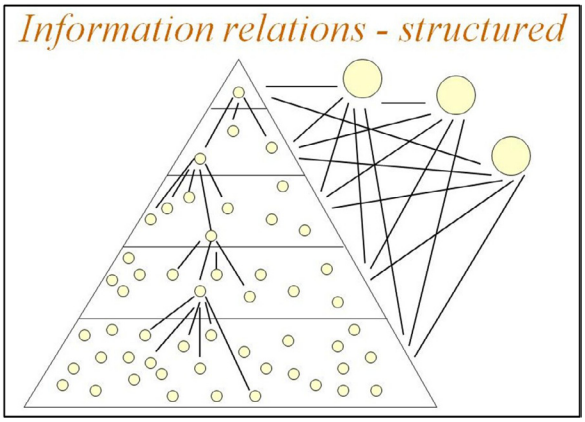

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Figure 3: Regional Information Relations – Structured.

Indicator	Regional Information Relation		
	Individual	Structured offline	Structured online
Creation	Individual	Concept, cooperation	Concept, cooperation
Connection	Random links	Structured links	Structured links
Acquisition	Many times	Many times	Once
Update	Manual	Manual	Automatic
Recency	Very low	Low	Instant
Error rate	Very high	High	None
Accessibility	Low	High	High
Benefit	Incomplete information	Complete information	Complete information and services
Need of cooperation	None	Low	High
Data structure	Free	Free	Standardized
Technology	Free	Free	Open
Development potential	Low	High	Very high

Source: own processing

Table 1: Comparison of regional information relations.

the access to full and timely information, and enable to develop services that implement data transfer and exchange. Such type of relation is a Regional Information Relation – Structured (Figure 3) that is created in a cooperative manner (organisational and technological).

Structured relations could be of various quality. First level of the development is **offline structured relation** that poses a certain degree of structure in topic links between relating layers of regional information structure. Higher level, that is supposed to be the target, is structured relation enabling **online transfer** (information flows) between particular layers of regional structure. Main differences are summarized in the Table 1 above.

Besides various degrees of information relation development the depth of relation is evaluated as a number of layers from which the subjects are linked to the relation. In practice, there can be two, three and rarely four linked layers. Relations can exist between various layers and can reach over the regional structures (e.g. the relation with State organizations and institutions). The fundamental are relations between two layers that build high-level relations (Figure 4).

From the perspective of technology, everything can be connected, but the problem is in the human factor (Feng, 2013). Information transfer in the region must be compliant with following conditions:

- » Each information is acquired only once;
- » Further communication must be done in logical way;

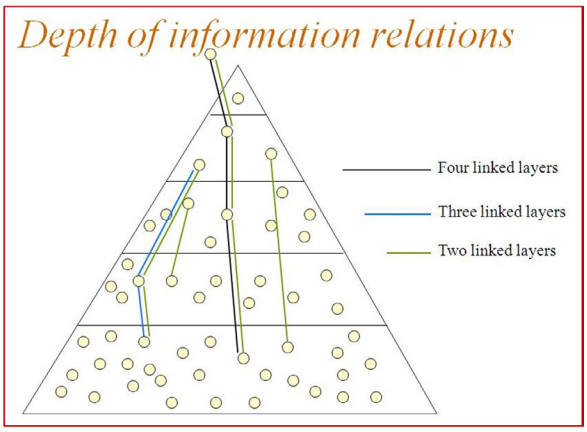

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Figure 4: Depth of information relations.

- » Information must be used for the marketing, otherwise it looses its purpose;
- » Information must be timely;
- » System of information transfer must be ensured on the basis of cooperation between commercial and non-commercial servers.

Only the structured online regional information relation complies with the above stated conditions.

Conclusion

The significant aspect of the regional development is accessibility and transferability of the information and service development based on the network technologies and the net economy. Information is necessary for decision-making, while services are tools for economic assets production.

Based on obtained research results we can conclude that the proposed framework of Regional Information Structure (RIS) and Regional Information Relation (RIR) is substantial and can be used for evaluation of implementation of the information and communication technologies in regions.

- » Regional Information Structure (RIS) provides description and setting of regional subjects that participate in creation, processing and transfer of publicly accessible information in the region that includes commercial and non-commercial subjects;
- » Regional Information Relation (RIR) describes the way of transfer of publicly accessible information among regional subjects where the highest target level is the structured relation that enables online transfer od data (information flows) among layers of regional structures.

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Key Factors Affecting the Profitability of Farms in the Czech Republic

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Anotace

Příspěvek se zabývá hodnocením ekonomické situace českých zemědělských podniků a jejím vývojem v delší časové řadě. Analýza byla provedena na základě vlastní databáze výběrového souboru zemědělských podniků tříděných podle regionů LFA, výrobního zaměření a velikosti podniku. Růst produkce je způsoben především růstem výnosů z rostlinné výroby, podíl výnosů z živočišné výroby a nezemědělské výroby klesá. Výrazným trendem ve sledovaném období je růst produktivity práce, který je ovlivněn především snižováním počtu pracovníků. Vzhledem k vysoké závislosti výsledku hospodaření v zemědělství na vnějších podmínkách je vývoj tohoto ukazatele charakteristický výraznými výkyvy. Závislost výsledku hospodaření na dotacích je největší v horských LFA. Podniky zaměřené na rostlinnou výrobu jsou nejméně závislé na dotacích, ale jejich výsledky hospodaření jsou nejvíce ovlivněny ostatními vnějšími podmínkami hospodaření, především klimatickými podmínkami a cenovým vývojem.

Klíčová slova

Výsledek hospodaření, rentabilita, produktivita práce, dotace, LFA.

Abstract

The paper deals with assessment of the economic situation of Czech farms and its development in a long time-line. The analysis is based on our own database of farms in a sample of farms classified by LFA, production type and size. An increase of production is mainly caused by an increase in crop production revenues, animal and non-agricultural production revenues are decreasing. An increase of labour productivity is an important tendency in the period influenced mainly by decreasing the number of workers. Due to the high dependency of profit or loss in agriculture on environmental conditions, the development of indicators is characterized by significant fluctuations. The dependence of profit on subsidies is greatest in the mountain LFA. Enterprises focused on crop production are the least dependent on subsidies, but their profit is the most affected by other external economic conditions, particularly by climatic conditions and price developments.

Key words

Profit/loss, profitability, labour productivity, subsidies, LFA.

Introduction

Compared to other sectors of the economy agriculture is known for its specific features. First of all, production processes in agriculture are complemented by a factor of influence of natural conditions, the weather, length of production processes and the associated length of current assets turnover. For obvious reasons, the position of the agricultural sector becomes a subject of political discussions because of the high proportion of utilization of public money. Generally, agriculture can be included in the primary sector, as there is a direct contact with nature and manufacturers gaining products in conjunction with natural influences. It is an economic activity that characterizes the production of products and related services. The traditional role of agriculture as a primary sector and food producers is accompanied by the production of non-food and non-production features that is becoming larger size.

In 2012, the agricultural sector contributed to the total gross value added of 1.32%, representing a decrease of 0.09 percentage points Developments in agricultural producer prices in 2012 showed an annual increase of 4.1%, which, however, lagged behind the growth in producer prices in 2011,

which amounted to 19.1%. According to the Czech Statistical Office (CSO) data, the share of employees in agriculture decreased by 0.02 percentage points Agriculture continues to be characterized by a lagging wage disparity in the level of average wages for the average of the Czech Republic. In 2012, this gap was reduced to 78%. The growth of nominal wages of workers in agriculture was 5.0%; which was higher than the rate of inflation, so the real wage grew by 1.7% (MZe, 2013).

In 2012, a high economic standard with the beginning in 2011 was maintained (after a decline in 2009 and a modest recovery in 2010) with 16.1 billion CZK as the overall economic performance of the sector which is the second highest profit achieved after 1990. The value of production of the agricultural sector in 2012 compared to 2011 showed only a slight increase of 2.5%. This trend was involved in crop production increase of 1.9% and livestock production by 3.7%. The increase in production value in 2012 was not as in 2011 due to growth in the volume of production, but only a rise in the price of agricultural production, which compensated the volume decline of most commodities (MZe, 2013).

According to the CSO data on final harvests, the crop production declined for almost all major commodities. The decrease in the volume of production occurred in cereals, legumes, potatoes, sugar beet, sunflower, poppy, hops, grapes and vegetables. A significant increase in the volume of output was recorded on the contrary, for rape by 6.0%, which corresponds to the trend of recent years, and fruits. The price increases of up to 15 % were recorded for all crop production market commodities (with the exception of potatoes). In livestock production, according to the CSO data on the results of livestock production the growth was recorded for milk and poultry meat, beef with stagnation, decline in pork and eggs. Prices of animal products increased (with the exception of cow's milk – a decline of about 6%). Record price growth was recorded for eggs (55.8%) after failure of imports from Poland. Overall, positive aggregate economic results of agriculture sector in 2012 were accompanied with high share of intermediate consumption of more than 70% in comparison with the top EU countries at around 50% (MZe, 2013).

The aim of the paper is to assess the economic situation of Czech farms and its development in a long time-line. This aim includes partial tasks: to evaluate the structure of production of agricultural companies and its changes up to 2000, to judge the financial indicators, the effectiveness of factors of production, to evaluate the results of synthetic models of financial health, to judge the dependence of profit on subsidies. Within the solution of partial aims the results among groups of companies divided according to LFA, type of production and economic size, will be compared.

Materials and methods

The data necessary to the research were based on original sample prepared at the University of South Bohemia in České Budějovice since 1996. The sample consists of about 100 farms all over the Czech Republic. The crucial data are collected from financial and production statements – Balance sheet, Profit loss statement, Annual statement on harvest and Statement on sowing areas. The data are completed by an original questionnaire with additional information on economy and production. The results are calculated as an average per farm or hectare of land or one worker. The paper used sorting of enterprises into groups according to the share of agricultural land in the LFA to the total utilized agricultural area (UAA), as well as the type of production and by the size.

According to the relation to the less favoured areas, the enterprises are classified according to the methodology of FADN (2012):

- Mountain areas (LFA M) – more than 50% of UAA in mountain LFA;
- Other LFA (LFA O) – more than 50% of UAA in LFA and LFA M less than 50%;
- NON LFA – more than 50% of UAA outside the LFA.

Classification by type of farming was based on the prevailing share of revenues from crop and animal production, with the fact that businesses with sales of crop production or livestock production higher than 2/3 were belonging to the group and the other belongs to a group of mixed agricultural production.

To sort the size of the company was using the rules of the European Union (Annex I of Commission Regulation (EC) No 800/2008). Given that there were only 0-5 micro-enterprises and large enterprises in the sample for each year, only the group of small and medium-sized enterprises was assessed.

Within the analysis of the structure of production the analysis of the indicators of the volume of aggregate production in monetary units, the volumes of production of major commodities of vegetable and animal production, natural yields and the efficiency of production are carried out.

For the analysis of profitability, capital structure and liquidity basic indicators of financial analysis (Giroux, 2003; Peterson and Fabozzi, 2006) will be used and assessment of the interaction between these indicators in the period 2000 to 2012.

The effectiveness of the factors of production is evaluated by means of the indicators of production intensity, labour productivity and activity. The relationship of revenues to the area of agricultural land is characterized by the intensity of production, the relationship towards the average number of employees is characterized by the labour productivity and the relationship between revenues and assets is characterized by the activity (turnover). The dynamics of labour productivity is decomposed into causal impacts of dynamics of revenues and number of workers:

$$\Delta LP = \Delta LP_R + \Delta LP_E$$

$$\Delta LP_R = \ln I_R / \ln I_{LP} \,.\, \Delta LP$$

$$\Delta LP_E = - \ln I_E / \ln I_{LP} \,.\, \Delta LP$$

where:

R – revenues

E – number of employees

LP – labour productivity, R / E

ΔLP – absolute change of labour productivity between periods

ΔLP_R – absolute change of labour productivity due to revenues

ΔLP_E – absolute change of labour productivity due to number of employees

For the aggregate evaluation of financial health of companies the most widely used prediction and diagnostic models were used. Among the worldwide most frequent models we can rank Altman's models, which exist in several modifications. In our case it was the modification of Z-score from 1983 (Altman, 2002) regarded the unknowingness of market values of equity of companies. From the Czech models the IN05 index was used (Neumaier and Neumaierová, 2005). The IN95 model is specified also for the branch of agriculture, but the parameters of model IN05 were estimated on newer data. For this reason also the Slovak model G-index (Gurčík, 2002) suitable for evaluation of the Czech agricultural companies (Kopta, 2009; Zdeněk, 2012) was included into the evaluation of companies, Altman's model in the form Altman (2002):

$$Z = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.120x_4 + 0.998x_5$$

where:

x_1 – working capital / assets,

x_2 – retained profits / assets

x_3 – profit before interest and tax / assets

x_4 – equity / debt

x_5 – revenues / assets

Index IN05 in the form of Neumaier and Neumaierová (2005):

$$IN05 = 0.13x_1 + 0.04x_2 + 3.97x_3 + 0.21x_4 + 0.09x_5$$

where:

x_1 – assets / debt,

x_2 – profit before interest and tax / interest cost (max. 9)

x_3 – profit before interest and tax /assets

x_4 – revenues / assets

x_5 – current assets / short-term liabilities

G-index in the form of Gurčík (2002):

$$G = 3{,}142x_1 + 2{,}226x_2 + 3{,}277x_3 + 3{,}149x_4 + 2{,}063x_5$$

where:

x_1 – retained profits / assets,

x_2 – profit before tax / assets

x_3 – profit before tax / revenues

x_4 – cash flow / assets

x_5 – inventories / revenues

For the evaluation of the development of subsidies the so called index of dependence on subsidies, which represents the cost rate adjusted for subsidies, where the value over 100% express what share of company costs is needed to be covered by subsidies. The dependence between the volume of subsidies and profit in time is described by linear regression and correlation analysis.

The farms in the EU countries are distinguishable by three main factors: the structural characteristics, for their financial characteristics and their productive orientation and the importance of subsidies on the farms. The four clusters of farms obtained show that the farms in the EU broadly fall

in the North and Central Europe, the Mediterranean and the East (Dos Santos 2013). Different methods of classification of farms are used in studies evaluating the economic efficiency of farms such as by type of farming according to the FADN classification, which is based on the economic categories of standard gross margin (Divila and Sokol, 1999), or by agricultural production areas, or by legal form of enterprise (Grznár and Szabo, 2002). Tavernier and Tolomeo (2004) studied the relationship between farm size and sustainable agriculture for different classes of farms. Different authors suggested various methodologies to establish farm types. Duvernoy (2000) successfully used land cover as a criterion to identify farm types. Adamišin and Kotulič (2013) evaluated the economic performance of farms in Slovenia sorted by legal forms of enterprise and demonstrated a higher economic return for the companies compared to the cooperatives. According to them, better economic performance of the company may be caused not only by different management approaches, but also a better starting situation. Bojnec and Latruffe (2013) find that small farms are less technically efficient. The decline in the number of medium-size farms which has been observed since the accession to the EU may be explained by the fact that medium farms cumulate all disadvantages in terms of performance: they are too small to be economically efficient, but they are too large to be profitable. Size has a positive effect on technical efficiency, by contrast, it has a negative effect on allocative efficiency, but the effect on the overall economic efficiency is positive. As for profitability, farm size has a negative link with it. Regarding subsidies, they have a negative influence on technical efficiency, by contrast, they have a positive influence on allocative efficiency, but the influence on the overall economic efficiency is negative. As for profitability, subsidies have a positive relationship with it. Brožová and Vaněk (2013) strive to analyze as well the viability of organic farms and their contribution to sustainable agriculture and environment. The research showed that the share of profitable organic farms was much higher than in conventional agriculture. However, this result was conditioned by including subsidies in the total revenues. Szabo and Grznár (2013) say that position of Slovak farms in the LFA conditions is far from flattering: they hardly achieve the average performance of the LFA farms in the EU-25; neither do they receive the amount of supports received by these farms in the Union. The legal persons and business companies achieve better results almost in all the indicators than agricultural cooperatives.

Adamišin and Kotulič (2013) say that slow structural change and high subsidization of agriculture calls for studies on whether such conditions could explain the low performance of the agricultural sector, and, if so, what is the effect of the implementation of the high subsidizing CAP on farms' behaviour and survival possibilities. As summarised by Gorton and Davidova (2004), the question of farms' productivity and efficiency in post-socialist countries is crucial to understand whether the countries could compete within the enlarged EU after their accession and how farm structures in these countries would evolve. In particular, farms' survival is an important issue, as it is decisive for land use and sustainable rural development, the presence of farms avoiding land abandonment and providing employment and green amenities in rural areas. Land abandonment has been relatively high in post-socialist countries after the transition, due to political and economic changes. Kuemmerle et al. (2009) cite declining returns from farming, tenure insecurity and demographic developments as main causes of such phenomenon. These problems are dealt with outside the EU too, for example by Singh (2013) at small farmers without any income from non-agricultural activities have very little chance to absorb losses caused by even one year of crop failure. That agriculture is becoming less attractive as a business and people are moving to urban centers, more and more land is coming to a forced lease.

The ongoing political discussions on the future of the CAP indicate a further strengthening and enhancement of the environmental objectives of EU agricultural policy. Alongside policy changes, important structural developments have taken place in the global markets, such as the energy price rise and the expansion of bioenergy production, greater commodity price volatility, shift in consumption patterns in developing countries and climatic changes. These external drivers put new pressures on the agricultural sector but there is also a reaction from the policy side leading to an adjustment in policy objectives and changes of policy instruments (Paloma at al., 2013). According to Petrick and Zier (2012), the amount of direct payments has become increasingly difficult to be defensible to the public and the results of their study suggest that a moderate reduction of these payments will have a negative impact on employment in agriculture. On the other hand Latruffe at al. (2013) say, that the removal of the CAP could

induce a substantial share of farmers to exit farming that the change in strategies following this policy change would vary across farm, and that economic opportunities outside agriculture would be essential. All these findings reveal that a dramatic break in support policy, such as the one implemented in New Zealand, may need to be accompanied by a specific transitional programme, such as the Exit Grant scheme in New Zealand (Rae et al., 2003), and a strong policy for the development of off-farm opportunities. Acs at al. (2010) proved, that loss of Single Farm Payment will have a serious effect on the long-term viability of hill farms in the Peaks. The loss of Single Farm Payment does not have effect on the intensity of livestock production, since due to the Agro-environmental Scheme the intensity of production is already relatively low.

Vavřina at al. (2012) analyses the current situation of measurement and management of economic performance of agricultural enterprises within the Visegrad group and further delineate the possibilities of efficient management of economic performance of those entities, especially in the context of scenario proposals of agricultural development beyond 2013. The CAP should reflect the current requirements, according to the Rome Treaty from 1955: primarily should improve the productivity, stabilize the markets, ensure the food base and maintain the reasonable prices for consumers. Direct payments are therefore significant instruments for agricultural producers how to ensure these requirements. Any further research on aiming to answer the question: How to efficiently distribute these payments according to maintain the social welfare and meet the strategic objectives needs to be conducted. Štolbová and Míčová (2012) analyse the economic results of the small and large farms in the LFA within the CR, and evaluates the impacts of the current LFA measures, where the payment distribution is based only on the grassland area, regardless of the farm size in the CR. Based on these analyses, it was suggested to distribute the LFA payments in the CR per 1 ha of UAA of farm. Also, it was showed that it would be suitable to introduce a graded decrease of the LFA payments rates according to the farm size. The analysis proves that the economic survival of the large farms, measured as the farm net value added per one annual work unit, will not be endangered. It is possible to conclude that there is a space for introducing the degressivity of the LFA payments depending on the farm size in the CR.

Results and discussion

1. Production structure

The volume of production in an average farm increased from 60.8 million CZK in 2000 to 96.6 million CZK in 2012. Classified by the LFA, production volume grew fastest in the NON-LFA (64.5%), slightly slower in the LFA O (63%) and significantly slower in mountain areas (15.8%) (table 1). The differences between small and medium-sized enterprises are not as significant, the production increased in small enterprises by 111% from 2000; the growth of production in medium-sized enterprises was not as fast (by 86% in 2012). For enterprises classified by type of farming, the slowest production growth occurred in the enterprises with mixed agricultural production (about 47%) and slightly faster in farms focused on livestock production (48%) the fastest growth occurred in crop production (by 85%).

Sale of cereals was growing in the NON-LFA by 4.8% per year in average; by about 1% per year in other LFA, decreasing slightly in mountain areas (table 2). According to the CSO

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Index 12/00
Mountain areas	45404	45280	42267	38054	47867	45605	47669	51300	51720	44041	52939	52162	52564	1.158
Other LFA	58593	67141	64656	60298	68843	73989	72637	81608	83837	68662	71869	82062	95615	1.632
NON LFA	75671	83210	82207	92016	100243	108673	103876	126576	133187	104444	107042	115305	124450	1.645
Small farm	24092	26989	27442	25241	29592	32322	32764	41289	42857	36871	44036	51048	50843	2.110
Middle farm	84471	92910	92493	94339	105857	112306	109455	130474	138177	114141	130765	139106	157192	1.861
Crop production	64780	69366	80331	67001	75486	89870	98966	108141	120084	102767	86530	118431	119639	1.847
Mixed p.	67696	74648	70251	75302	82155	82386	86136	104717	98846	79963	97074	82008	99485	1.470
Livestock p.	52537	61784	59453	60710	71151	78497	69090	73677	81399	64404	61624	72728	77780	1.480
Total	60894	68246	65262	67442	76108	80837	78054	91698	93804	75506	79436	86852	96584	1.586

Source: Own survey of the sample farms

Table 1: Production in an average farm (thous. CZK).

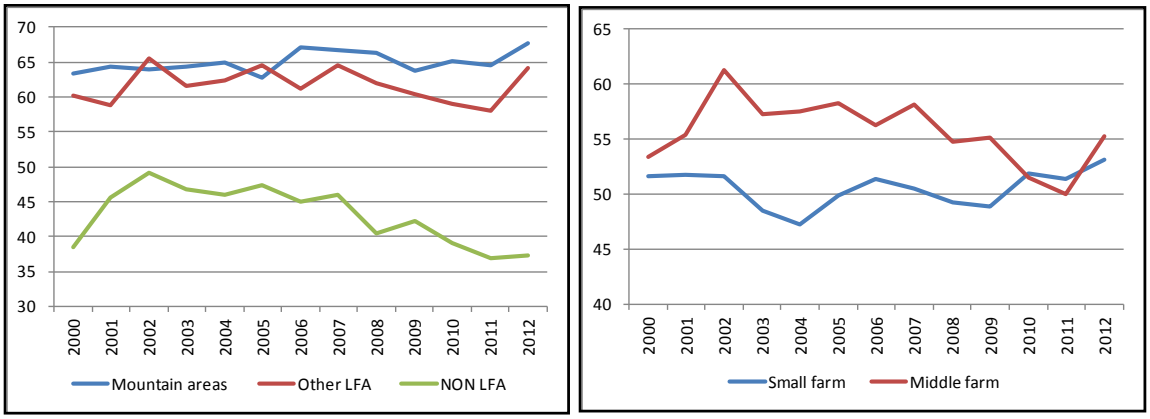
(2014) the production of cereals in the CR increased from 2000 by 2.2% (the average growth rate 0.2% annually), concurrently the sowing areas of cereals decrease (approximately by 1.1% annually), but the growth of natural yields is faster being 1.3% annually. Sales of legumes had an overall decreasing trend with a growth in the NON-LFA only by 3% a year. In the nationwide comparison the decrease of the production of legumes is at 46% of the situation in 2000 (CSO, 2014). Sale of potatoes shows an overall decline by 5% per year in average, only it remained at approximately the same level in mountain areas. This corresponds with the CSO data on production, according to which the average decrease of the production of potatoes in the monitored period makes 6% annually. In contrast, the sales of rape in all areas except the mountain were growing at an average rate of 3% per year, in the nationwide comparison the average growth rate from 2000 is 2.3%. Classified by type of production, farms reported an increase of cereals sales in crop production at an average rate of 8% per year, farms with livestock production reported decreasing sales of cereals at an average rate of 1.3 % per year and farms with mixed production did not report any changes in sales of cereals. For small and medium-sized enterprises selling cereals was growing at approximately the same rate. For sales of legumes, a significant increase occurred in farms with crop production, farms with mixed and livestock production reported a decline up to the quarter of 2000. Sales of potatoes were declining in all types. Rapeseed sales were growing in farms with crop production by an annual average of 9.5 %; by 2 % per year in farms with mixed production and decreasing slightly in farms with livestock production. Sales of legumes in small farms grew by an average of 5 % per year; it declined slightly in medium-sized enterprises. Sales of potatoes grew by 0.5% per year in small farms; it decreased by 3 % per year in the medium-sized enterprises. Sales of rapeseed grew at an average in medium-sized enterprises by 4.5 % per year. Small farms reported the growth by 0.1 % per year.

In 2012, the density of livestock was 54.5 animals per 100 ha. It increased by 2.9 % in the sample since 2000. This value does not correspond with the nationwide average, since according to the CSO (2014) the development in the Czech Republic indicates the average drop rate of the density of livestock by 1.1% annually. This discrepancy can be explained by narrowing the sample by long-term non-profitable subjects, where the unwillingness to take part in the further survey can be seen and thus the prevailingly developing subjects showing the increase of production are included in the sample. Also the aggregate volume of production in the sample shows significantly higher increase (by 58%) than the nationwide average (according to the CSO 2013), the production in current prices increased by 21%. Density of livestock increased by 6.5 % in other LFA areas and by 6.9 % in the mountain areas. The livestock density in NON-LFA decreased by 3.2 % compared to 2000. Classified by production type, the fastest growth of density was reported in mixed production, the average company focused on crop production reported decreased livestock density. Small and medium-sized farms reported the same level of livestock density (Fig. 1) in recent years. The growth performance was greatest in the NON-LFA. Small businesses were growing faster than the medium-sized. According to the analysis by Kopeček et al (2009), all model

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Index 12/00
Mountain areas	1149	975	1119	953	1031	925	740	899	922	826	841	842	959	0.835
Other LFA	1688	1939	2070	1488	2042	2209	1947	2199	2226	2433	2065	2180	1898	1.124
NON LFA	2827	2681	3793	3320	3483	4963	4680	4636	5377	4797	4429	4667	4973	1.759
Small farm	824	921	1273	916	1252	1371	1253	1201	1482	1703	1595	1587	1352	1.641
Middle farm	2637	2646	3265	2792	3076	4016	3621	4076	4390	4077	4021	4436	4506	1.708
Crop production	2198	1652	3094	2142	3987	4998	6369	6041	5298	5772	5022	5753	5694	2.590
Mixed p.	2536	2886	3535	3025	3014	4066	3437	3145	3976	3766	3126	2544	2524	0.995
Livestock p.	1202	1219	1521	1217	1489	1870	1467	1486	1520	1446	1232	1065	1032	0.858
Total	1929	2000	2471	2062	2364	2975	2651	2826	3036	2890	2585	2745	2708	1.404

Source: Own survey of the sample farms

Table 2: Sale of cereals (t).



Source: Own survey of the sample farms

Figure 1: Development of the density of livestock units per 100 ha of agricultural land.

results with the actual intensity of fattening cattle show a negative profitability of the industry. A prerequisite for achieving positive results in this sector would be necessary to increase the intensity of fattening level of at least 0.9 kg per day. In our group of farms such performance was reported by an average farm in the NON-LFA only and in farms with mixed production, but in some years only.

Average annual milk yield compared to 2000 increased from 5056 l per cow to 7211 l per cow in 2012 (by 43%), which in comparison with the national average (by 41%) means a slightly lower milk yield, but a higher growth rate. According to Řezbová and Tomšík (2012) increasing milk yield as one of the intensification factor compensates continuously declining number of dairy cows in the Czech Republic and ensures sufficient milk production needed to supply domestic demand. The sale of milk in an average company increased by 45% from 2000, at the same time the state of dairy cows decreased to 91% of the state in 2000.With the largest increase in the NON-LFA (56%), it increased by 35% in the LFA M and by 37% in the LFA O compared to 2000. The yield of dairy cows classified by the farm size was higher for medium-sized farms than for small; the average growth rate was the same 3% in both categories. According to the type of production, the yield of dairy cows was higher in an average farm focused on crop production.

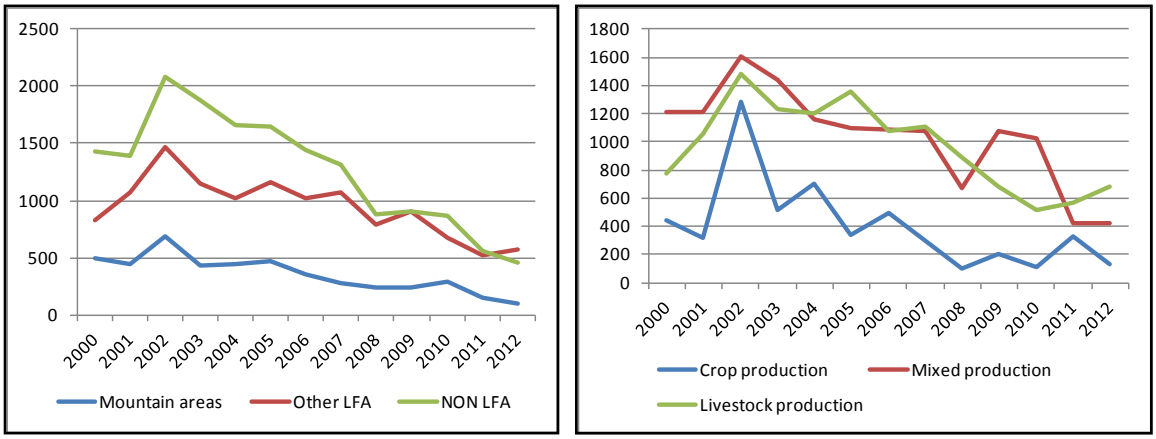
A significant long-term trend is to reduce the number of pigs. Foltýn and Zedníčková (2010) reported that the number of pigs decreased in all categories by an average of 40%. Reasons for that are primarily in reduced interest in breeding pigs that are not supported categories of animals in the EU. However, since the demand for pork has stagnated, lower domestic production has been compensated by increasing yield and increased imports of cheaper pork from abroad. The number of pigs in the average farm declined from 944 pieces to 445, i.e. by 53% since 2000. This is a more noticeable decrease than the national state of pigs, which dropped by 43% (CSO, 2014) in the monitored period.

The most significant decrease occurred in the mountain LFA (from 499 to 99 units, i.e. by 80%), followed by the NON-LFA (from 1432 to 456 animals – by 68%). The slowest decline in pig numbers occurred in the LFA O (by 30%). Classified by production type, the fastest decline in pigs occurred in farms specializing in crop production (Figure 2).

2. Development of profit and profitability

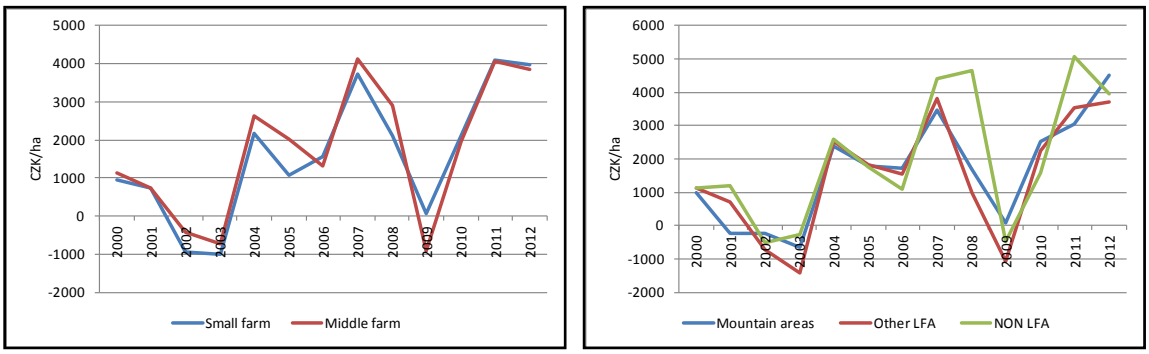
The overall indicator of management of each enterprise is the net profit/loss for the period. For the purpose of the analysis and to maintain the comparability of data, the profit before tax was monitored, adjusted per hectare of agricultural land. Profit in this form is an expression of both the efficiency and economics of the manufacturing process (Střeleček et al. 2011).

The development of the profit reported large fluctuations in different years. The highest profit per hectare of agricultural land for the entire period was achieved in the average farm in 2011 (4070 CZK/ha) and in 2007 (4034 CZK/ha), the loss occurred in 2002, 2003 and 2009. Prior to joining the EU, the largest profit was achieved outside



Source: Own survey of the sample farms

Figure 2: Development of pigs per farm in pieces.



Source: Own survey of the sample farms

Figure 3: Development of profit before tax.

the LFA area and the smallest was in the mountain LFA. After 2004, the higher profit was achieved by the LFA, except for the years 2007 and 2011 in which the greatest profit occurred out of the LFA. In these years, the economic results were significantly affected by exceptionally good external conditions of farming. The loss was always highest in the other LFA. Classified by farm size, the profit per hectare was generally higher in medium-sized enterprises, but in the last three years, the profit was higher in small farms. The loss in 2002 and 2003 was higher in small farms, but in the crisis year of 2009, the average small farm reported loss (Fig. 3). According to the type of production, the highest profit was achieved in farms with crop production achieved and the lowest in mixed production since 2004. Losses before 2004 were greatest for farms focused on crop production in the crisis year 2009; the loss was significantly higher in companies with mixed production.

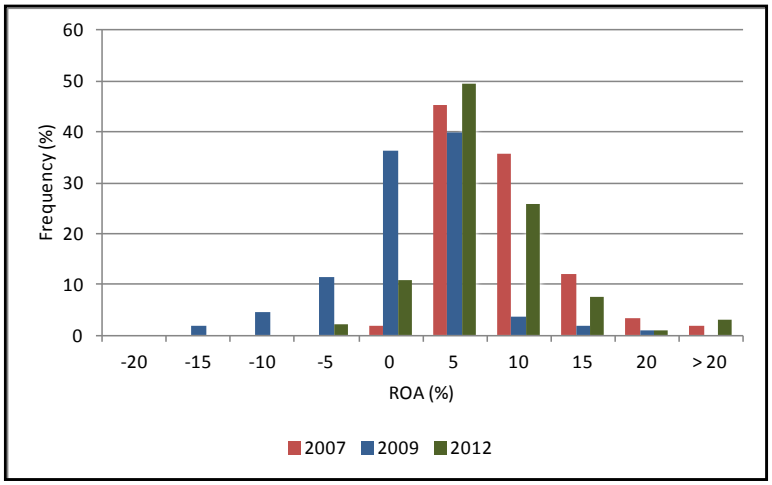
The most commonly used indicator of profitability is the return on assets (ROA). This indicator measures net profit for the period with total assets. In terms of farm development, only positive values are important. A negative rate of profit is always unsatisfactory. One of the important elements of the evaluation is to assess the economic performance of management efficiency, which is to assess the frequency distribution of farms by ROA. If the distribution of enterprises is platykurtic, significant reserves in the management exist within the real economic conditions. On the other hand, the leptokurtic distribution with low variability means that quantitative reserves are depleted in the management and change can only occur due to the qualitative conditions (Lososová and Zdeněk, 2013). If we compare the distribution of farms by size of income, then it is obvious that there were more than 50% of loss-making farms in the years 2002, 2003 and 2009, and only 2 % in 2007. It was 5% in 2011; in 2012 the number

of loss-making enterprises increased to 13% the same as in 2010. Flat shift of enterprises in direction for the worse, or vice versa for better economic outcomes highlights the significant influence of external factors, especially the prices and climatic conditions (Fig. 4).

3. The efficiency of production factors

Relation of revenues to area of farmland characterizes the intensity of production, the relation of revenues to average number of employees characterizes the labour productivity and the relation of revenues to assets characterizes the activity indicators. The intensity of production increased in the average enterprise by 4.1% per year, with the slowest growth in mountain areas (3.1%) and is lowest at around 80% of an average company. According to type of farming, the highest production occurred in farms with crop production, however with a slow growth (about 2.8% per year), the fastest growth occurred in the average company focused on livestock production which was still the lowest intensity of production. The average small farm reported the production of lower intensity (about 80% of the average), but it grew in average by 5.2% per year; the medium-sized farms reported production intensity higher by 10% compared to the average. It grew by an average rate of 4.2% per year.

Labour productivity classified by the LFA was the largest in the NON-LFA; decreasing with deteriorating conditions in all areas and increasing in all areas as quickly at an average rate of 7% per year. Classified to the type of production, the labour productivity was greatest in farms with crop production as well as the fastest growth rate (about 9 % per year) and the lowest in livestock production. According to the size, labour productivity increased at the same level



Source: Own survey of the sample farms

Figure 4: Distribution of farms by return on total assets

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Index 12/00
Mountain areas	676	705	700	666	820	844	910	1032	1107	1008	1209	1275	1442	2.13
Other LFA	733	842	824	771	1001	1052	1073	1271	1315	1166	1351	1566	1677	2.29
NON LFA	833	867	829	836	937	1017	1053	1244	1492	1307	1405	1746	1932	2.32
Small farm	785	853	881	814	1018	1054	1056	1293	1363	1203	1400	1672	1743	2.22
Middle farm	754	825	798	785	926	993	1033	1203	1363	1204	1326	1553	1743	2.31
Crop production	779	983	1001	848	774	1010	1057	1336	1543	1251	1595	1806	2125	2.73
Mixed p.	802	799	802	800	952	989	1025	1191	1369	1263	1340	1516	1667	2.08
Livestock p.	699	833	780	762	970	1012	1041	1212	1290	1138	1262	1515	1585	2.27
Total	758	829	804	786	939	1002	1037	1220	1363	1204	1349	1592	1743	2.30

Source: Own survey of the sample farms

Table 3: Development of labour productivity (thous. CZK/worker).

(of about 7% per year) in small and medium-sized enterprises (table 3). The causes of the increase in labour productivity were different in different areas; their effect on the change in labour productivity can be quantified using methods such as logarithms indices. In mountain areas, labour productivity increased during the period by 619 thousand CZK, due to reducing the number of workers. The impact of production was significantly lower than in other areas (ΔLP_R = 148 thousand CZK). The labour productivity growth in the LFA O can be explained mainly by increases in production (ΔLP_R = 559 thousand CZK) and a decrease in workers (ΔLP_E = 385 thousand CZK). The strongest production growth effect occurred in the NON-LFA, causing an increase in productivity of ΔLP_R = 650 thousand CZK and a decrease of the number of workers explaining the productivity growth of ΔLP_E = 450 thousand CZK. The impact on production to labour productivity growth was significantly higher in small farms (ΔLP_R = 897 thousand CZK). A decrease of the number of workers was the lowest. This could be explained by the increase in labour productivity since 2000 by ΔLP_E = 60 thousand CZK.

The ratio of asset turnover for the average enterprise stagnated, with a slight decline in this indicator in the mountain LFA. The highest value was reported in the NON-LFA (0.747) decreasing towards worse areas (0.569 in the mountain LFA). A similar development is seen in farms classified by the type of farming, the fastest turnover of assets in farms with crop production and the slowest in livestock production. For small farms, the rate of turnover assets increased until 2009 and slower in subsequent years compared to medium-sized farms.

4. Indebtedness and liquidity

Indebtedness of the average farm in all areas was decreasing (table 4), the average annual change in mountain LFA was −0.7 percentage point; 1.9 pp in LFA O, −3 percentage points in the NON-LFA. The difference in the level of indebtedness among areas were insignificant, the value of total debt was 34% in the NON-LFA, 37.9% in the other LFA and 41.2% in the mountain LFA in 2012. The highest value of debt classified by the type of farming was reported in farms with mixed production and the lowest in farms with crop production. The biggest average annual change was reported for farms focused on livestock production (−3.4 pp). The debt was higher in small farms, decreasing faster by 4 percentage points in the average and by 2 percentage points a year in medium-sized enterprises.

The value of current ratio for the average farm in the NON-LFA was 5.37 in 2012, 3.56 in LFA O and 4 in the mountain LFA. The values of current liquidity oscillated and any relation between LFA areas cannot be observed in all the years in all areas, however, it exceeds the recommended interval (table 5). For the quick ratio, acceptable values range from 1 to 1.5. Quick ratio values in 2005 ranged in the interval (nearly its lower limit in 2003), in the following years, the liquidity improved with minor oscillations. Farms with crop production were significant for fluctuations of the quick ratio; in 2003 it fell below the recommended limit, and since 2007 it significantly exceeded the upper limit. The quick ratio of farms classified by size ranged at the upper end, only small farms were below the lower limit in the period 2002 – 2004.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Index 12/00
Mountain areas	45	45	42	43	42	39	41	40	39	39	41	36	41	2.13
Other LFA	48	43	42	39	37	37	39	39	40	40	36	36	38	2.29
NON LFA	49	45	43	39	39	40	38	36	37	39	36	33	34	2.32
Small farm	67	61	56	53	55	48	46	46	45	41	41	39	41	2.22
Middle farm	44	41	39	37	36	37	37	36	37	39	35	33	35	2.31
Crop production	34	35	28	43	30	25	29	30	37	38	36	31	30	2.73
Mixed p.	47	41	44	38	41	40	41	39	36	37	37	37	42	2.08
Livestock p.	52	49	43	40	40	39	39	38	42	42	38	35	34	2.27
Total	48	44	42	40	39	39	39	38	39	39	37	35	37	2.30

Source: Own survey of the sample farms

Table 4: Development of indebtedness (%).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Index 12/00
Mountain areas	3.68	3.70	3.41	2.73	3.25	4.14	3.87	4.43	4.04	3.98	4.30	4.51	4.00	1.09
Other LFA	4.54	4.15	3.64	3.23	3.26	3.77	4.08	3.67	3.19	3.43	3.49	3.57	3.56	0.78
NON LFA	2.86	3.49	3.38	3.03	3.01	3.31	3.57	4.07	4.13	3.76	3.54	4.78	5.37	1.88
Small farm	2.68	3.04	2.49	1.85	2.23	3.61	3.61	3.91	3.56	3.81	3.43	3.84	3.74	1.40
Middle farm	3.81	3.93	3.82	3.44	3.37	3.55	3.83	3.98	3.74	3.61	3.75	4.43	4.46	1.17
Crop production	2.76	2.98	2.86	2.44	3.16	3.59	3.78	4.63	4.05	4.29	3.99	5.14	6.25	2.26
Mixed p.	4.02	4.08	3.54	3.23	3.00	3.40	3.77	3.71	4.12	3.53	3.29	3.64	3.44	0.85
Livestock p.	3.30	3.62	3.57	3.00	3.24	3.69	3.81	4.06	3.23	3.55	4.00	4.38	4.41	1.34
Total	3.58	3.77	3.49	3.06	3.13	3.56	3.79	3.97	3.70	3.66	3.63	4.20	4.22	1.18

Source: Own survey of the sample farms

Table 5: Development of current ratio.

5. Evaluation of the financial health

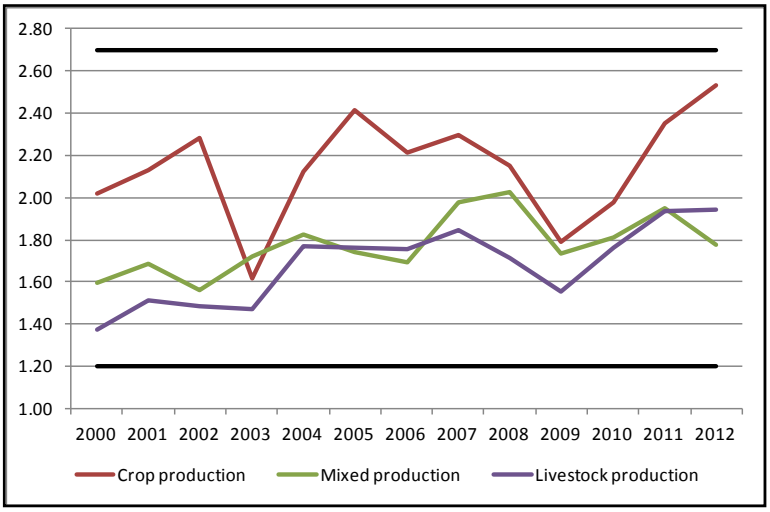
The Altman's model is one of the most widely used models for assessing the financial health of a company. Its purpose is that it provides different weights for different areas of the financial health of a company. In practice, this index accurately predicts the financial difficulties in a two-year prediction. For this reason, it is a good index to monitor the evolution in time. For an average farm we observe an increasing trend of this indicator, while the average farm during the period was ranging within thresholds. Classified by the LFA, the development of the Altman Z-score were very similar with the highest values in an average farm in the NON-LFA. According to the size of a farm, the developments of values of the Z-score were also very similar, with higher values reached by medium-sized farms, small farms in 2002 and 2003 reached the lower limit. Figure 5 shows the evolution of the Altman Z-score by type of production. The average company specializing in crop production achieved (excluding the crisis years) significantly higher values of the Z-score; other types of production followed the evolution of an average enterprise (Figure 5).

The IN05 Index of the Czech economists Mr. and Mrs. Neumaier has been considered as the most appropriate for the evaluation of Czech enterprises. The introducing presentations at the conference (Neumaier and Neumaierová, 2005) showed that the overall success of the index is 80%, which is relatively high value, since the result were compared to a sample of 1526 Czech companies. The average farm was reported in the grey zone with the exception of the crisis years of 2002, 2003 and 2009; it means that with 50% probability of bankruptcy and creating value in 70%. Upper limit was exceeded only in the last two years by the average farm with crop production that is a 92% probability of not going bankrupt and create value in 95%. Classified by the LFA, the lowest average value of the IN05 was reported in other LFA. Developments of farms by their size were very similar, with higher values reached by middle-sized farms.

The G-index takes into account the specificities of agriculture. According to Kopta (2009), the G-index is very effective in the evaluation of farms. According to this indicator, farms are classified as prospering ($G \geq 1.8$), average ($-0.6 > G > 1.8$) and unprofitable ($G \leq -0.6$). In our sample, the average farm came under the lower limit of the G-index only in 2002 and 2003, but the upper limit was not approached. The largest value of the G-index was reported in the average farm in 2012. According to the LFA classification, the best values for this indicator, were reported in the mountain LFA since 2004 and the lowest values were reached in other LFA (Fig. 6). Classified by the production type, the development was average in all types of production. In 2002, farms with livestock and mixed production got under the lower limit, similarly, for livestock production in 2003. The highest G-index throughout the period was reported in farms with crop production. Small farms reported significantly worse values of the G-index between 2002 and 2003, but in the other years they were higher than medium-sized enterprises (table 6).

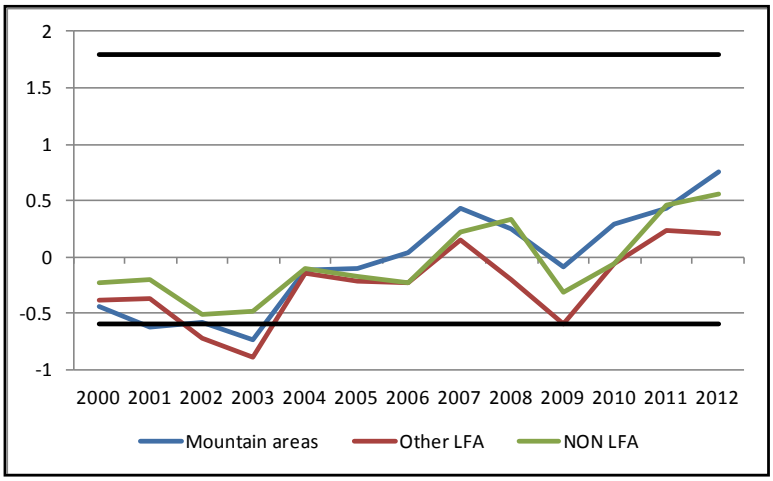
6. Dependence on subsidies

The average growth rate of subsidies reached 9% per year during the period with the largest increase of subsidies converted per hectare of agricultural land after the accession to the EU, and the most dynamic increase in the first three years



Source: Own survey of the sample farms

Figure 5: Development of the Altman Z-score model in the average farm by production type.



Source: Own survey of the sample farms

Figure 6: Development of the G-index in average enterprise by LFA.

Vulnerable	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Z-score	7.8	13.8	19.6	18.4	14.3	15.1
IN05	13.9	31.0	50.9	27.6	18.7	23.7
G-index	7.8	16.4	37.5	15.3	12.1	8.6
Grey zone	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Z-score	70.4	67.2	61.6	61.2	58.2	59.1
IN05	40.0	42.2	35.7	41.8	33.0	39.8
G-index	87.0	78.4	58.9	79.6	78.0	82.8
Prosperous	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Z-score	21.7	19.0	18.8	20.4	27.5	25.8
IN05	46.1	26.7	13.4	30.6	48.4	36.6
G-index	5.2	5.2	3.6	5.1	9.9	8.6

Source: Own survey of the sample farms

Table 6 Vulnerable and prosperous farms according to the model (in %).

	Slope (b)	Intercept (a)	Correlation coefficient	Coefficient of determination
LFA M	0.366	−745.1	0.732	0.536
LFA O	0.391	−378.1	0.574	0.330
NON-LFA	0.484	−118.9	0.609	0.371
Small farm	0.487	−1094.8	0.718	0.515
Middle farm	0.400	−93.2	0.597	0.357
Crop production	0.594	−500.6	0.614	0.377
Mixed production	0.379	−150.5	0.584	0.341
Livestock production	0.371	−303.9	0.663	0.439
Total	0.418	−305.8	0.633	0.400

Source: Own survey of the sample farms

Table 7: Dependence of profit on subsidies in average farm in 2000-2012.

after the accession. In 2012, the subsidies for the average enterprise reached to 8476 CZK/ha, with the fact that most grants were received by an average farm in the mountain LFA, where the average growth rate was 10.4%. The slowest growing subsidies were revealed for an average farm focused on crop production (6.6%). The cost/revenue ratio adjusted for subsidies can be described as an index of dependence on subsidies, the value above 100% indicates what proportion of the company's costs are to be covered by subsidies. In subsequent years, this figure varies considerably, the average increase was 0.8 percentage points in the mountain LFA, 0.3 in the other LFA and 0.2 percentage points in the NON-LFA. A similar development was reported in farms classified according to size and type of farming; only farms specializing at crop production showed a slight decrease in this indicator.

The highest dependence of the profit on the amount of subsidies was evident in the average farm in the mountain LFA, where 53.6% of the profit variability can be explained by the variability of subsidies; however, an increase in subsidies by 1 CZK increased the profit by 0.37 CZK (table 7). The correlation coefficient of the effect of subsidies on profit ranges from 0.57 to 0.73, which is a relatively high degree of dependence. Farms focused on crop production were the least dependent on subsidies, so that the proportion of subsidies that make up the profit was the highest there, almost 60%.

Conclusion

Development of economic indicators in farms since 2000 is characterized by the growth of production, which increased in 2012 by more than 58% in an average farm, which is a significantly higher increase than we can see in the monitored period with the agricultural production in the CR - by 21% (CSO, 2013). It is possible to explain this disharmony by the narrowing of the sample by long-term non-profitable subjects, showing the unwillingness to take part in further investigation and thus the sample includes prevailingly developing subjects showing the increase of production. The production volume grows faster in a smaller company than in a middle-sized one. According to the orientation of production the production grows faster in a company concentrated on a vegetable production and according to LFA it grows faster in an average company operating outside LFA. The slowest growth in production was reported in mountain LFA. Production growth is mainly due to increased revenues from crop production, the share of income increased in all categories of enterprises, while the share of income from livestock production and non-agricultural production was declining. In the NON-LFA, the most significant change occurred in the structure of production, with the fastest growing share of crop production and non-agricultural production and the share of income from livestock production markedly decreasing. The growth of labour productivity was a significant trend in the research period, which was influenced primarily by reducing the number of workers more than the growth of production. Labour productivity in current prices in a monitored complex increased to 230% in 2000 (in Czech agriculture it is 215%) with an average growth rate of 7.2% annually. The number of employees in a selective complex of agricultural companies decreased to 69% from 2000, which means the more moderate

decrease than in the agriculture in general, where it decreased to 56% of the state of 2000. The most significant decrease of workers could be seen in mountainous LFA (to 54% of the state of 2000). The slowest decrease of workers is evidently in a small company (to 95% of the state of 2000). In small companies there is not enough space for savings of workforce.

Due to the high dependency of profit in agriculture on environmental conditions, the development of indicators is characterized by significant fluctuations. The greatest loss occurred in 2002, 2003 and 2009. An average farm in other LFA was the most vulnerable in this respect. Before joining the EU, an average small farm had lower profit and higher loss than a medium-sized farm, since 2004 the situation improved, results of operations were at a similar level to that of a medium-sized farm. Classified by type of farming, the lowest profits and highest losses were reported in farms with mixed production. Evaluating the financial health of farms revealed farms in other LFA as the most vulnerable. Classification by the size did not reveal any major differences in farms. Classified by the type of production reported more favourable values in farms focused on crop production, although the differences were not significant. The dependence of the average farm on subsidies manifested itself most strikingly in the mountain LFA. This means the stability of the economic indicators of a farm in the crisis years. Crop production farms were the least dependent on subsidies with the greatest effect of changes in external economic conditions and the level of profit/loss was very sensitive to these changes.

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Spatial Data Monitoring and Mobile Applications – Comparison of Methods for Parsing JSON in Android Operating System

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Anotace

Příspěvek se na obecné úrovni zabývá problematikou zpracování formátu JSON pro zpracování v mobilních zařízeních na platformě operačního systému Android. Implementace je testována a demonstrována na zpracování rozsáhlé kolekce pozičních dat, která vznikají monitorováním pohybu zvěře (aplikace Zvěř online). Možností využití je obecně nejen v oblasti zemědělství, rozvoje venkova a ochraně životního prostředí prakticky neomezené množství, s narůstajícím počtem a dostupností mobilních zařízení nabývá řešená problematika dále na významu. Při vývoji aplikací pro mobilní zařízení je podstatné, jakým způsobem lze získávat aktuální data pro běh vlastní aplikace. Jelikož nelze přistupovat přímo k databázím, je nutné mezi klientem a serverem přenášet již vybraná data pomocí vhodného přenosového formátu. K tomuto účelu slouží serializace dat, kde jednou z používaných forem je formát JSON. Konkrétně jsou zde porovnávány metody pro jeho parsování, tedy převod do objektů, případně kolekcí, které se dají v aplikacích využít pro další zpracování. Rozhodující je zde především časové hledisko, které představuje dobu trvání zejména samotného převodu.

Klíčová slova

Android, JSON, data serialization, InputStream, XML, Protocol Buffers, Java, libraries, Game Online.

Abstract

The paper generally addresses the issue of processing the JSON format for mobile devices on the Android operating system platform. Implementation has been tested and demonstrated using the processing of an extensive collection of spatial data generated from game movement monitoring (the Game Online application). The potential for use not only in the sphere of agriculture, rural development and environmental protection is in general practically unlimited, and with the growing number and availability of mobile devices the discussed issue gains further relevance. The ways of obtaining current data for the operation of the application are essential for the development of applications intended for mobile devices. As direct access to databases is not possible, it is necessary to transfer preselected data between the client and server using a suitable transfer format. This is catered for by data serialization, where one of the applied forms is the JSON format. Specifically, the paper compares methods of its parsing, i.e. transfer to objects, or, where applicable, collections, which may be utilised in the applications for further processing. The decisive factor here is namely the time which represents, in particular, the duration of the transfer proper.

Key words

Android, JSON, data serialization, InputStream, XML, Protocol Buffers, Java, spatial data, Game Online.

Introduction

Recently, mobile devices have become an integral part of life of all people throughout the civilised world. The sales figures for tablets outnumber those of PCs – especially laptops. The number of smartphones sold in 2013 for the first time exceeded the number of classical mobile phones (Gartner, 2014). According to the same study, 78% of sold devices uses the Android operating system. According to (StatCounter, 2014) as well as a number of other studies and statistics, in 2013 Android ranked as the first operating system among those deployed in the used devices.

When developing an application, it is often

necessary to bear in mind also communication with the surroundings – particularly the Internet environment, which means that applications are not isolated units. It is necessary to gain current data and information. Furthermore, applications for mobile devices are often a required and needed complement to existing web applications. Data for mobile devices are updated via the Internet. For security reasons it is not possible to connect directly to database systems, which would be probably the most rapid solution. Instead, applications connect to web servers, which mediate the selection of data from these systems. For this reason it is necessary to select the method of data serialization in the transfer between the application (client) and the server.

In existing applications, primarily with a view to the extensive competition, much attention has to be paid to the performance and the speed of displaying and processing of information. Although the performance of mobile devices keeps growing, software is becoming more and more complex. Mobile device users have many applications installed, and many of them utilise services at the background of the system, which run constantly or are triggered at certain time intervals.

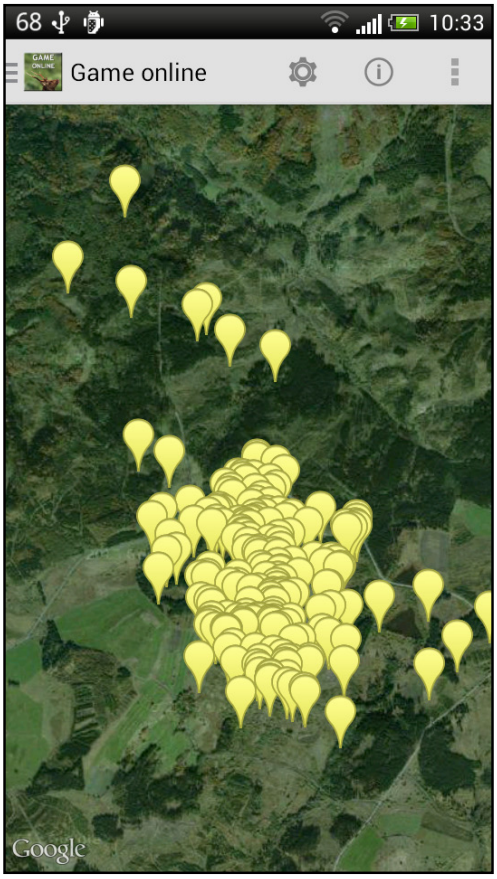
When selecting the method of serialization it is necessary to consider several aspects. One of them is the potential and speed of processing on the part of the server. Another one is the volume of data in the given format for communication. This affects primarily the speed of transfer between the client and the server. Furthermore, mobile devices are often connected via mobile operator networks, where the decisive economic factor is the volume of data. Moreover, especially in rural regions signal coverage as well as the technologies used are often of a significantly lower standard than those applied in cities (persisting technological digital divide). Another aspect is also the speed of processing (parsing) in client devices.

Specialised (map, spatial, etc.) applications often require a transfer and processing of large quantities of data. The primary information in applications using spatial data which are displayed on map data are the coordinates of individual positions. These often have to be extended with a whole set of other additional information, frequently of large volume. The paper discusses the issue of spatial data processing in the monitoring of game movements in a mobile application for the Android operating system, specifically the conversion of data transferred between the server and the client (in the server → client direction) and their conversion to objects and collections for further processing in the mobile application. The general objective has been to compare the methods of parsing the JSON format in terms of time demands and the number of rows/objects which is utilised here as well as in many other solutions.

Materials and methods

Within the scope of research conducted at the Department of Information Technologies of the Faculty of Economics and Management of the Czech University of Life Sciences Prague, in cooperation with the Faculty of Forestry and Wood Sciences, and Vojenské lesy a statky, and others, the Game Online web application has been developed (available from **zver.agris.cz**). It is based upon the monitoring of game movement using special collars. Subsequently, an application for mobile devices with the Android operating system, which currently represents the most wide-spread system environment of mobile devices, is being developed.

The designated animals are followed up via GPS, by means of a collar (Fig. 3), which records the position of the animal with the accuracy of several meters; the location; records of the animal‘s GPC receiver; the date and time in programmed intervals (i.e. usually 1 hour). The collar also contains an activity sensor which records the animal‘s activity (such as feeding, resting, or movement) (Owen-Smith, 2012). In addition, the sensor records the temperature and the accuracy of measurements. Newer collars are equipped with GSM modules which contain telephone SIM (*subscriber identity module*) cards allowing for the transfer of data to the user‘s computer. Generally, it is useful to validate the data and to store them in a database system for subsequent processing, display. (Fan, 2004) Information on the movement of wild animals is obtained by means of the GPS (*Global Positioning System*) in the collar equipped with a GSM module. Data are received via a ground station, thereafter validated and stored in a database server. The selection of data from the database is then safeguarded by the Game Online web application. This processes the data for mobile device applications and provides them in the necessary format (XML, JSON). The resulting application is shown in Fig. 1.



Source: own processing

Figure 1: Game application sample.

For the Android operating system, programming is performed using special development tools - *Eclipse ADT* or *AndroidStudio*, and the *Java* programming language. Language translation is then carried out by the Android's own virtual machine *Dalvik*, (from version 4.4 OS Kitkat it has newly been ART) (Android, 2014), rather than by the classical method to bytecode for Java Virtual machine (source).

The XML and JSON technologies are most often used for communication between the applications (clients) and the server. Another technology which could be utilised is the Protocol Buffers.

Protocol buffers are Google's language-neutral, platform-neutral, extensible mechanism for serializing structured data – think XML, but smaller, faster, and simpler. You define how you want your data to be structured once, then you can use special generated source code to easily write and read your structured data to and from a variety of data streams and using a variety of languages. (Google Developers, 2014) Nevertheless, due to the used technologies of the web application, the processing of Protocol Buffers is problematic on the part of the server.

XML (eXtensible Markup Language) is a markup language which is used in a number of applications as a data transfer or storage format. It is well readable and recordable both for people and machines. Its assets are the widespread usage and support of a number of development tools. Its minuses, on the contrary, are the higher demands for data volume – particularly compared to the other above-mentioned JSON technology. The difference in data volumes for tested data samples is provided in the table below.

Number of positions	XML	JSON
100	33KB	23KB
500	165KB	114KB
1000	329KB	227KB

Source: own processing.

Table 1 Comparison of data sizes for XML and JSON formats.

JSON (JavaScript Object Notation) is a lightweight data exchange format. It is based upon JavaScript. It utilises the convention known from C language-based programming languages (json.org, 2014). Like the XML markup language it is easily readable and recordable both for people and machines.

The JSON format is based upon two basic structures. One of them is the name value pair collection – in programming languages often called the object. It is enclosed in curly brackets {}. The value may be a string, number, object, field, true, false, or null (json.org, 2014). Another structure is a field. This is an ordered list of values, most often objects, which is enclosed in square brackets [].

Most authors discuss the comparison of parsing speed between the XML, JSON and, where applicable, Protocol Buffers technologies (Rodrigues, 2011) (Chen, 2013). Nevertheless, in the development for Android, several methods may be applied to the parsing of JSON alone. Each of them has a different duration. In terms of complexity, all of these methods exhibit a similar program code length, but utilise different libraries. Five available libraries were selected for the purposes of testing.

The first method, called Android, utilises parsing libraries supplied directly by Google as part

of the Android SDK (*Software Development Kit*) (org.json, 2014). Unlike with other methods, it is not necessary to compile additional libraries into the final application. The disadvantage is, however, that in communication with the server the downloaded data are in the *InputStream* class object, which requires conversion to a String class object. With large data volumes, this may be extremely demanding (Figure 2).

Another tested method, called *Gson*, comes from the *com.google.gson.stream.JsonReader* package. The google-gson Java library is also by Google and it is intended for the Java programming language (google-gson, 2014). The used version was 2.2.4. (Figure 3).

```
List<Deer> result = new ArrayList<Deer>();
try {
    String json = convertStreamToString(inputStream);
    JSONObject jsonObject = new JSONObject(json);
    Iterator iterator = jsonObject.keys();
    while (iterator.hasNext()) {
        List<HashMap<String, String>> positions = new ArrayList<HashMap<String,String>>();
        String idKey = (String) iterator.next();
        String id = jsonObject.get(idKey).toString();
        JSONArray deerArray = jsonObject.getJSONArray(idKey);
        int length = deerArray.length();
        for (int i = 0; i < length; i++) {
            HashMap<String, String> pos = new HashMap<String,String>();
            JSONObject posObject = deerArray.getJSONObject(i);
            Iterator posIterator = posObject.keys();
            while(posIterator.hasNext()) {
                String key = (String) posIterator.next();
                String value = (String) posObject.get(key);
                pos.put(key, value);
            }
            positions.add(pos);
        }
        result.add(new Deer(id,positions));
    }
```

Source: own processing.

Figure 2: Sample parsing using the AndroidJson method - org.json.

```
String id;
JsonReader reader = new JsonReader(new InputStreamReader(inputStream, "UTF-8"));
reader.beginObject();
while (reader.hasNext()) {
    id = reader.nextName();
    reader.beginArray();
    List<HashMap<String, String>> positions = new ArrayList<HashMap<String,String>>();
    while (reader.hasNext()) {
        reader.beginObject();
        HashMap<String, String> pos = new HashMap<String,String>();
        while (reader.hasNext()){
            String key = reader.nextName();
            String value = reader.nextString();
            pos.put(key, value);
        }
        positions.add(pos);
        reader.endObject();
    }
    reader.endArray();
    result.add(new Deer(id,positions));
}
reader.endObject();
reader.close();
```

Source: own processing.

Figure 3: Sample parsing using the Gson method - org.json com.google.gson.stream.JsonReader.

Another method, JSON.simple, uses the JSON. simple library (json-simple, 2014). The used version was 1.1. Parsing uses the heap based method (Figure 4).

Another used method, JSON.smart, is, in terms of the program code, almost identical to JSON. simple. It is performance-driven (json-smart, 2014). The used version was 1.1.1. (Figure 5).

```
JSONParser p = new JSONParser();
String id;
Set keys;
JSONObject jsonObject = (JSONObject) p.parse(new InputStreamReader(inputStream));
keys = jsonObject.keySet();
for (Object key: keys) {
    id = (String) key;
    List<HashMap<String, String>> positions = new ArrayList<HashMap<String,String>>();
    JSONArray jsonArray = (JSONArray) jsonObject.get(key);
    int size = jsonArray.size();
    for (int i = 0; i < size; i++) {
        HashMap<String, String> pos = new HashMap<String,String>();
        JSONObject positionJsonObject = (JSONObject) jsonArray.get(i);
        Set posKeys = positionJsonObject.keySet();
        for (Object posKey:posKeys) {
            String hashKey = (String) posKey;
            String hashValue = positionJsonObject.get(posKey).toString();
            pos.put(hashKey, hashValue);
        }
        positions.add(pos);
    }
    result.add(new Deer(id,positions));
}
```

Source: own processing.

Figure 4: Sample parsing using the JSON.simple method - org.json.simple.

```
JSONParser p = new JSONParser(JSONParser.MODE_JSON_SIMPLE);
String id;
Set keys;
JSONObject jsonObject = (JSONObject) p.parse(inputStream);
keys = jsonObject.keySet();
for (Object key: keys) {
    id = (String) key;
    List<HashMap<String, String>> positions = new ArrayList<HashMap<String,String>>();
    JSONArray jsonArray = (JSONArray) jsonObject.get(key);
    int size = jsonArray.size();
    for (int i = 0; i < size; i++) {
        HashMap<String, String> pos = new HashMap<String,String>();
        JSONObject positionJsonObject = (JSONObject) jsonArray.get(i);
        Set posKeys = positionJsonObject.keySet();
        for (Object posKey:posKeys) {
            String hashKey = (String) posKey;
            String hashValue = positionJsonObject.get(posKey).toString();
            pos.put(hashKey, hashValue);
        }
        positions.add(pos);
    }
    result.add(new Deer(id,positions));
}
```

Source: own processing.

Figure 5: Sample parsing using the JSON.smart method - net.minidev.json

```
JSONParser p = new JSONParser(JSONParser.MODE_JSON_SIMPLE);
String id;
Set keys;
JSONObject jsonObject = (JSONObject) p.parse(inputStream);
keys = jsonObject.keySet();
for (Object key: keys) {
    id = (String) key;
    List<HashMap<String, String>> positions = new ArrayList<HashMap<String,String>>();
    JSONArray jsonArray = (JSONArray) jsonObject.get(key);
    int size = jsonArray.size();
    for (int i = 0; i < size; i++) {
        HashMap<String, String> pos = new HashMap<String,String>();
        JSONObject positionJsonObject = (JSONObject) jsonArray.get(i);
        Set posKeys = positionJsonObject.keySet();
        for (Object posKey:posKeys) {
            String hashKey = (String) posKey;
            String hashValue = positionJsonObject.get(posKey).toString();
            pos.put(hashKey, hashValue);
        }
        positions.add(pos);
    }
    result.add(new Deer(id,positions));
}
```

Source: own processing.

Figure 6: Sample parsing using the Jackson method - com.fasterxml.jackson.core.

The last method used, called Jackson, uses the Jackson JSON Processor library. The library has been inspired by tools for XML – StAX, JAXB, etc. (JacksonHome, 2014). The used version was 2.3. (Figure 6).

In parsing, all of the methods employ browsing of individual structures using iterations in a similar manner. The samples shown above illustrate that the complexity of their source codes is similar. Therefore, in terms of implementation complexity, they are on a very similar level. The only exception is the Android method, which requires also the creation of a function for the conversion of an InputStream class object to a String one.

In order to achieve the established objective, a test application has been developed which gradually triggers all of the aforementioned methods. Parsing itself was in all cases closed in the try {}catch{} clause for the identification of exceptions (errors). Each method was enclosed in its own object with the needed methods. The time necessary for parsing using the respective method was measured always prior to triggering the method of the instance which safeguards parsing proper. Below, the measured time is specified in milliseconds.

```
long duration = 0;
long start = System.currentTimeMillis();
testJson.parsePublicTimeline(inputStream);
duration += (System.currentTimeMillis() - start);
```

Source: own processing.

Figure 7: Sample of parsing measurements proper

Data were converted with a view to the Game Online target application into a collection of objects dedicated to this purpose. This object represents one individual (animal) and all of the positions associated therewith. It has one ID attribute, and also contains a collection of HashMap <String, String> class objects for the positions.

```
public class Deer {
    public final String id;
    public final List<HashMap<String, String>> positions;

    Deer(String id, List<HashMap<String, String>> positions) {
        this.id = id;
        this.positions = positions;
    }
}
```

Source: own processing.

Figure 8: Declaration of object “Deer” used in the application

Measurements were performed gradually for 10, 50, 100, 200, 500, 1000, and 5000 spatial data. On the highest level, the tested JSON contains an object representing individual animals broken down by their IDs. A field of objects representing individual positions is then allocated to each individual.

```
{
  "12110":[
     {
        "specie_name":"Jelen Evropsk\u00fd",
        "name":"Barka",
        "color":"00FFFF",
        "id_deer":12110,
        "UTC_DATE":"21.01.2014",
        "UTC_TIME":"22:00:44",
        "LMT_TIME":"23:00:44",
        "TEMP":7,
        "LATITUDE":"50,303611",
        "LONGITUDE":"13,0705745",
        "RowNum":"1"
     }
  ],
  "12268":[
     {
        "specie_name":"Jelen Evropsk\u00fd",
        "name":"Bonif\u00e1c",
        "color":"7fffd4",
        "id_deer":12268,
        "UTC_DATE":"21.01.2014",
        "UTC_TIME":"22:00:43",
        "LMT_TIME":"23:00:43",
        "TEMP":7,
        "LATITUDE":"50,6010005",
        "LONGITUDE":"13,3487443",
        "RowNum":"1"
     }
  ]
}
```


Source: own processing.

Figure 9: Simplified sample of tested data - JSON.

In the course of testing, no statistically significant difference was observed in the design with one tested individual, or with more tested individuals. Therefore the testing of one individual was used in all cases.

The measurements were carried out gradually on 3 mobile devices with the Android operating environment:

1. Samsung Galaxy Note 10.1 (GT-N8010)
   - ARM Cortex A9 quad-core processor with 1.4 Ghz frequency
   - 2GB operational memory
   - OS Android version 4.1.2 – API level 16
2. HTC One S
   - Qualcomm MSM8260 1.7 Ghz dual-core processor
   - 1GB operational memory
   - OS Android 4.1.1 – API level 16
3. Samsung Galaxy Mini
   - Qualcomm MSM7227 600 Mhz single-core processor
   - 512 MB operational memory
   - OS Android 2.3 – API level 9

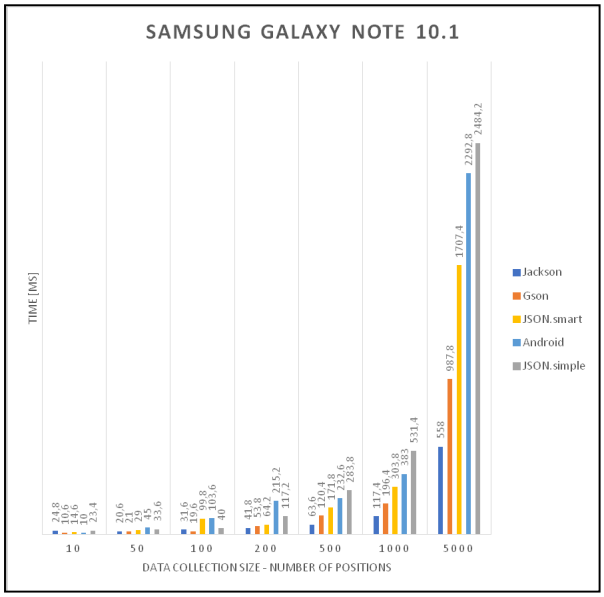
The *airplane mode* was set up on the devices, which switched off any networks and synchronisations in order to avoid any adverse external influences and to terminate maximum applications, i.e. for the processor time during parsing to be employed by other processes. Background services in particular, and other scheduled tasks, could adversely affect the result of measurements. JSON for each tested data scope was stored in *Assets*. From these, an InputStream class object may be obtained easily, which would otherwise be obtained during communication with the server. This allowed for the disconnection of the device from any networks.

Results and discussion

Graphs 1 - 3 provide the measured times necessary for parsing on individual devices. All of the values are provided in ms units. The measuring proper (triggering the application) was conducted ten times for each device. Thereafter, averages were obtained from the measured values in order to minimise adverse influences.

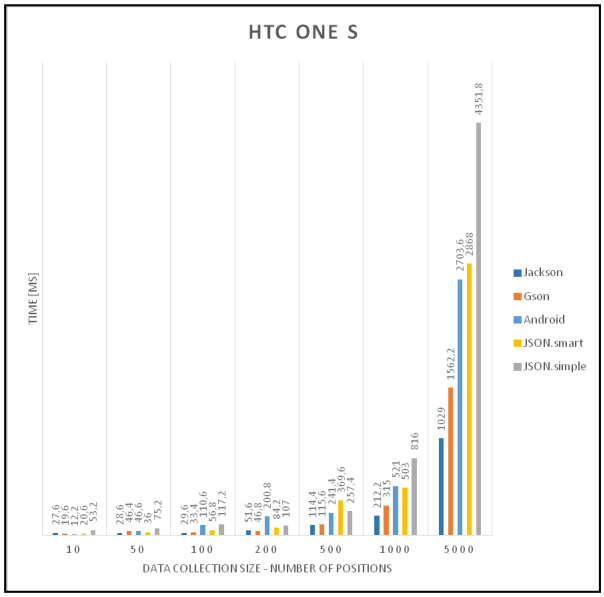
It is quite obvious that for large data collections the use of the Jackson method (*Jackson JSON Processor* library) is the most advantageous one. Results indicate that its use is best from approximately 50 positions. This method, however, is not suitable for small collections, where it actually proves to be one of the worst. Good results in this sphere were achieved also by the *Gson* method used with a single-core processor. For multi-core processors, the best one seems to be the *Android* method. Its results, however, are extremely poor for large data collections, although the method is supplied as part of Android SDK.

The very good results of the *Android* method if used for small data collections could be probably explained by the use of multi-core processors. This method is part of native SDK and is probably able to cooperate better with the operating system and to use the hardware, particularly the possibility to run in several threads. With the growing size of the data collection, the time necessary for the conversion of an *InputStream* class object to *String* seems to play a decisive role in this respect. This fact is further supported



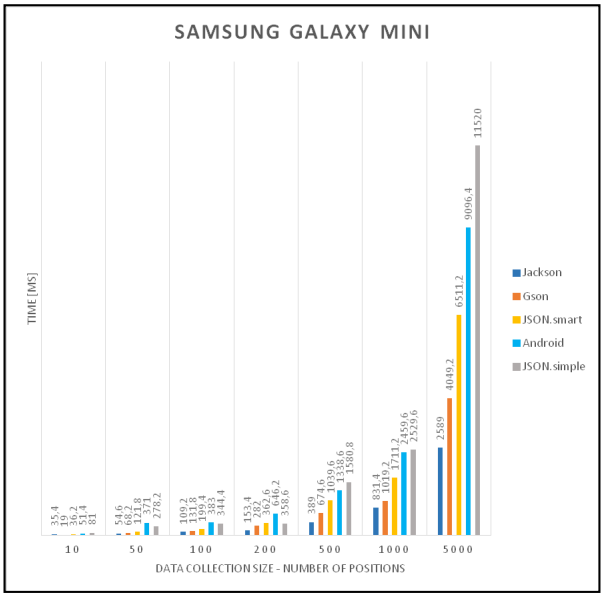
Source: own processing

Graph1: Measured values for Samsung Galaxy Note 10.1.



Source: own processing

Graph 2: Measured values for HTC One S.



Source: own processing

Graph 3: Measured values for Samsung Galaxy Mini.

by the results of the single-core processor where this method ranges among the worst ones starting from the smallest data collection. This fact is generally worth a more detailed examination. There is an option to measure the time for this method only after the conversion to *String* proper. Nevertheless, when obtaining application data from the server, the obtained data are in the *InputStream* class object and it will always require conversion to *String*.

An exact determination of the data collection size from which it is optimal to use the Jackson method would require a more detailed study in the range around the 50-position size. The obtained results, however, are sufficient for the objective of the research. In general, the scope of data used by the application should be taken

into consideration. Determination of the data collection size and subsequent program branching by results would probably lead to an unacceptable time delay which would be longer than the use of a non-optimal method.

Conclusion

The purpose of the research was to identify an optimal method for parsing the JSON format for use in the sphere of spatial data. With a view to the results of measurements, the *Jackson JSON Processor* library may be recommended for use in such applications. Nevertheless, it is necessary to take into account the amount of positions to be displayed by the given application. If it concerned small number at all times, it would be optimal to use the native library, or, if applicable, google-gson. In applications for agriculture, the environment, etc. as well as in the usage of applications for further research, it is necessary to display large quantities of positions. The objective of the conducted research was thus clearly met.

The presented results provide a basic view of the discussed issue. To be able to draw general conclusions about the optimal method for JSON format parsing, it would be certainly appropriate to conduct measurements with more devices. Moreover, it would be interesting to carry out the measurements for various data structures and various sizes of the individual values of the JSON structure. For the purposes of objectives set for this paper, however, the completed measurements are adequate. Further possibilities and procedures outlined will be the subject of follow-up research.

In further research which would enable to draw generally applicable conclusions it would be interesting to continue the testing also with various types of data. Furthermore, it would be appropriate to compare other possible formats for data transfer and serialization, such as XML, Protocol Buffers, etc., for the purposes of the discussed utilisation.

Application of other approaches to the design of similar applications would be also worth consideration. If, in the course of time, new data are only added to the data base and the existing ones remain unchanged, there is a possibility to store the data on an ongoing basis in the device database, although this implies a number of other potential problems. The database could take up too much memory in the device. It would also be necessary to safeguard data updates which could be, depending on the application usage, more time demanding than a simple download of the currently needed data. The implementation of such solution would be generally more complex. Economic efficiency could pose another problem.

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Agriculture Drought Risk Management Using Standardized Precipitation Index and AEZ Model

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Abstract

The objective of this study was to assess the drought risk management in the region under study. The SPI method was adopted for drought monitoring in Hamadan Province, Iran. The temporal and spatial extent of the area vulnerable to drought was delineated using AEZ model, GIS and other softwares. Five zones were recognized based on the drought severity index. Selection of compatible crops with respect to climate and land production capability of a region specially in drought condition is one of the effective elements to increase the water productivity in agriculture, based on Agro-ecological Zoning(AEZ) model, developed by FAO, suitable spatial extension of wheat cultivation, which is the main crop in Hamadan Province, were delineated. According to this study the most suitable lands potentially available for wheat production are located in the north-east region and a part of the central region, where as, least suitable ones can be observed in the north-east and the south – east regions. The results of the risk analysis study show that south-east, north and central regions are susceptible to longest duration intense droughts where as long duration droughts are intensive in north, west and south-east regions. The overlaid and integrated maps of risks with the maps obtained after applying the AEZ model resulted into the map of spatial suitability of potential crop production for each class of risk (longest duration and most intensive durations). This enables the decision makers to define spatial priority of crop cultivation and manage various potential regions susceptible to drought risks.

Key words

Hamadan, Drought, GIS, Agro-ecological zoning.

Introduction

Rainfall scarcity, high potential evapotranspiration and water resources constraints are problems in agriculture in Iran. During drought periods, when temperature rises and rainfall reduces, crisis arises at a faster rate. Subsequent loses due to droughts in agriculture sector, as well as direct and indirect vulnerability of agriculture, necessitate the accurate planning on the basis of potential and limited resources for sustainable agriculture. Till 1995 in all countries, there were not major plans for drought mitigation. Therefore, the traditional practice was to organize a task committee casually after the drought occurrence, to reduce the drought damages. These decisions were made, in those offices fast and random immediately after the drought reached to maximum. Therefore, little attention was paid to drought mitigation.

The occurrence of several intense and vast droughts in the United States like those of 1996 drew the attention of scientists, planners and the U.S. government in droughts management towards changing the disaster management approach to drought risk management. In drought risk management, the decisions are clear, applicable and dynamic. Moreover, in this approach the emphasis is on alertness and readiness for drought risk mitigations.

As frequency and intensity of drought increases, attention shifts towards reducing drought risk management in most countries. Today, drought risk management in many countries like, the U.S., Canada, Mexico, Australia and European countries is put into effect practiced instead of disaster

management (Cline, 2007). It can be concluded from various researches that, obviously, the economical losses and social damages can be reduced through using drought risk management. Thus, researches are conducted to predict the context and update the results. In planning for drought mitigation there has been a shift from disaster management to drought risk management, which is quite difficult when the behavior and characteristic of droughts and expected losses are not predictable.

To solve this problem, it is necessary to locate and monitor the areas of high drought risk and potentially susceptible to drought through adopting take up the necessary precautions and plans in order to reduce drought risk. The indices used for drought monitoring are: precipitation percentile, percent of normal precipitation, Palmer Drought Severity Index (PDSI) and Standardized Precipitation Index (SPI), etc.

There is an extensive literature for qualitative assessment of droughts including indices, models, and water balance simulation (Alley, 1984; Byun and Wilhite, 1999; Flug and Campbell, 2005; Karl and Knight, 1985; Karamouz, Torabi and Araghinejad, 2004; McKee, Doesken and Kleist, 1993; Palmer, 1965; Sen, 1989; Shin and Salas, 2000). In 1965, Palmer developed an index to measure the departure of the moisture supply (Palmer, 1965). Palmer based his index on the supply-and-demand concept of the water balance equation, taking into account more than just the precipitation deficit at specific locations. The objective of the Palmer Drought Severity Index (PDSI), as this index is now called, was to provide measurements of moisture conditions that were standardized so that comparisons using the index could be made between locations and between months (Palmer, 1965).

The understanding that a deficit of precipitation has different impacts on groundwater, reservoir storage, soil moisture, snowpack, and stream flow led McKee, Doesken, and Kleist to develop the Standardized Precipitation Index (SPI) in 1993 (McKee, Doesken, Kleist, 1993). The SPI was designed to quantify the precipitation deficit for multiple time scales. These time scales reflect the impact of drought on the availability of the different water resources. Soil moisture conditions respond to precipitation anomalies on a relatively short scale. Groundwater, streamflow, and reservoir storage reflect the longer-term precipitation anomalies. For these reasons, McKee et al. (1993) originally calculated the SPI for 3-, 6-,12-, 24-, and 48-month time scalesMcKee, Doesken and Kleist, 1993).

Agro-ecological Zones (AEZ) method was developed by the Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA) (FAO, 1996). As a mechanism method, it was frequently adopted to calculate potential productivity of crops at regional level (Deng, Huang and Rozelle,2006; Fischer and Sun, 2001).The second approach, AEZ analysis, combines crop simulation models with land management decision analysis, and captures the changes in agro-climatic resources (Darwin, Tsigas, Lewabdrowski and Raneses,1995; Fischer, Shah, Tubiello and Velthuizen,2005). AEZ analysis categorizes existing lands by agro-ecological zones, which differ in the length of growing period and climatic zone. The length of growing period is defined based on temperature, precipitation, soil characteristics, and topography. The changes of the distribution of the crop zones along with climate change are tracked in AEZ models.

Crop modeling and environmental matching procedures are used to identify crop-specific environmental limitations under various levels of inputs and management conditions, and provide estimates of the maximum agronomically attainable crops yields for a given land resources unit. However, as the predicted potential attainable yields from AEZ models are often much larger than current actual yields, the models may overestimate the effects of autonomous adaptation. Cline observed that AEZ studies tend to attribute excessive benefits to the warming of cold high-latitude regions, thereby overstating global gains from climate changes. This model has been used in several fields related to sustainable agriculture (Deng, Huang and Rozelle,2006; Lugue, 2009; Pratap, Pradhan, Lotta, and Nakarmi, 1992; Ravelo and Abril, 2009. Segal, Mandal and Vadivelu,1992; Subramanian, 1983; Venkateshwaralu, Ramakrishna and Rao, 1996).

This model offers much scope for developing strategies for efficient natural resource management and in this context, recent advances in remote sensing and GIS have made the task of integration and mapping of a wide range of databases much easier.In this study standard precipitation index(SPI) was adopted for monitoring droughts in Hamadan Province. The intensity and duration of droughts in this region were studied and the areas potentially subject to drought risk were identified.

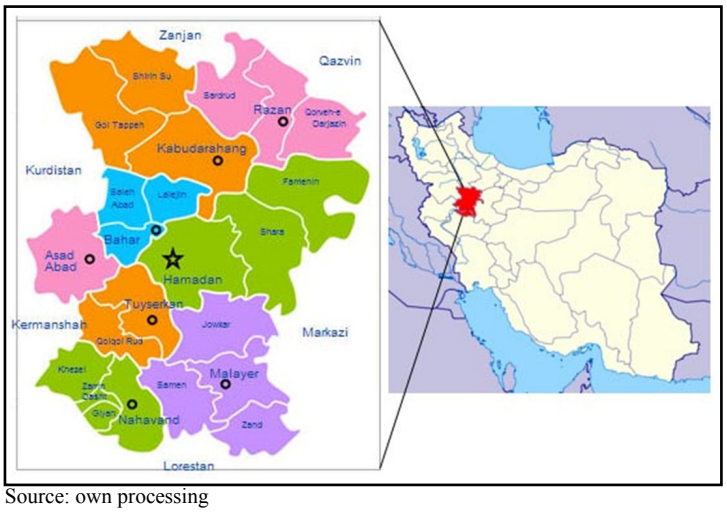
On the basis of probability of occurrence these regions were qualitatively classified and the risk layers were identified. These layers were overlayed on the layers obtained by applying AEZ model and finally the areal extension of wheat cultivation in drought conditions were worked out.

Materials and methods

The study area

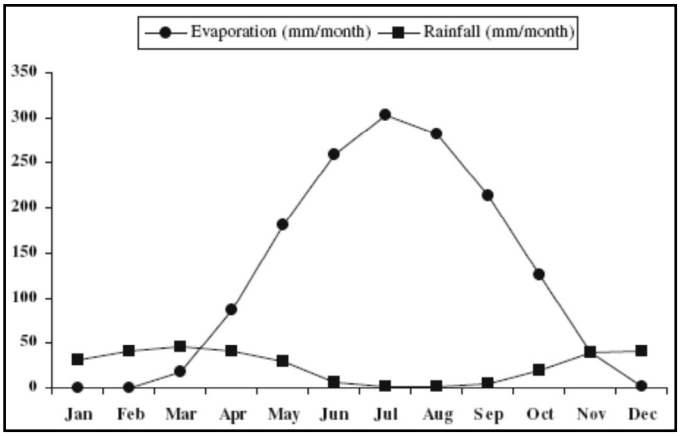
Hamedan province lies between longitudes 48° 28′ 30″ and 49° 1′ E and latitudes 34° 36′ and 35° 9′ N and is shown in Figure 1. The area occupies about 944 km2, with a mean altitude of 1950 m.a.s.l. The climate of the study area is considered to be semi-arid, the annual average precipitation being approximately 300 mm, of which about 37% occurs during winter. Another feature characterizing the precipitation in the study site is its irregular yearly distribution. The mean air monthly temperature is highest during August (23.45°C) and lowest during January (−1.91°C) with an annual average of 10.88°C. The annual potential evaporation far exceeds the annual rainfall (Figure 2) with a mean annual amount of approximately 1505 mm (1975–2010).

The area has complicated land use characteristics, mainly consisting of agricultural and urban/ residential areas. Groundwater has been used for various purposes, such as drinking, agricultural, domestic and industrial needs. The most important economic activity of the area is agriculture, the chief crops are garlic (Allium sativum), potato (Solanum tuberosum L.) and wheat (Triticum aestivum L.), with actual irrigation being lower than total theoretical demand, as there is a considerable deficit in relation to the amount of irrigated land.



Source: own processing

Figure 1: Location of study area.



Source: own processing

Figure 2: Monthly rainfall and evaporation in the study area.

Data processing

For this research 29 years (1973-2002) precipitation data of 13 meteorological stations were studied. The data of adjacent stations were also taken into consideration to reduce errors in data interpolations. The run test was used to confirm the homogeneity of the data. Next, the missing data were added or supplemented and erroneous data were corrected by using 29 years common data-period.

SPSS Software was applied to carry out the analysis. Regression analysis was done between the stations and the missing data were estimated using data of different stations with higher correlation coefficient and SPI values. Later, the computed SPI values were utilized for further studies to analyze the beginning and terminating intensity, covering area, frequency or return period, duration and the probability of occurrence of drought.

The following equation was used to calculate the probability of occurrences and the corresponding risk values:

$$P(N,m,n) = (n-m+1)/(N+n-2m+2) \quad (1)$$

where N is the length of data, m is the duration of drought and n is the return period. After quantifying the related risk of return periods of various drought events and with respect to the severity and the longest duration, the corresponding probability of occurence to the amount of risk was calculated. The available software in GIS environment such as ArcInfo and ArcView were used to prepare the drought maps of the region under study. The ArcView software was applied to draw the maps and iso-intensity curves of droughts. Furthermore, ArcInfo Software was used to convert the geographical coordinates to UTM coordinate system.

In this study, the 3IDW interpolation method was applied for delineating spatial extension of droughts. To estimate the values of parameters of IDW interpolation technique, trial and error procedure was adopted and the drought maps for various durations (1, 3, 6, 12 and 24 months), as well as, the maps for the longest durations, the maps of amount of risk involved in the occurrence, and the longest and most sever droughts were prepared.

In addition, to prepare AEZ maps, the physiological characteristics, also the phonological parameters of wheat crop were studied. Furthermore, the optimum and the extreme conditions of this crop were carefully investigated. Later, SPSS was used to perform statistical analysis to prepare all the digital layers for climatologically factors. In order to apply AEZ model, the required maps were scanned. These maps were digitized using R2V software to develop a data base containing land information of the region. Later, these maps were edited, and necessary corrections were made through ArcInfo software to convert the coordinate system into UTM.

The descriptive information of maps were added using ArcView software. Finally, the maps were classified based on the required conditions for the crop the topographical maps contour lines distanced with 100 meters were drawn to prepare the elevation map. By mapping Triangulate Irregular Network (TIN) on topographical network, the digital elevation model (DEM) was developed. By converting data for each 500 x 500 pixel in ArcView software and other extensions (viz. 3D analysis), the slope values were computed.

The land type and the soil depth information layers were digitized using maps of land quantities of the scale 1:250,000 which were procured from „soil Research Office“. Moreover, descriptive information was assigned to the maps.

The capabilities of ArcView software such as rational function AND and the spatial query and map calculator were utilized to compose and overlay the maps as well as to delineate and introduce the suitable places for wheat crop.

In order to compare the maps more accurately, they were normalized between 0 and 1. These were classified into five categories (i.e. highly suitable, suitable, average, weak and unsuitable) from crop-yield aspect. Finally, using AEZ the developed maps were overlaid. The risk maps were also overlaid for further analysis, obtaining the results and drawing conclusions.

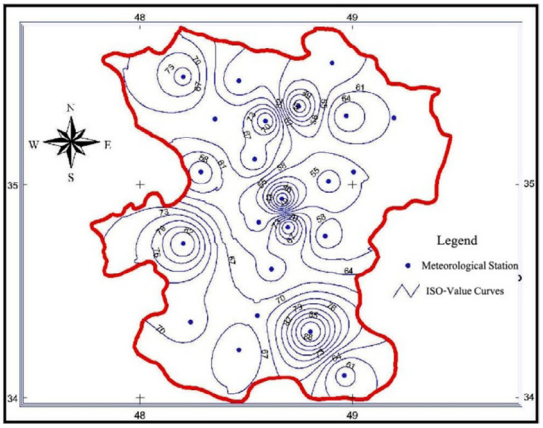
Results and discussions

A sample of result of the risk analysis for the longest duration, most intense or sever droughts for 20 years return period, and the corresponding probability of occurrence for various risk values were calculated and presented in Table 1. Risk maps of the longest durations and most sever droughts for 20 years return periods are given in Figures (3) and (4). As it is observed, the amount of risk for the longest drought duration is more in north, west and south-east regions.

Station	Longest Duration (month)			Intensity according to SPI		
	Drought duration (month)	Risk percent	Probability of occurrence	Duration (month)	Risk percent	Probability of occurrence
Aagtappa	34	76.47	probable	26	51	probable
Bahar	49	59.57	average	43	62.86	high
Gonbad	28	40	possible	28	54	probable
Jowkar	87	53.66	probable	87	53.66	probable
Keytoo	66	55.56	probable	66	55.56	probable
Korijan	43	62.86	high	43	62.86	high
Nashr	31	90.91	expected soon	31	90.91	expected soon
Shoorin	47	60.47	high	31	80.91	high
Dargazin	42	63.64	high	42	63.64	high
Hamadan	36	71.43	high	25	64	high
Malayer	32	84.62	high	32	84.62	high
Novejeh	62	56.16	probable	62	56.16	probable
Soolan	39	66.67	high	39	66.67	high
Ghazvin	35	71.68	high	35	73.68	high
Kermanshah	53	58.18	probable	53	58.18	probable
Saghez	34	76.47	high	34	76.47	high
Sanandaj	37	69.57	probable	37	69.57	high

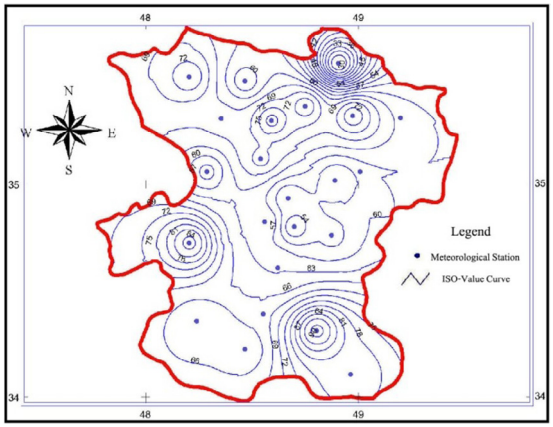
Source: own processing

Table 1. Risk values and probability of drought occurrence for 20 years return period.



Source: own processing

Figure 3: Map of probability of occurrence of most intensive durations potential



Source: own processing

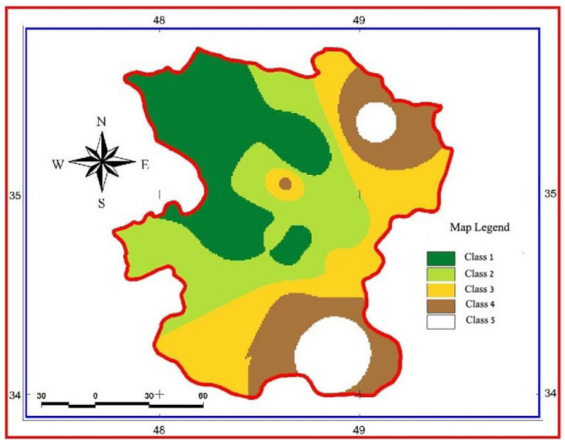
Figure 4: Map of probability of occurrence of longest durations.

The results obtained from the application of AEZ model were used to draw the zoning maps. These maps show spatial variation of the capable regions for crop cultivation in five classes. Figure (5) presents the spatial variation of capability of lands for wheat cultivation in Hamadan Province. According to this study the most suitable lands potentially available for wheat production are located in the north-east region and a part of the central region, where as, least suitable ones can be observed in the north-east and the south – east regions.

The utilities of ArcView software makes it possible to overlay and integrate the maps of drought risk obtained from AEZ model. Thus, the maps of spatial variations of suitability of crop production for each class of risk of occurrence (longest duration and most intensive) of droughts were obtained.

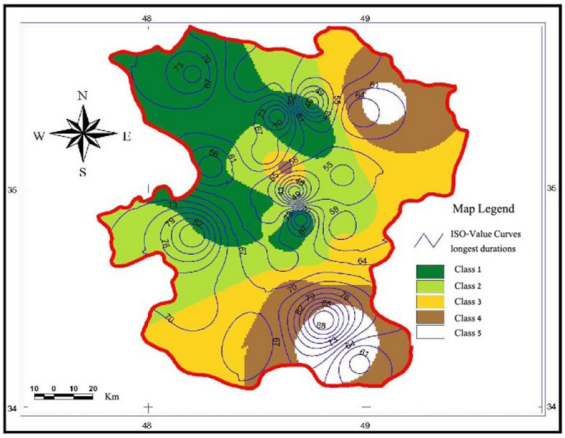
These are presented in Figures (6) and (7). Based on the results obtained it is clear that the priority of cultivation of a crop in a class of drought will be in regions having higher spatial suitability of crop production potential. In other words, in a region located in a drought class the spatial suitability of crop production is variable. Therefore, it is necessary to allocate higher priority to regions with higher crop production potential in agricultural drought risk management.

Thus, the study of the developed figures through regional analysis functions of GIS can give more insight into the variation trend of spatial suitability of crop production potential in each class of drought occurrence (longest duration and/or most intensive duration). This analysis was performed for the region under study but a sample is presented in Figures 8 and 9.This analysis shows that regions located in class-4 risk of occurrence of the longest drought durations have higher frequency of crop production potential with compare to regions located in class-4 risk of occurrence of most intensive durations. The class-4 risk of occurrence of most intensive durations has the lowest frequency of crop production potential and can be observed in south – east regions . Over all, occurrence of most intensive durations has more effect in reduction of crop production potential with compare to longest durations.



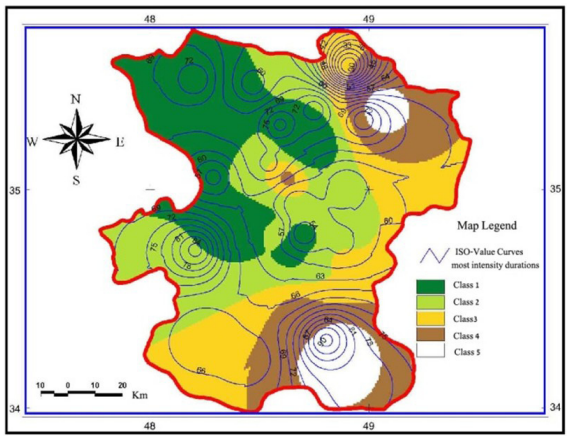
Source: own processing

Figure 5: Spatial variation of classified land capabilities for wheat production.



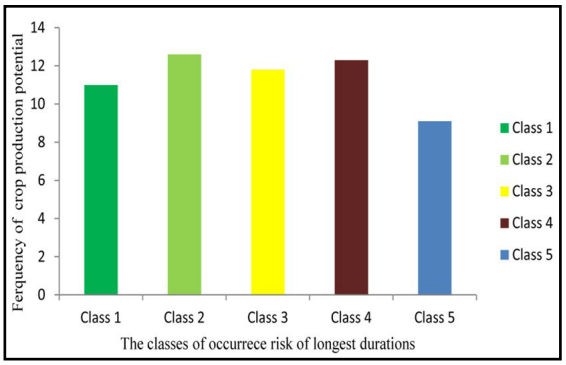
Source: own processing

Figure 6: Overlaid and integrated map of probability of occurrence of longest durations with map of spatial variation of production potential.



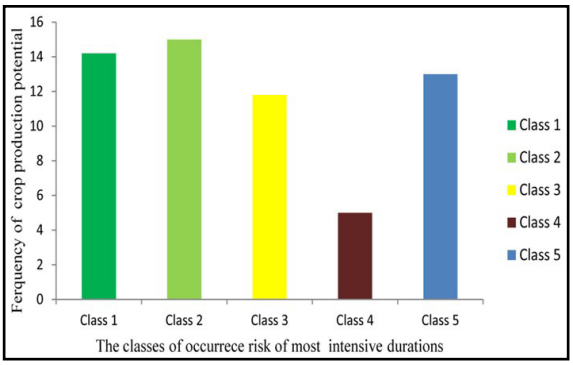
Source: own processing

Figure 7: Overlaid and integrated maps of probability of occurrence of most intensive durations with map of spatial variation of production potential.



Source: own processing

Figure 8: Frequency of crop production potential in each class of longest durations.



Source: own processing

Figure 9: Frequency of crop production potential in each class of most intensive durations.

Conclusion

Drought is a natural hazard originating from a deficiency of precipitation that results in a water shortage for some activities or some groups and is often associated with other climatic factors (such as high temperatures, high winds and low relative humidity) that can aggravate the severity of the event.

Drought disrupts cropping programs, reduces breeding stock, and threatens permanent erosion of the capital and resource base of farming enterprises. Continuous droughts stretching over several years in different parts of the world in the past significantly affected productivity and national economies. In drought condition the agriculture sector is the first and important sector that effected from it. Drought periods can result in significant losses to crop yields, increasing the risk of forest fires (Pausas, 2004) and triggering processes of land degradation and desertification.

With experience of consecutive droughts and depletion of available water resources, more accurate planning based on capabilities and constraints in all regions are necessary for increasing productivity of water and soil resources. Drought risk management and drought monitoring with preliminary precautionary measures and adaptation can definitely reduce loses. The development and integration of the results of Agro-ecological Zoning model with the maps of drought risk in a region can help in suitable planning for optimal operation of water and soil resources as well as for looses reduction.

The results show that the most suitable lands potentially available for wheat production are located in the north-east region and a part of the central region, where as, least suitable ones can be observed in the north-east and the south – east regions. Based on the results obtained it is clear that the priority of cultivation of a crop in a class of drought will be in regions having higher spatial suitability of crop production potential. In other words, in a region located in a drought class the spatial suitability of crop production is variable. Therefore, it is necessary to allocate higher priority to regions with higher crop production potential in agricultural drought risk management.

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Econometric Analysis of the Nexus of Exchange Rate Deregulation and Agricultural Share of Gross Domestic Product in Nigeria

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Abstract

This study examined the relationship between exchange rate deregulation and the agricultural share of gross domestic product in Nigeria from an econometric perspective using time series data. The data were analysed using augmented dickey fuller unit root test, unrestricted vector autoregression and pairwise granger causality. The results of the data analysis revealed the existence of unidirectional causality from exchange rate to agricultural share of gross domestic production in Nigeria and this implies that market driven exchange rate policy has been significant in influencing the trend in agricultural share of gross domestic production in Nigeria. However, it is recommended that the monetary authority of Nigeria should closely monitor the movement of the market driven exchange rate so that exchange rate deregulation does not become counterproductive through unhealthy price distortions on agricultural production, international trade and foreign direct investment in the agricultural sector of Nigeria's economy.

Key words

Correlation, technical efficiency, farm income, dietary diversity, Nigeria.

Introduction

Nigeria's domestic economy is partly determined by agriculture which accounted for 40.9 per cent of its Gross Domestic Product (GDP) in 2010 (CBN, 2011) and the agricultural sector is one of the leading sectors in the country in terms of its contributions to income, employment, foreign exchange earnings and domestic food supply (Omojimite, 2012). Despite the immense potentials of agriculture in Nigeria, food production to meet local demand has been a challenge over the years and as noted by Oparaeke et al. (2009) who posited that if the current food production trend of 1.35 per cent is not increased to tally with or surpass the population growth rate, then the country will be in a for a turbulent future. In a bid to increase food production in Nigeria over the years, several policy reforms have been put in place by successive governments and one of such policy reforms in time past is the Structural Adjustment Programme(SAP) introduced in July 1986 (Oyinbo and Emmanuel, 2012). The Structural adjustment programme aimed at facilitating economic growth as a means of jump-starting the economy towards sustainable economic growth and development. The emergence of Structural adjustment programme in Nigeria embraced exchange rate deregulation and thus, deregulation placed much emphasis on the market forces in determining the prices of goods and services and allocating the resources within the economy (Idowu et al., 2007). The exchange rate over-valuation prior to deregulation helped to cheapen imports of competing food items as well as agro-based and industrial raw materials and the result was rapid expansion in the importation of these goods to the detriment of local production of similar goods (Imimole and Enoma, 2011). This led to the abolition of the fixed exchange rate regime and the introduction of flexible exchange regime via the adoption of Structural adjustment programme. This new exchange rate policy helped to remove the over-valuation problem to the extent that the naira now became under-valued. The movement away from fixed to flexible exchange rate regimes allowing significant depreciation of Naira was aimed at enhancing export by making Nigerian goods cheaper (Shittu et al., 2007).

There has not been a consensus among academic economists regarding the impact of exchange rate variations on economic variables. However, the traditional view is that fluctuations in exchange rates affect relative domestic and foreign prices,

causing expenditures to shift between domestic and foreign goods (Obstfeld, 2002). Several economists and policy analysts to mention a few had focused considerable research attention on Nigeria's non-oil trade behaviours; a prominent feature of these studies has been a lack of consensus on the suitability of trade and exchange rate deregulation in the Nigerian case.

Since the inception of exchange rate deregulation in Nigeria, there have been fluctuations in the value of the naira. However, exchange rate of the naira to the US dollars was relatively stable in 2010 (CBN, 2010). The average exchange rate of the naira at the Whole Sale Dutch Auction System (WDAS) segment of the foreign exchange market in 2010 was 150.30 per US dollars; a depreciation of 0.9 per cent compared to the level in 2009. A market driven exchange rate policy is expected to be important in determining the importation of inputs for agricultural production and also, the export of agricultural produce through its influence on prices but it is worth noting that there exists a dearth of empirical information on the relationship between exchange rate deregulation and agricultural gross domestic product in Nigeria which is in line with Petreski (2009), who posited that the relationship between exchange rate and economic growth remains blurred and requires in-depth empirical investigation. This study was therefore, designed to fill the gap in research by providing empirical information on the relationship between exchange rate deregulation and agricultural share of gross domestic product in Nigeria. The hypotheses put forward were stated in the null and alternative forms:

Null form (H_O): There is no a significant relationship between exchange rate and agricultural share of gross domestic product in Nigeria.

Alternative form (H_a): There is a significant relationship between exchange rate and agricultural share of gross domestic product in Nigeria.

Literature review

A review of relevant empirical studies (Aghion et al., 2009; Cho et al., 2002; Gala, 2008; Ghura and Greene, 2004; Jumah and Kunst, 2001; Kriesler et al., 2013) have indicated two school of thoughts with regards to the influence of exchange rate on economic growth (gross domestic product) and this is attributed to variations in data periods, models and estimation methods. One school of thought posited that fixed exchange rate policy is significant in influencing economic growth while the other school of thought asserted that market driven exchange rate policy is significant in influencing economic growth.

Omojimite (2012) in a study on institutions, Macroeconomic Policy and Growth of Agricultural Sector in Nigeria found out that exchange rate was negative and significant in influencing agricultural production.

Chukuigwe and Abili, (2008) in a study on econometric analysis of the impact of monetary and fiscal policies on non-oil exports in Nigeria noted that considering the importance of the exchange rate as a major price that affects all sectors of the economy and all economic agents, it is imperative to monitor the movements in the real exchange rate in order to foster competitiveness and improve the supply of exports in the medium to long term and that The Central Bank of Nigeria should continue to intervene in the foreign exchange market to maintain stability.

Okhiria and Saliu (2008) in a study on exchange rate variation and inflation in Nigeria noted that Dutch disease results from an appreciation of the exchange rate, caused by the large inflows of petroleum revenues, which again leads to reduced competitiveness of various non-petroleum sectors of the economy. Dutch disease will often have particularly serious effects on the poor because traditional sectors such as agriculture and other production in rural areas will loose out to imports that become more competitive as a result of currency appreciation.

Imimole and Enoma (2011) in a study on exchange rate depreciation and inflation in Nigeria noted that theoretically, exchange rate is an important determinant of inflation rate. Although exchange rate depreciation may not directly control inflation, it helps to restructure the price mechanism of both import and export, such that Naira depreciation subtly tends to moderate prices in Nigeria, especially imported price inflation.

Materials and methods

Description of data

Time series data on exchange rate (Naira per US Dollar) and agricultural share of real gross domestic product(GDP) extending over the period

of exchange rate deregulation (1986 to 2011) were utilized in this study. The data were collected from various issues of Central Bank of Nigeria statistical bulletin and annual reports (CBN, 2008; 2011).

Analytical procedure

Augmented Dickey Fuller (ADF) test, Unrestricted vector autoregression (VAR) and Pairwise granger causality test were employed using Eviews 7.2 statistical package to analyse the data in order to achieve the objective of the study. ADF test was used to ascertain the time series properties of all the variables so as to avoid spurious regression which results from the regression of two or more non-stationary time series data. Unrestricted VAR was employed to select the optimal lag length used in the granger causality test and finally, the pairwise granger causality test was used to determine the causal relationship between exchange rate and agricultural share of gross domestic product over the period of exchange rate deregulation. The model of the Augmented Dickey Fuller (ADF) with the constant term and trend is as follows:

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \beta Y_{t-1} \sum_{i=1}^{n} \gamma_i \Delta Y_{t-1} + \varepsilon_t \qquad (1)$$

The null hypothesis (H_O: $\beta = 0$) of the ADF test indicates that the series is not stationary and the alternative hypothesis (H_1: $\beta < 0$) indicates that the series is stationary. If the absolute value of calculated ADF statistic (τ) is higher than the absolute value of the critical values, we reject the hypothesis which states that the series is stationary. However, if this value is lower than the critical values, the time series is not stationary. The Granger causality test assumes that the information relevant to the prediction of the respective variables, X and Y, is contained solely in the time series data on these variables. The test involves estimating the following pair of regressions:

$$X_t = \beta_0 + \sum_{i=1}^{p} \beta_i X_{t-i} + \sum_{j=1}^{p} \alpha_j Y_{t-j} + \mu_{1t} \qquad (2)$$

$$Y_t = \gamma_0 + \sum_{i=1}^{p} \gamma_i Y_{t-i} + \sum_{j=1}^{p} \delta_j X_{t-j} + \mu_{2t} \qquad (3)$$

It is assumed that the disturbances μ_{1t} and μ_{2t} are uncorrelated. Thus there is unidirectional causality from X to Y if $\alpha_i = 0$ and $\delta_i \neq 0$. Similarly, there is unidirectional causality from Y to X if $\delta_i = 0$ and $\alpha_i \neq 0$. The causality is considered as mutual (bilateral causality) if $\delta_i \neq 0$ and $\alpha_i \neq 0$. Finally, there is no link between X and Y (independence) if $\delta_i = 0$ and $\alpha_i = 0$.

Model Specification

To determine the relationship between exchange rate deregulation and agricultural share of gross domestic product in Nigeria, the pairwise granger causality test is modelled as bivariate vector autoregressive (VAR) model as follows:

$$EXR_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i EXR_{t-i} + \sum_{j=1}^{p} \omega_j GDP_{t-j} + \epsilon_{1t} \quad (4)$$

$$GDP_t = \beta_0 + \sum_{i=1}^{p} \beta_i GDP_{t-i} + \sum_{j=1}^{p} \varphi_j EXR_{t-j} + \epsilon_{2t} \quad (5)$$

The VAR model is expressed in matrix notation as:

$$\begin{bmatrix} EXR_t \\ GDP_t \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} b_{11,1} & b_{12,1} \\ b_{21,1} & b_{22,1} \end{bmatrix} \begin{bmatrix} EXT_{t-1} \\ GDP_{t-1} \end{bmatrix} + \begin{bmatrix} b_{11,p} & b_{12,p} \\ b_{21,p} & b_{22,p} \end{bmatrix} \begin{bmatrix} GDP_{t-p} \\ EXR_{t-p} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} \qquad (6)$$

Where:

EXR_t = Exchange rate in year t (Naira per US Dollar)

GDP_t = Agricultural share of real gross domestic product in year t(Naira‘ million)

a = Constant terms

b = Estimated coefficients of exchange rate and agricultural share of real gross domestic product in year t

$\epsilon_{1t}, \epsilon_{2t}$ = Gaussian white noise error terms

p = optimal lag length

Results and discussion

Descriptive statistics of variables

It is important to examine the summary statistics of the variables under study (exchange rate and agricultural share of gross domestic product). The basic features of exchange rate (ECR) and agricultural share of gross domestic product (GDP) under study are given in Table 1. ECR is positively skewed, leptokurtic and the probability value (0.17) of its Jarque bera statistic (3.50) denotes that its errors are normally distributed. GDP is positively skewed, leptokurtic and its errors are normally distributed based on the Jarque Bera statistic (3.46).

Statistic	ECR (Naira per US Dollar)	GDP (Naira‘ million)
Mean	70.81860	157700.8
Median	57.37225	111692.4
Maximum	158.2300	335400.0
Minimum	2.020000	69608.06
Std. Dev.	59.44565	87890.64
Skewness	0.109590	0.747625
Kurtosis	1.216498	2.020795
Jarque – Bera	3.497997	3.460836
Probability	0.173948	0.177210
Sum	1841.284	4100221
Observations	26	26

Source: own processing

Table 1: Descriptive statistics of Exchange Rate and GDP in Nigeria (1986 – 2011).

Variable	ADF Statistic	Lag	Test Critical value (5%)	Decision
Level				
lnEXR	-2.016752	0	-3.603202	Non-stationary
lnGDP	-1.873371	0	-3.603202	Non-Stationary
First difference				
ΔlnAEXR	-5.247509	0	-3.690814	Stationary
ΔlnGDP	-4.866667	0	-3.612199	Stationary

Note: ln = natural logarithm, Δ = difference operator
Lag length selection was automatic based on Schwarz information criterion (SIC)
Source: own processing

Table 2: Result of Augmented Dickey Fuller Test.

Augmented Dickey Fuller Unit root test

The result of the augmented dickey fuller test with the assumption of trend and intercept in Table 2 shows that lnEXR and lnGDP were non-stationary at level form (exhibit random walk) and therefore, needed to be differenced so as to avoid spurious result when the variables are used in their non-stationary form.

Vector Autoregression (VAR) Lag Order Selection Criteria

Granger causality test is known to be sensitive to lag length (Oyinbo et al., 2012) and therefore, VAR model was fitted to the time series data in order to find an appropriate lag structure for the granger causality test. The result as shown in Table 3 indicates that the optimal lag length is four based on Likelihood ratio (LR), Final prediction error (FPE) and Akaike information criterion (AIC).

Granger Causality Test

The result of the granger causality carried out using an optimal lag length of four is given in Table 4. The result indicates that there is unidirectional causality from exchange rate and the agricultural share of gross domestic product in Nigeria over the period of exchange rate deregulation and therefore, the hypothesis that exchange rate does not granger cause agricultural share of gross domestic product is rejected while the hypothesis that agricultural share of gross domestic product granger cause exchange rate is accepted. The result implies that deregulation of exchange rate has been significant in influencing the volume of agricultural share of the Nigerian gross domestic period over the period under study. This could be attributed to the influence of market determined exchange rate on importation of inputs for agricultural production and agricultural exports known to be contributing the largest share of non-oil export

Lag	LR	FPE	AIC
0	NA	0.064459	2.933882
1	84.62852	0.000860	-1.386750
2	2.881067	0.001067	-1.185864
3	4.347656	0.001185	-1.115459
4	14.64704*	0.000546	-1.955094*
5	3.039158	0.000660	-1.878057

Note: * indicates lag order selected by the criterion
LR: Likelihood ratio, FPE: Final prediction error, AIC: Akaike information criterion
Source: own processing

Table 3: VAR Lag Order Selection Result.

Null Hypothesis (H_0)	Obs.	F- statistic	Prob.	Decision
GDP does not granger cause EXR	22	0.02316	0.9988	Accept H_0
EXR does not granger cause GDP	22	17.8745	3.E-05	Reject H_0

Source: own processing

Table 4: Result of Pairwise Granger Causality Test.

and this is in consistent with Enoma (2011), who noted that exchange rate depreciation helps to restructure the price mechanism of both import and export, such that Naira depreciation subtly tends to moderate prices in Nigeria, especially imported price inflation. Therefore, it is imperative for the monetary authority of Nigeria to monitor the trend in exchange rate depreciation so as to avoid excessive devaluation of the naira that could be detrimental to the contribution of agriculture to the gross domestic product through its inflationary effect on trade (agricultural input importation and agricultural product exportation) and investment in the agricultural sector of Nigeria's economy. This is in line with the opinion that an attempt to over-stimulate the economy, by expansionary monetary policy or currency devaluation will result in higher rate of inflation, but no increase in real economic growth (Goldstein, 2002).

Conclusion

Augmented dickey fuller unit root test, Unrestricted vector autoregression (VAR) and Pairwise granger causality were employed to analyse the time series data on exchange rate and agricultural share of gross domestic product over the period of economic deregulation in Nigeria in order to achieve the objective of the study. The key finding of this study is the presence of unidirectional causality from exchange rate to gross domestic product over the period under study. This placed an emphasis on the significant role of exchange rate deregulation on the agricultural share of gross domestic product in Nigeria. However, it is recommended that the central bank of Nigeria should carefully monitor the movement of the market determined exchange rate so that exchange rate deregulation does not become counterproductive through price distortions on agricultural production, trade (agricultural input importation and agricultural produce exportation) and investment in the agricultural sector of Nigeria's economy.

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Asymmetry in Price Transmission of the Czech Wheat Agri-food Chain

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Anotace

Tento článek je zaměřen na posouzení symetrie, resp. asymetrie cenové transmise ve vybraných dílčích vertikálách pšenice potravinářské v České republice, konkrétně hladké mouky, světlého pečiva a konzumního chleba. Asymetrie cenových přenosů je zkoumána ve vztahu cena zemědělských výrobců-cena průmyslových výrobců a cena průmyslových výrobců-spotřebitelská cena. Vlastní analýza je založena na pojetí symetrického a asymetrického chování, kdy je zkoumán vliv kladných a záporných změn cen na jednotlivých úrovních vertikály na navazující úrovně, dále potom na symetrii a asymetrii cenových přenosů mezi navazujícími cenovými úrovněmi. Pro naplnění cíle jsou použity upravené Vector error correction modely a impulse-response analýza. Analýza je založena na časových řadách jednotlivých cen obsahujících měsíční údaje v období leden 1999 – říjen 2011. Vlastní analýza ukázala, že některé vztahy mezi cenami na jednotlivých úrovních zkoumaných výrobkových vertikál vykazují symetrickou povahu, zatímco jiné dílčí vazby jsou povahy asymetrické. Z komplexního hlediska lze však vertikály považovat za asymetrické a asymetrii lze označit jako tzv. „upward asymmetry“. Z analýzy je dále zřejmá pomalá reakce cen na jednotkové cenové šoky, avšak i přes délku období je po vychýlení z rovnovážného stavu dosaženo nové rovnovážné úrovně.

Klíčová slova

Cenová transmise, VECM, impulse-response analýza, asymetrie, zemědělsko-potravinářský trh, výrobková vertikála, pšenice.

Abstract

This article focuses on the assessment of the symmetry or asymmetry of price transmission in selected partial verticals of foodstuffs wheat in the Czech Republic, specifically of smooth flour, white baked goods and consumer bread. The asymmetry of price transmissions is examined in the relationship of agricultural producer price – industrial producer price and industrial producer price – consumer price. The analysis itself is based upon the concept of symmetrical and asymmetrical behavior, where the effect of positive and negative changes in prices on individual levels of the vertical to connecting levels is examined, as well as also symmetry and asymmetry of price transmissions between connecting price levels. For the fulfillment of the objective, adjusted vector error correction models and impulse-response analysis are utilized. The analysis is based upon time series of individual prices containing monthly data within the period of January 1999 – October 2011. The analysis itself showed that some relationships between prices on individual levels of the analyzed product verticals show a symmetrical nature, while other partial relationships are of an asymmetrical nature. However, from a comprehensive standpoint, verticals can be considered to be asymmetrical and the asymmetry can be called “upward asymmetry”. Further, the analysis shows a slow reaction of prices to unit price shocks, but even despite the length of the period, a new equilibrium level is reached after deviation from a state of equilibrium.

Key words

Price transmission, VECM, impulse-response analysis, asymmetry, agri-food market, product vertical, wheat.

Introduction

The analysis of price transmissions has a steadily greater significance when examining markets, and not only agri-food markets. Peltzman (2000) analyzed the nature of price transmission within selected product verticals in the USA. That extensive research was conducted on the example

of 282 commodities, of which 120 were agricultural commodities. On the basis of the conducted analysis, it was established that price transmission can generally be considered to be asymmetrical, which does not confirm the general economic theory, which according to the author erroneously assumes symmetrical price transmissions.

Asymmetrical behavior can be caused by various factors. Imperfectly competitive markets and transactional costs, and further also political interventions, asymmetrical information or management tend to be mentioned as the most frequently indicated causes of asymmetrical behavior. In agri-food verticals, imperfectly competitive markets, primarily in terms of the agricultural initial producer and consumer, as the first and final segment of the given vertical, usually tend to be considered to be the cause of asymmetrical price transmission. Von Cramon-Taubadel, Meyer (2000) state that in political discussions, the main cause of asymmetrical price transmission is considered to be primarily abuse of market strength on the part of certain segments of the chain. In this regard, Vavra, Goodwin (2005) state that imperfectly competitive market structure can serve as a significant factor for explaining asymmetrical price transmission, but nevertheless this relationship cannot be considered to be causal. The reason is that asymmetry in price transmission can be expressed both in the case of perfect competition, as well as in the case of imperfectly competitive markets. Thus, it cannot be associated only with imperfect competition and abuse of market strength. For example, Azzam (1999), McCorriston et al. (2001) and Weldegebriel (2004) also reached the same conclusion. For example, Jensen, Møller (2007) and Meyer, von Cramon-Taubadel (2004) indicate transactional costs as one of the main causes of asymmetry in price transmission. Gardner (1975), Kinucan, Forker (1987) and Serra, Goodwin (2003) see the cause of asymmetrical price transmission primarily in state interventions, for example in the form of the support of agricultural producer prices or the introduction of production quotas. Von Cramon-Taubadel, Meyer (2000) further state that even despite the existence of many possible causes of asymmetrical price transmission, the problem of an impossibility of differentiation and identification of the individual causes of asymmetry arises in the case of empirical analysis.

From a theoretical standpoint, the issue of symmetry and asymmetry in price transmission was dealt with, for example, by Frey, Manera (2007) and Meyer, von Cramon-Taubadel (2004).

The objective of this article is to establish, on the basis of quantitative analysis, whether the product vertical of foodstuffs wheat can be considered, in terms of price transmissions, to be symmetrical or not. On the basis of knowledge of the functioning of agri-food markets, it can be assumed that an increase and decrease in prices on individual levels will not be transmitted to a further level in the same manner. However, it can be assumed that the vertical of foodstuffs wheat is characterized by asymmetrical behavior in terms of price transmissions.

Materials and methods

The view of symmetry and asymmetry within price transmission can be various and differs within the interpretation of various authors. The fulfillment of the objective of this article is based primarily upon the general, frequently utilized definition of asymmetry in price transmission. This concept of asymmetry is set out, for example, by Stigler, Tortora (2011) - “asymmetric price transmission” is the situation where the response of a price to another price’s change depends on whether the change was positive or negative. When a price increase is better transmitted than a price decrease, it is said “positive” or “upward” asymmetry, the opposite case being called “negative” or “downward” asymmetry.

Symmetry or asymmetry in price transmission can be analyzed by way of various approaches and models. Frey, Manera (2007) indicate four types of models appropriate for the analysis of asymmetrical price transmission, specifically the Autoregressive Distributed Lag model (ADL), the Partial Adjustment Model (PAM), the Error (or Equilibrium) Correction Model (ECM), and the Regime Switching Model (RSM). Acquah (2008) indicates three types of approaches, or models, for the analysis of asymmetrical price transmission, specifically the Houck approach, the adjusted VECM model, and the TVECM model.

On the basis of a theoretical model according to Frey, Manera (2007), the adjusted vector error correction model (VECM) is defined for the analysis of asymmetrical behavior in price transmission in the following manner:

$$\Delta y_t = \mu + \sum_{h=1}^{r} \beta_h \Delta y_{t-h} + \sum_{i=0}^{s} \alpha_i^{+} \Delta x_{t-i}^{+} + \sum_{j=0}^{q} \alpha_j^{-} \Delta x_{t-j}^{-} + ECT + \varepsilon_t,$$

where the effect of the relevant prices is analyzed according to whether the price change is positive (+) or negative (-). Further, μ represents a constant, ε_t is the random element of the model, and ECT is the Error Correction Term.

The nature of price transmissions, i.e. the symmetrical or asymmetrical reaction of prices upon unit changes in the agricultural producer price (FP), the industrial producer price (WP) or the consumer price (CP) and a deviation of the markets from a state of equilibrium is analyzed with the utilization of impulse-response analysis and VECM model alpha vectors.

The analysis of symmetry or asymmetry in price transmission is conducted for three partial verticals of foodstuffs wheat in the Czech Republic. The analysis focuses on price transmissions between the agricultural producer price (FP), the industrial producer price (WP1) and the consumer price (CP1) within the vertical of smooth wheat flour, as well as transmissions between the agricultural producer price (FP), the industrial producer price (WP2) and the consumer price (CP2) within the vertical of white wheat baked goods, and price transmissions between the agricultural producer price (FP), the industrial producer price (WP3) and the consumer price (CP3) within the vertical of caraway consumer bread[1].

The analysis itself is based upon time series of individual variables (agricultural producer prices, industrial producer prices and consumer prices within partial verticals of foodstuffs wheat), which contain monthly data within the period of January 1999 – October 2011. The data were provided by the Ministry of Agriculture of the Czech Republic and the Czech Statistical Office. The calculations have been conducted within the Gretl econometric software.

Results and discussion

This part of the article contains the results of empirical analysis including comments explaining the behavior in the analyzed verticals. Neither a statistical standpoint nor other characteristics of the estimated models are a basis for this analysis, or its evaluation, and therefore they are not set out or commented on in the article in detail, but attention has been paid to them in estimating models. The main focus of attention in this section is on the form of estimated parameters among variables expressing positive and negative changes in individual prices, and the results of impulse-response analysis, which shows the reaction of individual prices to unit shocks on other price levels. In the following text, the results of the effect of positive and negative changes on individual prices in the analyzed verticals are set out first, and further, alpha vectors showing the reaction of prices upon deviation from a state of equilibrium and subsequently the results of impulse-response analysis are shown.

The marking of variables used in the quantitative analysis is set out in the Material and Methods section. The agricultural producer price s the same in all analyzed verticals, marked as FP. Further, the vertical of smooth flour is based upon the industrial producer price and the consumer price marked as 1, i.e. WP1 and CP1; the vertical of white baked goods marked 2, i.e. WP2 and CP2; and the vertical of consumer bread marked 3, i.e. WP3 and CP3.

The effect of positive and negative price changes on the further levels of product verticals is set out in Table 1. The table contains estimated parameters of adjusted VECM models of the relevant variables. Cases of symmetrical reactions are marked in blue (in absolute value, the parameter of the positive price change is at least approximately equal to the value of the parameter of the negative price change), while asymmetrical reactions are red (absolute values of parameters of positive and negative price changes are not equal).

The conducted analysis shows that the reactions of prices to a decline or increase in price levels of connecting articles of a vertical are, in partial verticals of foodstuffs wheat, both symmetrical as well as asymmetrical. It may be stated that the reaction of industrial producer prices to a change in the agricultural producer price is predominantly asymmetrical, in all examined verticals. That means that changes in agricultural producer prices are transmitted to the next level regardless of whether they decline or increase.

Further, it can be stated that the reaction of the industrial producer price to a change in the consumer price is symmetrical within the verticals of white baked goods and consumer

[1] The abbreviations of the models' variables are based on the following terminology: FP stands for farm-gate price, WP stands for wholesale price and CP stands for consumer price.

	ΔFP+	ΔFP-	ΔWP1+	ΔWP1-	ΔWP2+	ΔWP2-	ΔWP3+	ΔWP3-
FP			0.006865	-0.003321	0.095743	0.078987	0.002898	-0.010080
WP1	-0.044101	-0.045950						
WP2	-0.027026	-0.025326						
WP3	-0.007711	-0.000788						
CP1			0.004684	0.000893				
CP2					0.171750	0.173412		
CP3							0.010766	0.005214
	ΔCP1+	ΔCP1-	ΔCP2+	ΔCP2-	ΔCP3+	ΔCP3-		
FP								
WP1	-0.001390	-0.007598						
WP2			0.029128	0.032981				
WP3					-0.037457	-0.037075		
CP1								
CP2								
CP3								

Note: The blue color shows symmetrical behavior, while red denotes asymmetrical reactions.
Source: own calculations

Table 1: Positive and Negative Price Changes.

bread, while being asymmetrical in the case of the vertical of smooth flour.

The analysis further shows that in the case of asymmetrical reactions, the reaction to a positive change in price is almost always faster than the reaction to a negative change, which means that prices within the analyzed verticals react faster to an increase in prices within the connecting levels than to their decline, both upwards as well as downwards within the given product vertical. The asymmetry established in these product verticals can thus be considered to be "upward asymmetry". The vertical of smooth flour is an exception, whereby the reaction of WP1 to a decline in CP1 is faster than the reaction to its increase.

It is thus evident from the above that the industrial producer price has a specific position. Even despite certain exceptions, its position shows a symmetrical reaction to changes in prices on other levels of the analyzed verticals. Changes in agricultural producer prices as well as changes in consumer prices are thus transmitted into industrial producer prices in the same manner regardless of whether the change is a decline or an increase. However, this conclusion does not correspond to certain results of other authors. The fact is that previously conducted empirical studies show that generally, industrial producer prices grow much faster than agricultural producer prices and that the reactions of the prices of industrial producers is different in the case of the growth and decline of agricultural producer prices. The reaction of industrial producer prices to a decline in agricultural producer prices is not as fast or complete as in the case of their growth[2]. The differences in the conclusions can be attributed to the choice of the analyzed product vertical as well as the examined destination. The results thus cannot be positively generalized to all agri-food verticals, although partial similarities can undoubtedly be found.

Table 2 contains alpha vectors in individual VECM models, which were derived in the preceding study or the characteristics and description of price transmissions between agricultural producer prices, industrial producer prices and consumer prices within verticals of smooth flour, white baked goods and consumer bread[3]. The table contains alpha values, in each case for the first and second price within the analyzed relationship. In the FP-WP1 relationship, the alpha value for FP is thus given first, and subsequently the alpha value for WP1 is given. The same then goes accordingly for the other analyzed relationships. The higher alpha value

[2] See for example Peltzman (2000), Gauthier, Zapata (2006), Vavra, Goodwin (2005) or Kaabia, Gil (2007).

[3] The results of this analysis including complete VECM models are set out in the publication Rumánková, L.: Market Relations in the Czech Wheat Agri-food Chain.

(in absolute value) in every alpha vector is always marked in color.

Alpha values show the speed of the reaction of individual prices upon the deviation of the system from a state of equilibrium. It is evident from the calculated values that the price at a lower level of the analyzed vertical always reacts faster. However, overall, the reactions of prices are not very fast, and the attainment of a new state of equilibrium thus occurs relatively slowly. This fact indicates the presence of imperfections on the analyzed markets.

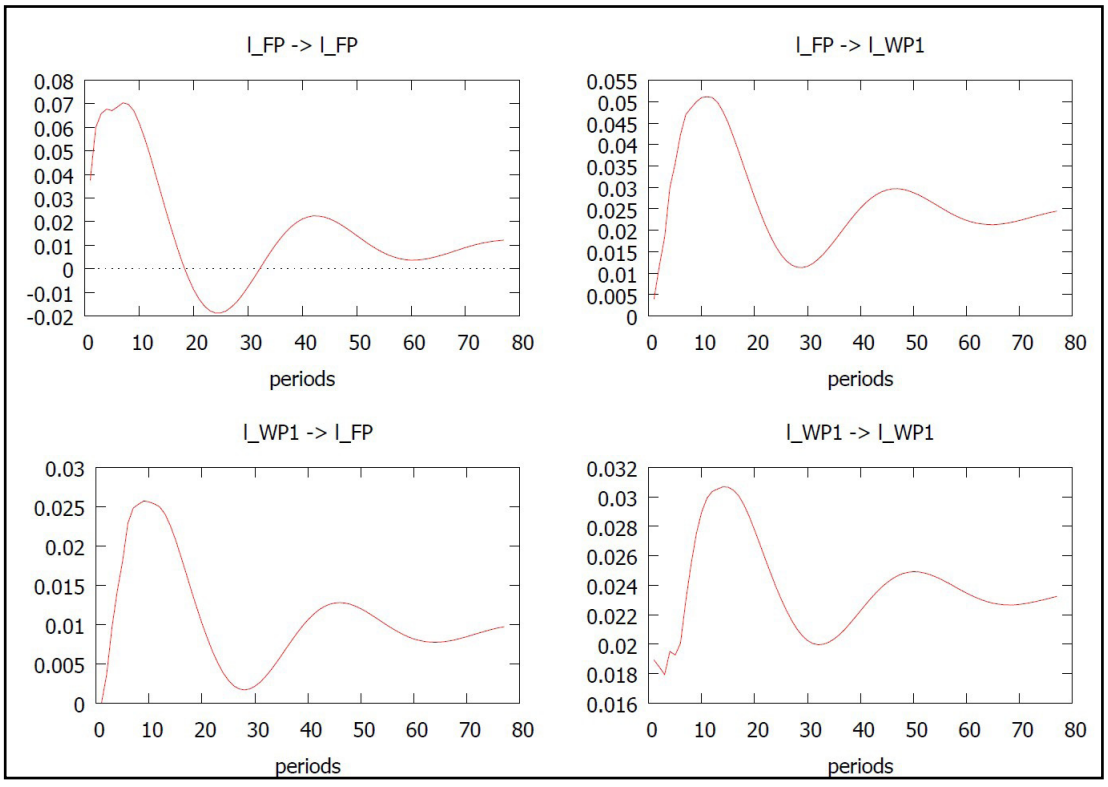
Last but not least, focus is given to the results of impulse-response analysis, i.e. the reaction of individual prices to individual unit shocks of all variables. Graph 1 contains the graphic results of impulse-response analysis for the partial vertical of smooth flour. The results for the other partial verticals then look similar. Table 3 contains an overview of the speed of the return of individual prices to a state of equilibrium after the relevant unit shock of one of the variables, i.e. of the analyzed prices.

Impulse-response analysis showed that upon a deviation of the system from a state of equilibrium caused by a unit shock of any of the prices, another state of equilibrium becomes set. Nevertheless, this is a long-term matter. However, prices head towards such a state even within the short-term. In all cases, a new state of equilibrium is established after approximately 50 periods, i.e. months. However, the speed of the reaction of individual prices slightly differs. The analysis shows that the reaction of the agricultural producer price is generally faster

	FP-WP1	WP1-CP1	FP-WP2	WP2-CP2	FP-WP3	WP3-CP3
1st price	-0.123980	-0.196060	-0.121740	-0.106640	-0.091835	-0.123860
2nd price	0.050621	-0.084875	0.027117	-0.070072	0.018970	0.028794

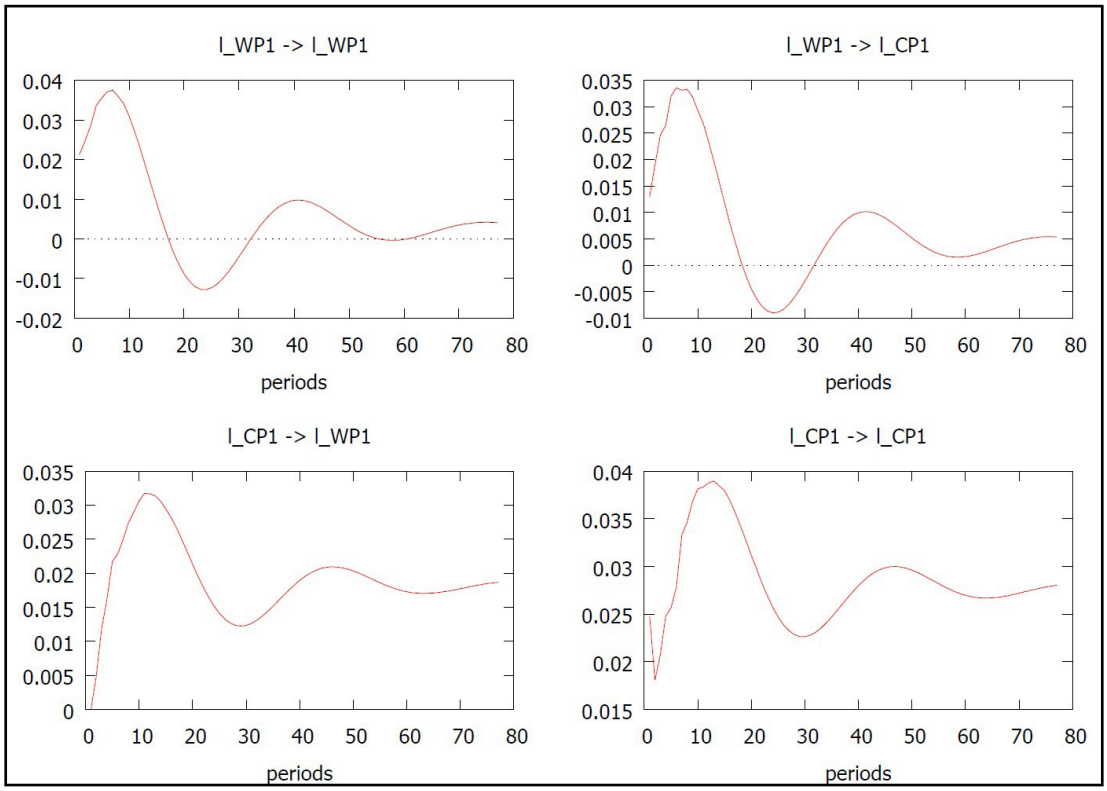
Note: Higher (absolute) values within each alpha vector are marked in color.
Source: own calculations

Table 2: Alpha Vectors.



Source: own processing

Graph 1: Impulse-Response Analysis within the Partial Vertical of Smooth Flour.



Source: own processing

Graph 1: Impulse-Response Analysis within the Partial Vertical of Smooth Flour (continuation).

FP-WP1	FP	WP1	WP1-CP1	WP1	CP1
FP shock	45	50	WP1 shock	50	50
WP1 shock	45	50	CP1 shock	50	50
FP-WP2	FP	WP2	WP2-CP2	WP2	CP2
FP shock	50	55	WP2 shock	50	55
WP2 shock	55	65	CP2 shock	50	50
FP-WP3	FP	WP3	WP3-CP3	WP3	CP3
FP shock	50	55	WP3 shock	45	45
WP3 shock	55	55	CP3 shock	50	50

Source: own calculations

Table 3: Impulse-Response Analysis.

than the reaction of the industrial producer price, both to FP shocks, as well as WP shocks. Further, it was established that industrial producer prices and consumer prices adapt to WP and CP unit shocks in relatively the same manner. It can thus be stated that the agricultural producer price reacts the best to unit shocks, but nevertheless, the reaction of industrial producer prices and consumer prices is only several periods (approximately 5 months) slower.

The results of impulse-response analysis support the results of analysis conducted on the basis of alpha vector values. If a deviation of the system from a state of equilibrium occurs, for any reason, the establishment of a new equilibrium price level is thus a long-term matter. This result once again shows the presence of imperfections within the analyzed product verticals.

Conclusion

The objective of this article was to identify, with the utilization of quantitative analysis, the nature of relationships between the agricultural producer price, the industrial producer price, and the consumer price within partial verticals of foodstuffs wheat in the Czech Republic. The analysis itself was based upon the analysis of time series of individual variables containing monthly data within the period of January 1999 – October 2011. The nature of price transmissions was analyzed with the utilization of an adjusted vector error correction model, impulse-response analysis and alpha vectors.

The conducted analysis has established that some partial links between the analyzed price levels are symmetrical, while others are asymmetrical. The analysis showed that prices within the analyzed verticals react faster to an increase in prices within connecting levels than to their decline, both in the upward direction as well as downward within the given product vertical. The asymmetry established in such product verticals can thus be considered "upward asymmetry".

Further, a specific position of the industrial producer price was identified, which was the only one to show more significant signs of symmetrical reactions. However, this finding does not change anything in regard to the established presence of imperfections within the analyzed product verticals.

The analysis further showed that prices at a lower level of the vertical react faster upon deviation from a state of equilibrium. However, the reactions of prices are not very fast, and thus a new state of equilibrium is established relatively slowly. Upon unit price shocks, it occurs after approximately 50 months. This is thus a long-term matter. In this case, the agricultural producer price reacts the fastest.

From a comprehensive standpoint, it is therefore necessary to consider the analyzed verticals of foodstuffs wheat as asymmetrical. Even despite partial symmetrical price transmissions in all verticals, asymmetrical reactions predominate. The basis of asymmetry within the analyzed verticals can generally be attributed to transaction costs, asymmetrical information as well as an imperfectly competitive environment. Price transmission within the vertical of foodstuffs wheat in the Czech Republic is also influenced, among other things, by government interventions. As stated by Syrovátka (2013), governments' interventions into the wheat market equilibrium or into wheat price level are not usually and/or regularly realized. Thus, we cannot speak about any price fixing within the Czech wheat market. This situation can thus lead to asymmetrical behavior within the analyzed product vertical, because, as has already been stated, asymmetry can be based upon an imperfectly competitive environment, which government interventions undoubtedly lead to.

Studies of market relations within the wheat vertical in other world countries also show the presence of asymmetry upon price transmissions. Several factors are considered to be the causes of these market imperfections. Agricultural producers and consumers are usually considered to be disadvantaged segments of the chain. Goychuk (2013) showed that Ukraine farmers belong among the major losers, due to the export restrictions, since the high world wheat price is not fully transmitted to them. Then, bakers are caught up in-between bread market and controlled by government and millers who are slow at passing on to them the decreases in wheat prices. Similarly, Acharya et al (2012) established that there are partial symmetrical as well as asymmetrical relationships in price transmission on the Indian wheat market.

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The Russian Federation – Specifics of the Sugar Market

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Anotace

Ruská federace představuje významnou sílu v oblasti produkce a spotřeby zejména řepného cukru ve světě. Populace přesahující více než 140 milionů obyvatel konzumuje ročně přes 5,6 mil. tun čistého cukru a objem spotřeby trvale roste. Po dlouhé době stagnace ruského cukrovarnictví (Cukrovarnictví nebylo schopné zejména v období transformace ekonomiky uspokojit domácí poptávku, a Rusko se tak stalo silně závislé na importech jak rafinovaného, tak i surového cukru.), se Ruská federace v posledních deseti letech zaměřila na prosazování plánů spojených s obnovením produkčních kapacit jak v oblasti cukrové řepy, tak i v oblasti výroby cukru. Vládní program prosazovaný jak na federální, tak regionální úrovni velmi výrazně posílil produkční potenciál a snížil závislost Ruska na importech cukru. Cílem článku je identifikovat nejvýznamnější trendy a tendence ovlivňující vývoj ruského cukrovarnictví v posledních dvou dekádách. Z níže provedené analýzy následně vyplývá, že období let 1992 – 2000 znamenalo pro ruské cukrovarnictví velmi kritické období, kdy došlo k propadu jeho vlastních pěstitelských a zpracovatelských kapacit. Došlo k výraznému úpadku nejen v oblasti kvantitativních, ale i kvalitativních charakteristik ruského cukrovarnictví. V důsledku výše uvedeného došlo k poklesu konkurenceschopnosti a výraznému nárůstu závislosti na importech. V období let 2000 – 2012, pak naopak došlo k resuscitaci ruského trhu a hospodářství. Toto se projevilo jak v oblasti růstu produkce cukrové řepy, tak i v oblasti růstu vlastní produkce cukru. Závislost Ruska na importech cukru ze zahraničí výrazně poklesla a změnila se i struktura obchodovaného cukr obsahujícího zboží. V důsledku řady reforem došlo i k posílení konkurenceschopnosti ruského cukrovarnictví a to zejména ve vztahu k zemím se kterými má Rusko uzavřeny dohody o celní unii, či zóně volného obchodu.

Klíčová slova

Ruská federace, cukrová řepa, rafinovaný cukr, surový cukr, produkce, faktory, obchod, konkurenceschopnost, struktura

Abstract

The Russian Federation represents a significant force in the global production and consumption of beet sugar. Its population which is in excess of more than 140 million people consumes over 5.6 million net tons of sugar annually, and the amount is steadily growing. The Russian sugar industry was unable to meet the domestic demand, especially during the economic transformation period (sugar beet and sugar production are very sensitive in relation to changes in economic, political, production and consumption environment (Špička, Janotová, 2013), and Russia has thus become heavily dependent on imports of both refined and raw sugar. After a long period of stagnation the Russian Federation has over the past decade focused on promoting plans for restoring the production capacities of both the sugar beet growing and sugar manufacture.

The government programme promoted at both the federal and regional levels has very significantly boosted the production potential and reduced Russia's dependence on imports of sugar. This article aims to identify major trends and directions affecting the development of the Russian sugar industry in the past two decades. From the analysis outlined below it follows that the period of 1992 - 2000 was a very critical time for the Russian sugar industry during which there was a downswing in its cultivation and processing capacities. There was a significant decline not only in the quantitative but also qualitative characteristics of the Russian sugar industry.

As a consequence, there has been a fall in competitiveness and a significant increase in import dependency. In the period 2000 - 2012, then was contrary to resuscitate the Russian market and the economy. This was reflected in the growth of sugar beet production, as well as in the growth of its own sugar production.

Russia‘s dependence on imports of sugar from abroad dropped significantly and changed the structure of traded goods containing sugar. Due to a series of reforms, and to strengthen the competitiveness of Russian sugar industry, especially in relation to countries with which Russia has signed an agreement on customs union or free trade area.

Key words

Russian Federation, sugar beet, refined sugar, raw sugar, production, factory, competitiveness.

Introduction

The Russian Federation represents a specific phenomenon of the European and world market of sugar and sugar producing crops – especially sugar beet. Following a long period of stagnation in the Russian sugar production the Russian sugar market has stabilized (Rylko, 2008) and the Russian Federation is gradually moving to the forefront of the world's sugar beet and beet sugar producers (Rezbova, Belova, Skubna, 2013; Reinbergr, 2012).

In recent years a very dynamic growth was recorded especially in the cultivation of sugar beet and subsequently also in the production of both raw and refined sugar. The production growth was also logically reflected in the strengthening of the position of the Russian sugar industry both on the domestic and regional markets (the European and Asian markets, and especially the market of CIS countries) (Ivanov, 2011). In this respect, the actual Russian market is a very important sugar outlet Smrčka, Hönig, Hromádko, 2012) - for about 140 million Russians consume an annual average of about 40 kg of sugar per person.

The following text deals with selected aspects of the Russian sugar market development from the perspective of the 1992 – 2012 period. This study has monitored the developments in the production of sugar beet and sugar and then also in the trade with sugar and sugar-containing products. The aim was to evaluate the general developmental trends and define the further development of the Russian sugar market with emphasis on the identification of developments in the areas of comparative advantage, both in relation to the global and regional markets and in relation to the most important trade partners of Russia.

The article identifies particularly the current position of Russia in the sugar market and highlights the prospects of its further development. In this respect some of the historical consequences of the Russian sugar industry development are also mentioned. Apart from the historical development with an emphasis on the developments in the 1990's of the 20th century, its current development is analyzed in more detail, with emphasis on the past ten years, when the production of sugar beet and sugar manufacture was restored in the Russian Federation.

Materials and methods

The article analyzes the development of selected characteristics of the Russian sugar industry with emphasis on the period of 1992 - 2012. The monitored period was divided into two periods: 1992 - 1999, i.e. the transformation of the Russian economy associated with its general decline, and then 2000 – 2012, i.e. a period of consolidation and gradual economic growth (data is analyzed through basic and chain indices – chain indices are summarized through the GEOMEAN calculation). The article analyzes selected characteristics of the development of the sugar industry market in three levels: growing beet sugar, sugar production, and foreign trade in sugar. In relation to the development of the sugar beet production this study has monitored hectare yields, harvest areas, sugar content, and the total volume of production

The actual production of sugar was then monitored separately. Individual characteristics related to the development of production of sugar beet and sugar itself are compared with the European and world average in order to better illustrate the development of the Russian sugar market. The analysis of foreign trade has been processed at two levels - commodity and territorial. In the analysis of the commodity structure of trade the trade is analyzed within the framework of the HS17 aggregation - sugar and sweets (i.e. sugar and sugar containing products). The development of trade implemented within the framework of HS 1701 aggregation, which includes the trade with refined and raw sugar, is then analyzed in more detail.

The changes in the value and volume of exports and imports realized in relation to individual countries and territories have been analyzed. In this regard the selected territories include the Asian market, the Latin American market, North American market, European market, Oceania, OECD countries market, the EU market, with an emphasis on the old (EU15) in the new Member States (EU12) market, and the market of the CIS countries, and finaly the Visegrad group market. The analysis also focused on the identification of the current (2012/2013) most important trading partners (individual countries) both in terms of exports and imports.

Finally, the material is also complemented by an analysis of the competitiveness of the Russian sugar in relation to individual regions. The analysis of competitiveness is based on the application of the Lafay index (Lafay, 1992; Qineti, Rajcaniova, Matejkova, 2009). The Lafay index (LFI) is a common tool used for the analysis of specialization and competitiveness in the context of bilateral trade relations. LFI index allows to analyze the situation of a particular product (group of products) within the foreign trade structure a specific analyzed country or groups of countries:

$$LFI\ {}^{i}_{j} = 100\left(\frac{x^{i}_{j} - m^{i}_{j}}{x^{i}_{j} + m^{i}_{j}} - \frac{\sum_{j=1}^{N}(x^{i}_{j} - m^{i}_{j})}{\sum_{j=1}^{N} x^{i}_{j} + m^{i}_{j}}\right)\frac{x^{i}_{j} + m^{i}_{j}}{\sum_{l=1}^{N} x^{i}_{j} + m^{i}_{j}}$$

where: x^{i}_{j} and m^{i}_{j} represent exports and imports of a product j implemented by a country or a group of countries in relation to the rest of the world or in relation to a selected business partner or group of partners (partner country/ies) and N is the number of analyzed items. A positive index of LFI value indicates the existence of comparative advantages within the analyzed traded aggregation, with the higher index value the specialization of a given country grows for a given commodity. A negative value of the LFI index indicates the absence of specialization and, consequently, also of the comparative advantage (Zaghini, 2005).

Results and discussion

Production of sugar beet and sugar during the transformation period

During the past 20 years there have been very significant changes in the production of sugar beet. In the1990's – i.e. a period of transformation of the Russian economy (the transformation period represented a real shock for the Russian economy and thus also for agriculture (Liefert and Liefert, 2012; Pustovalov, 2004) - including the sugar industry. A number of production and processing capacities had collapsed. The national economy had generally decreased (Sapir, 2001; Robinson, 1999; Ellman and Scharrenborg, 1998) and this decline had also affected the purchasing power not only of individual companies but also of individual consumers.).

There was a very significant reduction in the sugar beet production mainly due to a decrease in harvested area and hectare yields (Table 1).

In the years of 1992 - 1998 there has been a general decline in the harvested area down from 1.4 million ha to about 0.7 million ha (during the monitored period, the size of hectare areas decreased by an average of 11% per year, which was a significantly higher pace compared with the world (about 4% per year) and especially compared to Europe (about 5% per year).

The share of the sugar beet growing areas in the total volume of growing beet areas in the world and especially in Europe (in this respect, it is important to highlight Europe's position as the most important center of production of sugar beet and manufacture of sugar in the world) decreased from 17% to about 10.4% or from about 23% to about 15%. Also, the average yields per hectare declined from about 18 tons to about 15 tons. The average hectare yields then fell to a level of 40% of the average hectare yields in the world and in Europe (Table 2).

The decrease in the area and yields per hectare, which occurred during the transformation period, was logically reflected in the decrease of the total production of sugar beet (Table 3). That decreased from 25.5 million tons to approximately 10.8 million tons during the years 1992 - 1998. Russia's share of the world or European production declined from about 9% to 4% and from 12.5% to 6% respectively. In this regard it should also be stated that during the above-mentioned period the Russian sugar beet production was declining by an average of 14% per year, which was significantly higher in comparison with the general decline in the volume of production of sugar beet which had occurred in the world (1.1% annually) and, in particular, in Europe (2.5% per year).

This development illustrates the generally devastating impact of the transformation on Russia's economy (Sanchez-Andres, Garcia-Testal, 2008) -

in this case the sugar beet production. In this regard, the decline in the value of the gross sugar beet production should be pointed out. It had decreased during the monitored period from about 1 billion international dollars (international accounting unit used by the IMF) to about 460 million international dollars (when the decline is compared with the decline in the value of production in the world and then also in Europe - again, we can see a significant drop on Russia's side due to the transformation).

The general decline in sugar beet production - a key commodity for the production of beet sugar - in the case of the Russian Federation showed a very significant decrease in the production of its own sugar (Table 4). The volume of the production expressed in equivalent raw sugar has declined during the transformation period from 2.5 million tons to less than 1.4 million tons. The production in the monitored period was decreasing by about 10% per year, which was in stark contrast with the development of the sugar market in the world where the volume of production grew by an average of 2% per year.

(It must be pointed out that the decline in Russia's share in the world sugar production was much more pronounced than was the case in the European market as a whole - which generally on average - in the 1990's of the 20th century had recorded a drop in production. However this decline was much less painful - for illustration it can be noted that in the same period the production on the European market declined by an average of 1% per year.). Russia's share in the world or European sugar production fell from 2.2% to 1.1% and from 9% to 5.4% respectively.

	1992	1996	1998	2000	2004	2008	2010	2012	Rate of growth 1992-1998	Rate of growth 1999-2012
Russian	1439	1060	707	747	790	800	924	1102	0.8883	1.0322
World	8468	7646	6784	6012	5474	4273	4700	4884	0.9637	0.9768
Europe	6272	5563	4674	4185	3944	2907	3234	3425	0.9522	0.9780

Source: Faostat, 2014

Table 1:Development of harvest area of sugar beet (in thousands ha).

	1992	1996	1998	2000	2004	2008	2010	2012	Rate of growth 1992-1998	Rate of growth 1999-2012
Russia	17.76	15.25	15.27	18.82	27.65	36.25	24.09	40.89	0.9752	1.0729
World	33.33	34.77	38.79	41.60	45.96	51.76	48.71	55.10	1.0256	1.0254
Europe	32.59	34.75	37.75	40.65	45.79	52.83	46.62	54.99	1.0248	1.0272

Source: Faostat, 2014

Table 2: Development of hectare yields od sugar beet (in t/ha).

	1992	1996	1998	2000	2004	2008	2010	2012	Rate of growth 1992-1998	Rate of growth 1999-2012
Russia	25.5	16.2	10.8	14.1	21.8	29.0	22.3	45.1	0.8663	1.1074
World	282.2	265.9	263.2	250.1	251.6	221.2	228.9	269.1	0.9884	1.0016
Europe	204.4	193.3	176.5	170.1	180.6	153.6	150.8	188.3	0.9758	1.0047

Source: Faostat, 2014

Table 3: Development of the volume of sugar beet production (in mil. tons).

	1992	1996	1998	2000	2004	2008	2010	2012	Rate of growth 1992-1998	Rate of growth 1999-2012
Russia	2.54	1.87	1.38	1.67	2.44	3.48	2.78	4.75	0.90	1.09
World	115.62	126.32	130.23	132.24	145.66	163.34	155.49	170.84	1.02	1.02
Europe	28.21	28.35	25.77	25.72	26.56	21.85	21.46	27.74	0.99	1.01

Source: Faostat, 2014

Table 4: Production of sugar – in raw sugar equivalent (in mil. tons)

Production of sugar beet and sugar in a period of stabilization and growth

The Russian economy during the period of 1999 - 2012 can be assessed relatively positively. After a period of a very wild transformation (Rutland, 2013) there was a gradual stabilization of the economy (Hanson, 2007; Hanson, 2014) and individual sectors of the national economy started to consolidate (the only problem is a period of global financial crisis (2008 - 2011); (Strouhal, Ištvánfyová, 2010)). This consolidation was then also evident in the sugar industry. The volume of production of sugar beet and sugar increased very significantly.

The harvested areas and, in particular, average yields per hectare - also recorded a very significant change. In this respect, it can be said that the volume of the harvested areas increased from about 700 thousand to more than 1.1 million hectares - making Russia‘s share in the world or European sugar beet crop areas increase to 22% and 32% respectively. The average yields per hectare also recorded an almost miraculous increase from about 15 tons/hectare to almost 41 tonnes/hectare. In the average hectare yield Russia has thus reached about 74% of the world or European average. The Russian beet production in the second development stage achieved significantly better results than was the case in the global and European production.

The Russian production and hectare yields increased on average by 3.2% and 7.3% per year respectively. In this respect it is should be mentioned that there was a marked decline in harvested areas in the world and in Europe (about 3% per year on average) and a significantly lower rate of growth of average yields per hectare (2.5% and 2.7% per year respectively). It is important to mention that apart from the quantitative characteristics the qualitative characteristics are also improving in harvested beets. The average weight of one tuber has increased in 2012 to about 511 g and sugar content is currently between 15 - 16.5%.

There has been a very significant increase in the value of the production of sugar beet in Russia. During the above mentioned period it increased from less than half a billion US dollars to more than two billion (the average annual increase of realized value by about 12%), which was significantly more compared with the world (0.3% per year) and European (0.8% per year) average.

Sugar beet production is realized in a number of regions of the Russian Federation. The following can be found among the most important regions in terms of production: „the Central Federal District“ (55% of harvested area), including Belgorod region (8.3%),Voronezh (11.3%), Kursk (10.4%), Lipetsk (9%), Orel (5%) and Tambov (9.6%). Additionally they also include the „Southern Federal District“ (15.8% of the total harvested area), „North Caucasus federal district“ (5.7% of harvested area), „Volga federal District „ (22.8% of the total harvested area) and“ Siberian Federal District „(2% of the total harvested area). The highest harvest volumes come from „the Central Federal District“ - the average yields per hectare have reached about 35 to 42 tons in the period 2012/2013.

The Russian Federation has (Azrilevich, Gudoshnikov, 1999) at its disposal a high sugar beet production potential - however, insufficient refining capacity limits the further growth. Another weak point is the insufficient storage capacity and the capacity for primary processing of sugar beet. Approximately 15% of the Russian harvested beet production is lost due to poor storage conditions (Sergeev, Seregin, Sushkov, 1997).

Another factor positively influencing the market situation for sugar beet in the Russian Federation is the rise in prices of sugar beet, which does not limit its consumption. The rising prices make the business in the production of sugar beet increasingly promising. In the years of 1999 – 2012 alone there was more than a threefold increase in the price of a tonne of sugar beet (from 16.25 USD to about 51.9 USD).

Significant improvements in sugar beet production were accompanied by an improvement in the situation in Russia’s own sugar production. There has been consolidation in the sugar production and an increase in production capacities (so far, in this regard this primarily concerns an increase in the capacity of existing sugar mills, and a restart of some sugar mills, which were previously closed. Unfortunately, since the 1980’s of the 20th century no new modern refineries have been built in Russia).

However, the current sugar market in Russia is becoming increasingly more attractive, especially over the past 5 years. The volume of investment going into the sugar industry has multiplied at the moment the Russian government launched the „State programme of sugar beet and sugar production“.

On the basis of this project in 2011 alone investments worth 4.5 billion rubles were made to support further growth of the analyzed sector.

Furthermore, the state resources released more than 1 billion rubles in order to support more than a dozen projects aiming at the construction of new facilities and especially at the reconstruction of existing capacities. In this respect, it is still important to highlight the government support for investments in the capacity building aimed at the production of seed.

Support for the sugar industry comes not only at the government level, but investments aimed at sugar beet and sugar production are also implemented at regional level - the initiative in this regard comes particularly the administrations of the Voronezh Region, Stavropol Region and Rostov Region). An increase in the state support and stabilization of the internal and external (CIS market) markets have contributed to a very significant restart of the production of sugar beet and sugar).

At present, sugar production and processing are executed in sugar 78 mills - 41 of which are located in the „Central Federal District", 15 of them in the „South Federal District", another 15 is located in the „Volga Federal District" (however, in reality only half of them are functional), 3 sugar factories are also located in the „North Caucasus federal district" and one sugar factory can be found in Siberia.

Sugar production in the Russian Federation increased very significantly in the post-transformation period. It must be noted, however, that a very large share of the resulting production comes from sugar cane - which is imported in bulk into Russia in raw state and there it is subsequently refined (Gudoshnikov, 2009). In the period of 1999 - 2012 the Russian sugar production increased from about 1.4 million tonnes to more than 5.5 million tons.

During the monitored period, there has been a very significant growth - about 9% per year - which exceeded the growth rate of the production of sugar in the world (2% per year) and especially also in Europe (1% per year). Russia's share in the world production of sugar (including sugar cane) has grown from 1.1% to 2.8%. Its share in European production has increased even more significantly - from 5.4% to more than 17%.

In respect to the further development of the Russian sugar industry market, it is important to highlight the important role of the „Russian national agricultural programme for the period of 2013 - 2014". The aim of this programme is to increase the proportion in the total sugar beet supply, including reserves, to the level of about 93.2% by the end of 2020. The production of sugar beet should generally exceed 41 million tons (this goal, however, has been already broken - Russia currently produces more than 45 million tons of sugar beet per year) and the degree of self-sufficiency of the Russian sugar market should reach at least 80%.

Part of this programme is to support both the production and processing of sugar, and the cultivation and processing of sugar beet. The programme, which focuses not only on the sugar industry, but also on other sectors of agricultural production, contains a number of very effective support tools based on grants, subsidies, soft loans, price support for purchases of fuel, fertilizers and energy, including tax breaks such as zero tax income for farmers.

An important factor influencing the development of Russian sugar market is its high price, which has a relatively low impact on its consumption. The rising prices make business in the production of sugar very interesting. In the years of 1999 – 2012 alone there has been more than a threefold increase in the price of one kilogram of sugar (from 0.38 USD to about 1.13 USD). In this respect the Russian market is characterized by a distinct difference existing between the average retail and wholesale prices of sugar. For example, at the turn of 2012/2013 the price of one kilogram of sugar in wholesale trade was around about 0.81 USD, in retail the average price was at the level of the above mentioned 1.13 USD (the retail price of sugar has a tendency to significantly oscillate over time).

Development of the Russian foreign trade with sugar and sugar containing products

Despite the considerable production capacities, which Russia has at its disposal in the area of sugar production, the Russian Federation is unable to ensure full self-sufficiency (Gudoshnikov, 2008) in sugar consumption. The Russian Federation's foreign trade balance in sugar and sugar-containing products is continually negative. The value of the sales implemented within the HS17 - Sugar and confectionery commodity aggregation was characterized by a very dynamic drop in the value of exports and, vice versa, by a very dynamic growth in the value of imports, particularly in the 1990's of the 20th century. The worst situation in this respect was in 1998 - when the Russian exports implemented in the framework of the above

aggregation amounted to only about 45 million USD and vice versa imports ranged between 1.3 to 1.4 billion USD (Table 5).

A significant turning point in the development of the implemented foreign trade value occurred in the 2000 – 2012 period. With the steady increase in Russia's own sugar production, the growth in the volume and value of imports started to gradually cease and it actually even managed to strengthen Russia's export position, especially in relation to the CIS countries. In relation to the performance of the foreign trade value in the HS17 aggregation it can be stated that throughout the entire observed period a positive trend prevailed in the growth of the export proceeds value (average annual growth rate reached about 14%). By contrast, in the case of imports, the observed period can be characterized by a gradual decrease in realized value (the average rate of decline in value of available imports reached about 5%).

The key share in the transactions carried out within the framework of the HS17 aggregation is played mainly by sugar - both in the refined and raw forms. While in the realized exports of sugar the refined sugar is overwhelmingly predominant over raw sugar, in the case of imports the raw sugar dominates over the refined form.

In this respect it should be stressed that most imports of raw sugar do not come from sugar beet but it is sugarcane sugar imported mainly from Latin America and Southeast Asia (which are the largest producer in the world (Svatos, Maitah, Belova, 2013)) for further processing in refineries located on the territory of the Russian Federation (Gudoshnikov, 2001). In this regard, it is important to mention the importance of imports of raw cane sugar and particularly the improvement in the productivity of Russian sugar refineries, in which the raw cane sugar currently allows them to produce even during the period of the year when they do not get sugar beet.

As the Russian market gradually develops, its gradual transformation also occurs. While in the 1990's sugar (either refined or in raw state) contributed to the total exports and imports by about 71% or about 90% respectively, over the years there has been a transformation of the market and the share of trade with pure sugar in the total trade in sugar and sweets has dynamically decreased.

In the case of exports, the share of sugar in the resulting value realized in the framework of the HS17 aggregation reduced to about 17.5%, in the case of imports, there was a reduction of about 52%. In this respect, it can be said that the Russian export focused more on exports with higher added value, with an emphasis on sweets and vice versa in the case of imports, there was a limit in the growth in imports of raw sugar, which is no longer needed to such a large extent as it was in the 1990's, when the Russian production capacity in the cultivation of sugar beet and subsequently in processing of the sugar producing crops was significantly reduced.

HS17	1996	1998	2000	2002	2004	2006	2008	2009	2010	2012	Rate of growth 1996-2012
Export mil. USD	141.0	44.7	63.6	78.5	78.8	124.6	137.5	135.7	97.6	278.3	1.139552
Import mil. USD	1447.6	1333.8	895.4	997.3	727.0	1279.1	1228.9	777.9	1505.6	667.2	0.951733
Balance mil. USD	-1306.6	-1289.1	-831.8	-918.8	-648.2	-1154.4	-1091.4	-642.2	-1408.0	-388.9	0.917971

Source: Faostat, 2014

Table 5: Development of the value of the Russian foreign trade implemented within the HS17 aggregation – Sugar and sweets.

HS17	1996	1998	2000	2002	2004	2006	2008	2009	2010	2012	Rate of growth 1996-2012
	1701	1701	1701	1701	1701	1701	1701	1701	1701	1701	1701
Export mil. USD	100.3	18.VIII	37.8	49.3	33.1	74.2	25.III	56.7	10.V	48.6	1.070
Export ths. tonnes	225.1	44.4	155.3	214.0	121.3	167.5	53.5	133.7	15.V	67.9	1.031
Import mil. USD	1275.9	1210.2	765.7	893.1	610.0	1118.7	974.0	560.4	1233.7	349.1	0.915
Import ths. tonnes	3149.5	4060.2	4821.0	4604.4	2783.2	2743.4	2485.0	1352.0	2184.8	590.9	0.871
Balance mil. USD	-1175.6	-1191.4	-727.9	-843.8	-576.8	-1044.5	-948.7	-503.7	-1223.2	-300.5	0.906
Balance ths. tonnes	-2924.4	-4015.8	-4665.6	-4390.4	-2661.9	-2575.9	-2431.5	-1218.3	-2169.3	-523.0	0.865

Source: Faostat, 2014

Table 6: Development of the Russian foreign trade implemented in the HS 1701 aggregation.

The Table 6 shows a very significant reduction on the part of imports of sugar, both at the level of realized value and volume. This caused a significant reduction in the development of a negative trade balance. The entire analyzed period can be summarized through the development value of the average rate of growth both on the export side, and on the side of imports follows.

The average annual growth in the value and volume of exports reached the level of 7% or 3.1% respectively, in the case of imports, then there was a decline in the growth rates in the realized value and volume by an average of 8.5% and 12.9% respectively. These developments have had a very positive impact on the situation in the foreign trade balance, when the amount of negative balance in the period tended to gradually reduce (by about 10% per year) and the volume of the negative balance also tended to reduce (about 13.5% per year).

However, when we consider the evolution of the value and volume of the foreign trade in sugar for the Russian Federation, it is clear that the realized values tend to oscillate dramatically over time. This is mainly due to the fact that during the transformation, the Russian sugar market developed very chaotically. Only the recent actions of the Russian government which had defined very ambitious plans for the achievable level of self-sufficiency in the Russian market, had contributed to its gradual stabilization.

According to these plans, the Russian market should achieve a minimum level of self-sufficiency at least at the level of 80% in the basic commodities - sugar and sugar beet. Achieving this goal was then and still is supported by massive interventions both in promoting the cultivation of sugar beet and, especially, in building the processing capacity - since it is the processing capacities which are the Achilles heel of the Russian sugar industry because their volume is not able to handle the potential production of sugar beet.

Teritorial structure and competitiveness of the Russian foreign trade in sugar and sweets

A very specific aspect of the Russian foreign trade in sugar is its competitiveness and territorial structure. As previously mentioned, the Russian foreign trade implemented within the HS17 aggregation is characterized by a negative foreign trade balance and by an overwhelming predominance of imports over exports. The most important trade partners of Russia are on the side of imports, especially Latin America, Europe and Asia (Table 7). By contrast, the major part of exports regions comprises Asia and Europe – in this respect, the member countries of the CIS possess a particularly high degree of dominance.

As mentioned above, within the HS17 aggregation sugar (HS 1701) represents about 18% of the exports or about 50% of the imports. In this regard, it should be noted that most of the exports go to Asian member countries of the CIS (93% of the total value or 94% of the total realized amount). In relation to the imports it can then be stated that most of the sugar imports (represented

Export - HS 17 - 2012	Trade Value – mil. USD	Import - HS 17 - 2012	Trade Value – mil. USD
Africa	2.4	Africa	10.7
Asia	176.5	Asia	130.3
CIS	199.6	CIS	104.4
EU12	12.1	EU12	71.2
EU15	19.4	EU15	88.9
EU27	31.6	EU27	160.1
Europe	97.1	Europe	254.2
Latin America	0.0	Latin America	226.7
North America	1.9	North America	12.8
Oceania	0.4	Oceania	0.0
OECD	45.7	OECD	169.2
Visegrad Group	1.4	Visegrad Group	46.9
World (Aggregate)	278.3	World (Aggregate)	667.2

Source: UN Comtrade, author's data

Table 7: Territorial structure of the Russian foreign trade realized within the HS17 aggregation in 2012.

by raw sugar in more than three-quarters) goes to Russia from the countries of Latin America (63% of the value of imports, or 66% of total realized imports) – for details see Table 8).

Other important regions that export sugar to Russia are Asia (11%) and Europe (14% - with a high predominance of exports from EU countries). Regarding the final balance, it can be stated that the Russian Federation reaches a positive balance only in relation to the CIS and Asian countries. In relation to other regions the balance of sugar trade is highly negative. In this respect, the huge share of Latin America in the resulting negative balance of trade in sugar must be highlighted (although it must also be emphasized that Russia‘s negative balance of trade in sugar gradually decreases in line with the gradual expansion of its production capacities).

The results shown above indicate that, in general, the Russian Federation does not have comparative advantages in the sugar trade. If it is able to obtain comparative advantages - it can do so only within a range of selected segments of the countries with which Russia is linked through a network of special governing trade agreements (Bodin and Gudoshnikov, 2010; 2011; 2012) - in particular the CIS countries market.

The following Table 9 provides an overview of the distribution of comparative advantages of Russian exports of sugar in relation to individual regions. The results presented in the table show that Russian sugar does not have comparative advantages in relation to the overwhelming majority of the analyzed regions. The only group of countries to which Russia can implement comparative advantages is the CIS countries.

When we focus on the current commodity structure of the Russian trade in sugar and sugar-containing products, it can be stated that at present the Russian Federation implements the HS 17 commodity aggregation export operations with 61 countries and import transactions are realized with as many as 69 countries. However, it should be noted that the territorial structure is highly concentrated.

In the case of exports - trade flows implemented in relation to the first thirty partners represent approximately 99.4% of the total value of exports. Export in this regard is extremely concentrated in terms of looking at the share of TOP 10 (82.3%) or TOP 5 (65.3%) partners. Table 10 shows that the most important partners include the CIS member states - or countries of the former Soviet Union, which are linked to Russia by very strong economic, political and other bonds.

The most important partners in this regard are Kazakhstan, Ukraine, Azerbaijan, Belarus, Tajikistan, Kyrgyzstan and Turkmenistan. Among the TOP 10 export markets, apart from the former post-Soviet countries, there are also Turkey, Vietnam and Germany. Not only the territorial structure of Russian exports is highly concentrated. A high level of concentration is also exhibited by the territorial structure of the Russian import implemented within the HS17.

Export - HS 1701- 2012	Trade value in mil. USD	Net weight 1000 tonnes	Import - HS 1701- 2012	Trade value in mil. USD	Net weight 1000 tonnes
Africa	1.82	2.48	Africa	9.91	6.76
Asia	45.40	64.04	Asia	36.80	62.97
CIS	45.27	64.16	CIS	8.75	12.34
EU12	0.00	0.00	EU12	34.38	53.40
EU15	0.00	0.00	EU15	4.69	2.42
EU27	0.00	0.00	EU27	39.07	55.82
Europe	0.93	1.12	Europe	47.82	68.15
Latin America	0.00	0.00	Latin America	221.33	391.13
North America	0.47	0.30	North America	0.96	0.46
Oceania	0.00	0.00	Oceania	0.00	0.00
OECD	0.48	0.30	OECD	27.60	36.79
Visegrad Group	0.00	0.00	Visegrad Group	21.90	33.90
World (Aggregate)	48.62	67.94	World (Aggregate)	349.13	590.95

Source: UN Comtrade, author’s data

Tabulka 8: Territorial structure of the Russian foreign trade realized within the HS1701 aggregation in 2012.

1701	2012	LFI
Africa	-0.044567	-4.456792
Asia	-0.012296	-1.229678
CIS	0.064468	6.446821
EU12	-0.119980	-11.998093
EU15	-0.015517	-1.551777
EU27	-0.067102	-6.710224
Europe	-0.071426	-7.142604
Latin America	N/A (import from Latin America to Russia)	N/A (import from Latin America to Russia)
North America	-0.0390145	- 3.901459
Oceania	0 – no trade	0 – no trade
OECD	-0.051145	-5.114574
Visegrad Group	-0.026353	-2.635381
World (Aggregate)	-0.144789	-14.478974

Source: UN Comtrade, author's data

Table 9: Competitiveness of the Russian sugar export (HS 1701 aggregation) in relation to selected territories (LFI Index values).

Period	Trade Flow	Partner	Trade value in USD	Trade Flow	Partner	Trade value in USD
2012	Export	World	278 306 731	Import	World	667 247 744
2012	Export	Kazakhstan	79 317 693	Import	Brazil	221 648 417
2012	Export	Ukraine	43 359 435	Import	Ukraine	81 434 762
2012	Export	Turkey	21 010 470	Import	China	56 258 758
2012	Export	Azerbaijan	19 382 683	Import	Cuba	32 392 399
2012	Export	Belarus	18 734 812	Import	Poland	29 770 037
2012	Export	Viet Nam	11 010 731	Import	Thailand	26 475 216
2012	Export	Tajikistan	10 868 349	Import	Lithuania	21 947 752
2012	Export	Germany	9 433 786	Import	Germany	21 864 570
2012	Export	Kyrgyzstan	8 040 190	Import	France	19 019 300
2012	Export	Turkmenistan	7 927 573	Import	Turkey	17 824 966
2012	Export	Mongolia	7 826 337	Import	India	12 933 692
2012	Export	Netherlands	5 906 767	Import	USA	12 120 462

Source: UN Comtrade, author's data

Table 10: List of countries – partners of the Russian agrarian trade realized within the framework of the HS 17 aggregation in 2012.

About 98.2% or 79.2% and 63% of the total value of imports heading to Russia are implemented within the framework of TOP 30 or TOP 10 and TOP 5 respectively.

The dominant partners in this regard are particularly Brazil, Ukraine, China and Cuba whose share in total imports represents about 60%. Other major import partners are Poland, Thailand, Lithuania, Germany, France and Turkey. In relation to trade in sugar (HS1701), which accounts for about twenty percent of exports or fifty percent of imports implemented within the HS 17 aggregation. It can then be stated that Russia implements export operations with 31 countries, while its imports come from about 41 countries.

Sugar trade includes both refined sugar and raw sugar. Refined sugar dominates in Russian exports, while its imports are dominated by raw sugar - imported especially from Latin America and Southeast Asia. The territorial structure of trade in sugar is more concentrated than in the case of aggregated across the HS17 group. About 99% and 92% of the value of total exports is implemented within the TOP 10 or TOP 5 exporters respectively (Table 11).

Period	Export	Commodity Code	Trade value in USD	Net weight in 1000 tonnes	Import	Trade value in USD	Net weight in 1000 tonnes
2012	World	H4-1701	48 617 371	67.94	World	349 133 309	590. 95
2012	Kazakhstan	H4-1701	31 316 726	44.45	Brazil	218 227 316	387.83
2012	Tajikistan	H4-1701	4 396 778	6.27	Cuba	32 301 765	61.46
2012	Turkmenistan	H4-1701	3 640 225	5.47	Thailand	26 457 389	43.90
2012	Kyrgyzstan	H4-1701	3 482 530	4.98	Poland	21 365 236	33.08
2012	Montenegro	H4-1701	1 809 225	2.48	Lithuania	12 474 607	19.51
2012	Georgia	H4-1701	1 308 034	1.73	India	10 204 646	18.96
2012	Mongolia	H4-1701	953 909	0.85	Mauritius	9 895 818	6.76
2012	Moldova	H4-1701	664 608	1.00	Belarus	5 895 678	8.72
2012	USA	H4-1701	470 137	0.29	Colombia	3 095 819	3.30
2012	Ukraine	H4-1701	194 537	0.052	Moldova	2 808 502	3.57
2012	Azerbaijan	H4-1701	131 729	0.094	Germany	1 727 653	0.75
2012	Afghanistan	H4-1701	82 594	0.135	Finland	1 115 822	0.62
2012	Belarus	H4-1701	64 692	0.062	USA	955 843	0.46

Source: UN Comtrade, author's data

Table 11: List of countries – partners of the Russian agrarian trade realized within the framework of the HS 1701 aggregation in 2012.

The dominant partners in this respect are especially Kazakhstan, Tajikistan, Turkmenistan and Kyrgyzstan. They are followed by other partners - Montenegro, Georgia, Mongolia, Moldova, Ukraine, Azerbaijan, Afghanistan and Belarus. The only exception - a country with no direct historical ties to Russia – within the framework of the TOP export destinations, is represented by the USA (although their share of realized exports does not exceed 1%).

Just like the territorial structure of exports, that of imports also exhibits a high level of concentration. About 98.2% and 89% of the total value of Russian imports of sugar are implemented within the TOP 10 or TOP 5 import destinations respectively. The territorial structure of Russian imports is dominated by a very narrow segment of Latin American, Asian and European countries. The most dominant positions in this respect are held by Brazil, Cuba, Thailand, Poland, Lithuania, India, Mauritius and Belarus.

The Russian sugar trade has been influenced by many factors in recent years. The most important ones include the existence of a customs union between Russia, Belarus and Kazakhstan, and the free trade zone between Russia and the CIS countries. Imports of sugar from the above countries are burdened with preferential tariffs that are significantly lower compared to the duty on sugar from other countries (duties range around 340 USD / tonne and above).

An exception in this respect is presented by import of raw sugar, which is an important raw material for the production of white - refined sugar (depending on the destination and the world price the duties imposed on raw sugar ranged between 250 and 270 USD / ton). Speaking about the amount of duty it is worth noting that an important role in this respect is played by the season of the year and also by the fact of whether it concerns beet sugar or sugarcane sugar. For example, in the period from 1 January to 30 June, the average duty on imports of beet raw sugar for refining hovered around 250 USD / tonne, while from July to the end of December, the duty ranges around 270 USD / ton.

In the case of raw cane sugar the duty during January to April of last year reached about 160 USD / ton, while from May to late July the duty ranged around 205 USD / ton. However, in relation to the development of market protection, it can be expected that the tariff barriers will gradually decrease as Russia will become increasingly more integrated in the WTO in future years

Conclusion

Concerning the objectives of this article, on the basis of the above considerations it follows that after a period of strong stagnation in the development of its own sugar market the Russian Federation is again becoming a major

force in the production and consumption of beet sugar in the world. Population in excess of more than 140 million people is a sufficient basis for the development of a domestic sugar industry capacity. The market of the former Soviet Union countries with which the Russian Federation is linked through a network of the customs union or free trade area also represents a very significant potential for the development of the Russian sugar industry.

Currently the Russian Federation consumes more than 5.6 million tons of sugar annually. Its production potential includes millions of hectares of available arable land suitable for the cultivation of sugar beet. The base of nearly eighty sugar mills, many of which are able to process raw sugar beet and raw cane sugar is a very important stage for further growth in sugar production.

After a long period of stagnation of the Russian sugar industry, which had not been able to meet domestic demand, especially during the economic transformation period, and Russia had thus become heavily dependent on imports of the refined as well as raw sugar, the Russian Federation has focused over the past decade on promoting plans associated with recovery of the production capacities in both sugar beet cultivation and the production of sugar. The government programme promoted at both the federal and regional levels significantly boosted the production potential and reduced Russia‘s dependence on imports of sugar. The growth in the production potential and its own production of sugar beet and sugar has returned the Russian Federation to the leading players in the sugar market. This follows not only from the increase in the volume of production, but it is also demonstrated by the comparison of the growth rates of both of beet and sugar production.

In this respect, the Russian Federation is much more dynamic compared with both the European and especially the world average. An important aspect that contributes to increased productivity and competitiveness of the Russian sugar industry both at the domestic and international levels, is also the increase in the quality indicators associated with the development of the industry. In the Russian Federation the beet yields per hectare have been increasing and its sugar recovery ratio and sugar content are also on the rise. Another important aspect is the modernization of the existing capacity associated with processing and storage of sugar beet and products derived from it.

This development has subsequently led to the reduction of Russia’s dependence on imports of sugar from abroad. Due to a series of reforms, the competitiveness of the Russian sugar industry has strengthened, particularly in relation to the countries with which the Russian Federation has signed an agreement on customs union or free trade area. In the future it can be expected that the Russian sugar industry will boost their capacities and especially their own position both on the domestic market and the market of the CIS countries and East Asia.

Russia is likely to support the efforts of its producers to establish themselves on less traditional markets - however it is expected that the exports pillar will not be sugar itself, but mainly products containing sugar of Russian origin. In this respect, further increase in export opportunities for Russian sugar can be expected, although it will happen indirectly. However, this trend may be much more positive for the Russian economy and trade, as the products containing sugar represent much higher value-added goods and from this subsequently much greater potential benefits will be derived.

It is important to note that the Russian government supports and will support the growth of the sugar industry, both through direct and indirect measures. The entry of the Russian Federation into the WTO will not jeopardize the sugar market as such, since Russia has included sugar among sensitive items - which means only limited or even no liberalization (However, due to general trends an increase in import quotas in respect of certain partners can be expected).

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Monopolistic Competition in the International Trade of Agricultural Products

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Anotace

Cílem článku je vyjádřit chování mezinárodních firem prostřednictvím modelu monopolistické konkurence využívajícího optimalizace počtu firem v odvětví, a jehož vlastnosti nejlépe odpovídají potřebám mezinárodní směny. Předpokladem aplikace modelu monopolistické konkurence v oblasti mezinárodní směny agroprodukce je tvrzení, že obchod rozšiřuje velikost trhu. V odvětvích, kde působí rostoucí výnosy z rozsahu, platí, že jak rozmanitost statků, které země vyrábí, tak rozsah jejich výroby jsou ovlivněny velikostí trhu. Analýza prokázala platnost modelu pro odvětví agroprodukce; při rozšíření trhu či zvýšení dotací a tedy poklesu nákladů zemědělců se zvýšil počet firem v daném odvětví.

Klíčová slova

Mezinárodní směna, monopolistická konkurence, firma, rovnováha, odvětví, biopotraviny.

Abstract

The aim of the paper is to describe the behavior of international firms using model of monopolistic competition, which is using optimizations of the number of firms in the sector and its characteristics, best corresponding to the needs of international trade. The assumption for application of the monopolistic competition model in the international trade area of agro production is the idea that trade increases the market size. In the sectors where increasing returns to scale apply it is valid that both heterogeneity of the goods the country produces and the extent of their production are influenced by the market size. The analysis has shown the validity of the model for the production of agricultural commodities; the expansion of the market or the increase of subsidies and thus decrease of the cost of farmers caused by an increase of the number of firms in the sector.

Key words

International exchange, monopolistic competition, firm, equilibrium, sector, organic foods.

Introduction

The term globalization was used by the American economist T. Levith for the first time in 1985 when analyzing the global economy development in the seventieth. Multinational firms play key role in the globalization process because they are the main bearers of technological innovations and carry out majority of the international transaction flows.

The impact of multinational firms may be characterized within the imperfect competition theory as oligopoly or as monopolistic competition (Helpman, Krugman, 1985). A frequent form of structure of the sector is an oligopoly, i.e. several competing firms, each of which is big enough to be able to differentiate the prices of its production, but at the same time too small to fix the prices in the sector. The price policy within the oligopoly can be characterized by mutual dependence. The firms fix the prices of their production both with regard to the assumed consumers' behavior and with regard to the assumed competitors' behavior. Analysis of such behavior is complicated. "In the modern market economy where the supply exceeds demand, the importance of the „consumer's behaviour in the market analysis" continuously increases (Šrédl, Soukup, Severová, 2013)". Analysis of the firms' behavior in another imperfectly competitive structure, which is also often common, namely in the monopolistic competition is much easier. "The monopolistic competition includes some of the features

of perfect competition and monopoly. Often there are many firms in the market, for which the entrance to (and the exit from) the sector is free, if they can compete by the deepened differentiation of their product or services (Soukup, Šrédl, 2011)."

However, the production sectors are commonly assumed to be perfectly competitive in most of the studies, whereas the monopolistically competitive feature of some sectors, especially of the sector for final good production, is mostly ignored. A few studies like Anwar (2006, 2008) feature the intermediate production sector with monopolistic competition when analyzing the relation between international factor mobility and skilled-unskilled wage gap, but Anwar (2006, 2008) also neglects to take the monopolistically competitive final-good production into consideration.

M. Páscoa characterized monopolist competition by this way: „According to Chamberlin what marks the contrast between monopolistic competition and perfect competition is the shape of the demand curve not the shape of the cost curve." (Páscoa, 1997)

V. Damjanovic writes about specific features of monopolistic competition in his last article. „We find that a U-shaped relationship between the probability of default and the degree of competitiveness exists in a monopolistically competitive market as well." (Damjanovic, 2013).

The aim of the paper is to describe the behavior of international firms using model of monopolistic competition, which is using optimizations of the number of firms in the sector and its characteristics, best corresponding to the needs of international trade.

Materials and methods

We have used in this article the model making use of optimization of the number of firms in the sector, the characteristics of which correspond best to the international trade needs. A lot of various models are used for monopolistic competition analysis. Bogliacino and Rampa summarize the basic approaches of the economic theory to this issue in their article (2010): "A satisfactory picture should be grounded on some essential building blocks. The first one is uncertainty: the very novelty of goods (ideas, technologies, behaviors, etc.) implies that agents must act using conjectures over some unknown feature, as in standard Bayesian approaches (Young, 2005). The second block is heterogeneity: individual models are necessarily different at the outset, since they summarize personal conjectures, previous learning and priori ideas (Cowan, Jonard, 2003, 2004; Lopez, Pintado, Watts, 2006). The third block is interaction: the learning activity on the part of agents exploits past observations, stemming mainly from other agents' choices. Interaction thus shapes the overall process, making it path dependent. Coupling all this with some degree of non-linearity might finally allow for multiple equilibriums, and hence non-uniqueness of outcomes (Young, 2007)."

This article analyses a situation when a firm enters into international trade and the impacts of this entry on creation of the optimum number of the firms in the sector, of the equilibrium quantity and equilibrium price in the given sector.

The model of monopolistic competition of firms in the international trade of agricultural products

There are two key assumptions for monopolistic competition in the sector (Kierzkowski, 1984). It is differentiation of the product and the assumption that each firm considers the competitors' price as given. The firm manufactures and sells the more the higher the demand in the sector is and the higher the competitors' prices are. It manufactures and sells the less the higher the number of firms in the sector is and the higher its price is.

Average costs (AC) depend on the number of the firms in the sector (n). We assume according to Krugman (2006) that all firms in the sector are symmetric; it means that the demand and cost curves are the same for all firms in spite of the fact that they produce and sell differentiated products. If the individual firms are symmetric, it is easy to find out the sector's status. If we assume symmetricity of the firm models, under equilibrium they shall sell for the same price, which means that each firm's share in the production and sale of goods is 1/n of the total sale volume in the sector. At the same time we know that the average costs are inversely proportional to the number of products manufactured by the firm. The more firms there are in the sector, the higher the average costs are since each firm produces less.

The situation in the sector may be expressed graphically with two curves (Figure 1): growing CC' and falling PP'. CC' curve expresses the relation among the number of the firms in the sector, the sale volumes and the average costs. PP' curve expresses the relation among the number

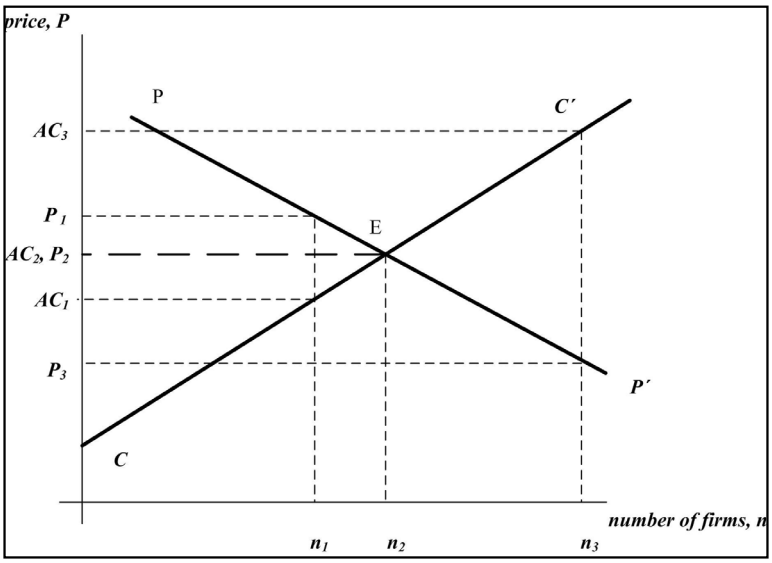

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Figure 1: Equilibrium of the sector under monopolistic competition.

of the firms in the sector and the price. The equilibrium state is thus situated in their intersection point, in point E, which corresponds to the number of firms in the sector n_2. In case of this number of firms, the profit in the sector is zero (we have in mind the economic profit). If there are n_2 firms in the sector, then the price maximising the profit is P_2.

The total firm's costs may be expressed by the relation

$$TC = \beta q + \alpha \,. \tag{1}$$

For the average costs, it results thereof

$$AC = \beta + \frac{\alpha}{q}, \tag{2}$$

where α, β are coefficients of the cost function.

It is valid

$$q = \frac{\overline{q}}{n}, \tag{3}$$

where $\overline{q}$ is the number of products in the sector, n is the number of firms, q is the number of one firm's products. By means of connecting these two relations we shall receive:

$$AC = \beta + \frac{\alpha}{\overline{q}} \cdot n \;\; . \tag{4}$$

The price, for which a typical firm sells its goods, depends also on the number of firms in the sector. The more firms there are, the stronger the competition shall be among them and the lower the price shall be. In Fig. 2 this is shown by the relation

$$P = \beta + \frac{f}{n}, \tag{5}$$

where f expresses intensity of this competition.

The intersection point of both curves corresponds to the average costs AC_2. It means that in a long period of time the number of firms in the sector shall approach n_2, E thus represents the long-term equilibrium point. If the number of firms n_1 was smaller than n_2, then the price of a piece of goods the firm offers would be P_1 while the average costs would be only AC_1 and the firms would thus achieve monopoly profit, which would attract other firms to enter into this sector, and their number, i.e. n_1 would start increasing. In the same way - to the contrary - if the number of firms n_3 was higher than n_2, the price P_3 would be lower than the average costs AC_3, the firms would thus lose interest and leave this sector, and the number of firms in this sector would thus decrease. The economic profit is

$$\pi = \frac{\sqrt{\alpha \cdot f \cdot \overline{q}}}{n} - \alpha, \tag{6}$$

$$\pi_1 > 0\,,\ \pi_2 = 0\,,\ \pi_3 < 0\,. \tag{7}$$

If $AC = P_2$, it must be valid in point E:

$$\beta + \frac{\alpha}{\overline{q}} \cdot n = \beta + \frac{f}{n_2} \tag{8}$$

$$\frac{\alpha}{\bar{q}} \cdot n_2 = \frac{f}{n_2} \tag{9}$$

$$\alpha \cdot n_2^2 = f \cdot \bar{q} \tag{10}$$

$$n_2 = \sqrt{\frac{f \cdot \bar{q}}{\alpha}} \tag{11}$$

It is possible to deduce from it:

$$q_2 = \sqrt{\frac{\alpha \cdot \bar{q}}{f}} \tag{12}$$

$$P_2 = \beta + \sqrt{\frac{\alpha \cdot f}{\bar{q}}} \tag{13}$$

Herewith also the quantity of the products of one firm and the equilibrium price of the final goods are determined.

Firm's involvement in international trade

Let's assume now that a firm under monopolistic competition enters international trade. Increased market size allows each of the firms to produce more and to have lower average costs. Therefore curve AC_1 shall shift to AC_2 in Fig. 2. At the same time, growth in the number of firms and product differentiation occur under the fall of the price of each of the products from P_1 to P_2.

Growth of the total sale volumes shall decrease the average costs under any given quantity of firms n. The reason lies in the fact that if the market grows under the same number of firms, the extent of sale per one firm shall grow and the average costs of one company shall fall.

If we thus compare two markets, where one has higher extent of sale than the other one, AC_2 curve of the bigger market shall lie below AC_1 curve of the smaller market. Meanwhile the other curve P, expressing the relation between the price for one product and the number of firms, shall not change.

In our model, the international trade influence is expressed by an increase in the magnitude $\bar{q}$ and a decrease in the inclination of AC.

$$n_2 = \sqrt{\frac{f \cdot \bar{q}_2}{\alpha}} > n_1 = \sqrt{\frac{f \cdot \bar{q}_1}{\alpha}} \tag{14}$$

$$q_2 = \sqrt{\frac{\alpha \cdot \bar{q}_2}{f}} > q_1 = \sqrt{\frac{\alpha \cdot \bar{q}_1}{f}} \tag{15}$$

$$P_2 = \beta + \sqrt{\frac{\alpha \cdot f}{\bar{q}_2}} < P_1 = \beta + \sqrt{\frac{\alpha \cdot f}{\bar{q}_1}} \tag{16}$$

The average cost function shows us the long-term consequences of increased market extent. Originally, the equilibrium was achieved in point 1 under price P_1 and the quantity of firms was n_1. Increased market extent shifts AC curve more to the right bottom and the new equilibrium is achieved in point 2. The number of firms increased from n_1 to n_2 and the price fell from P_1 to P_2.

Our model assumes that production costs are the same in both countries that trade with each other and that the trade does not require any costs. These

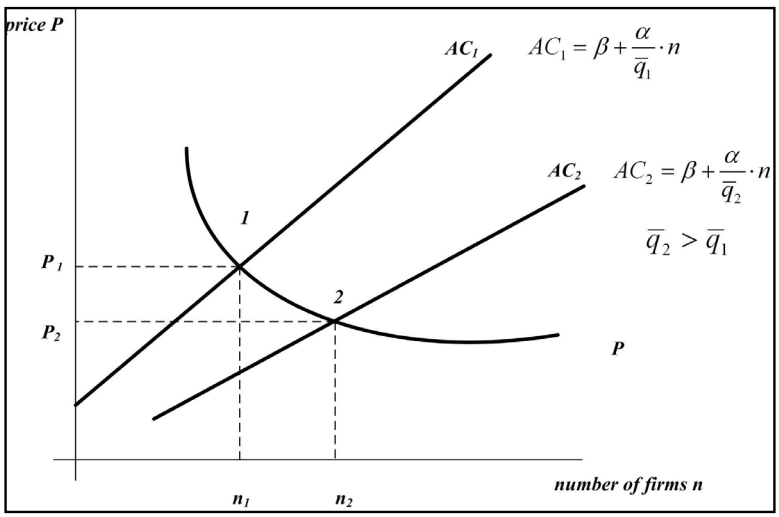

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Figure 2: Extension of the marketsize (shifting of AC curve).

assumptions express the fact that even if we know that the integrated market shall support higher number of firms, we cannot say where these will be located. These are the sectors with monopolistic competition where a great number of firms produce differentiated goods.

Similar conclusions have been achieved also by Feenstra and Kee (2010): "We conclude that export variety in the monopolistic competition model with heterogeneous firms is quite effective at accounting for the time-series variation in productivity, but not the large absolute differences in productivity between countries."

Monopolistic competition in long period of time

Let's suppose now that during long period of time the quantity of both factors being used in creation of the final goods was changing, where X_1 is labour quantity, X_2 is capital value and r is a coefficient that expresses the level of technological progress. The production function shall have a simple form. The producers shall aim at occurrence of optimum combination of labour and capital minimising their total costs *TC*.

$$q = r X_1 . X_2 \tag{17}$$

$$x_1 = \frac{q}{r x_2} \tag{18}$$

$$TC = Px_1 X_1 + Px_2 X_2 \tag{19}$$

$$TC = \frac{Px_1}{r Px_2} q + Px_2 X_2 \tag{20}$$

$$\frac{dTC}{dX_2} = Px_2 - \frac{Px_1}{r X_2^2} q = 0 \tag{21}$$

$$X_2 = \sqrt{\frac{Px_1}{Px_2}} \cdot \sqrt{\frac{q}{r}} \tag{22}$$

$$X_2 = \sqrt{\frac{Px_1}{Px_2}} \cdot \sqrt{\frac{q}{r}} \tag{23}$$

For the total cost function in the long period of time and the corresponding functions of the limit and average costs we shall receive

$$TC_d = 2\sqrt{Px_1} Px_2 \cdot \sqrt{\frac{q}{r}} \tag{24}$$

$$MC_d = \sqrt{\frac{Px_1 Px_2}{r}} \cdot \frac{1}{\sqrt{q}} \tag{25}$$

$$AC_d = 2\sqrt{\frac{Px_1 Px_2}{r}} \cdot \frac{1}{\sqrt{q}} \tag{26}$$

$$AC_d > MC_d \tag{27}$$

$$\beta = \frac{Px_1}{r X_2} \tag{28}$$

$$\alpha = Px_2 X_2 \tag{29}$$

In the long period of time we would thus receive for the price value and the production quantity of one firm

$$P_d = \frac{Px_1}{r\sqrt{X_2}} + \sqrt{\frac{f}{\bar{q}} Px_2} \tag{30}$$

$$q_d = \sqrt{\frac{\bar{q}}{f} Px_2 X_2} \tag{31}$$

This corresponds in Fig. 3 with the situation where the long-term average costs curve LAC shifts to the left bottom, thus the impact of external returns to scale.

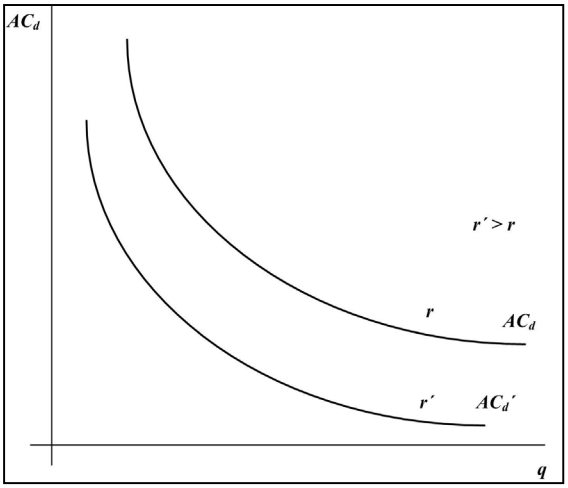

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Figure 3: Influence of technology change in the monopolistic competition model in long period of time.

Results and discussion

Organic farming and farms

The model of international trade within the example of organic farming proves that if the adoption of state subsidies in the production occurs in the long run, then it will reduce AC of producers (organic farms) as a result and this reduction in average cost

will be reflected in the increasing number of farms and therefore increasing production.

An example of the monopolistic competition in the international agricultural products market can be organic food production on organic farms. Nowadays more than 32 million hectares of the agricultural land resources, 0.4 million hectares of aquacultures are farmed organically, and approximately 1.2 million organic farms are involved in the whole world. In spite of the fact that this area does not achieve even 1% of the global agricultural area share, the potential the organic agriculture brings is indisputable. From the point of view of the total area, the developing countries in Latin America, Africa and Asia have the biggest share in the organically farmed land resources. However, it is necessary to mention that a big part of these areas is intended for free picking and apiculture. In the mentioned areas, there's also the highest labour percentage representation in organic agriculture. Compared to this, the Western European countries have the highest relation of the organically farmed areas to their own area, in particular Liechtenstein, Austria and Switzerland. The Western Europe represents also the global market with organic food centre. Germany, Great Britain, France and Italy are the leading countries of this industry.

In 1990 implementation of the first subsidies for the organic farmers in Czech Republic started steep growth in the number of farms involved in the alternative way of farming. An important part of evaluating common economic politics of countries in the European Union (EU) is the observation of microeconomic consequences of governmental subsidies in agriculture (Prášilová, Severová, Chromý, 2011). Of the original 3 enterprises farming on the area of 482 ha, 135 farms farming on the area of 15.4 thousand ha were registered until the end of 1992. Since 1993, when the payment of subsidies was cancelled temporarily, the development of organic farming has occurred in particular in mountain and piedmont regions. Between 1994 and 1998 organic food market in our country stabilized and our firms became successful exporters of these products.

In support of the Czech organic farmers flowed more than 980 million in 2009, which is more than forty percent more than in 2008. The volume of grants has increased eleven times in ten years. Estimated number of organic farmers in 2010 has risen to 3500 and still growing. The acreage of organic agricultural land increased by 50 thousands hectares and the share of organic agriculture land exceeded 10.5%. The number of organic farms increased year-on-quarter to 626 businesses (Prášilová, Severová, Chromý,, 2011). The analysis has shown the validity of the model for the production of organic food; the increase of subsidies and thus decrease of the cost of farmers caused by an increase of the number of organic farms in the sector.

Livestock production

The production of meat products (Prague Ham)

The application of the model of monopolistic competition here is applied in the short run. The company produces (as a monopoly producer) family specialty Prague ham with a long tradition in monopolizing profit. The increase in the price of meat products as well as branded products exported to the EU and other countries lead to an increase in production capacity (see q in Figure 1 and 2).

The company which specializes in ham and smoked food was founded by the father of the current director Jiří Lenc in 1990. What was once a small family firm employing four people became a billion-dollar company employing 370 workers over the years. One of the largest independent manufacturers of sausages; the family-owned company Le & Co is planning further expansion six years after relocating to new premises in Jirny. They are planning to invest 30-40 million CZK into a new warehouse of 1,500 square meters (Kütner, Le&Co..., 2013). This is due to an increase in sales of company products and the consequent need for greater stocks of consumable items, as well as the increasing share of sliced meat products that are more difficult to package. There will be approximately five new job positions after the construction of the warehouse with a capacity of approximately 3,100 pallet spaces.

The increase in sales was also reflected by the company's revenue, which reached 1.43 billion CZK in 2011. The company recorded an increase in percentage in 2012; they also forecast the same increase in 2013. These figures have been influenced by several factors: an increase in the number of customers, an increase in mutual trade between the company and some of its contemporary customers and an increase in (sales) prices of meat products. The company

is therefore one of the promoters of the efforts of the Czech Meat Processors Association to get Prague ham on the list of traditional specialties guaranteed by EU.

Crop production

Beer

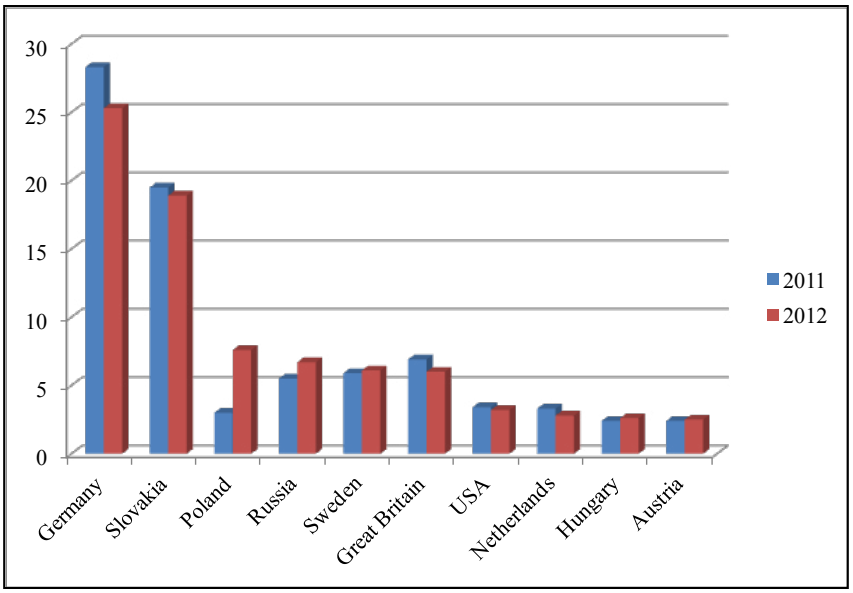
The decrease in the final price of exported Czech beer (by duty rate) concerning the accession of Russia to the WTO may be an example of the use of the model of monopolistic competition in the short run. The share of exports of domestic beer in Russia on the export of all beer exported from the Czech Republic to abroad has been slightly increasing, but many brewers expected it to be higher. This is because Russia entered the World Trade Organization (WTO) in August 2012 after eighteen years of negotiations. This should also bring a reduction in import duties and decrease the price of exports to the country, which is the third largest trading partner of the European Union. However exports have not significantly increased. Actions by the Russian government to reduce alcoholism in the country have stunted cheaper imports of Czech beer which is well-known and popular in Russia. Among other things this also means increasing excise taxes on alcohol and generally stricter rules for the sale and advertising of beer.

One of the few breweries that has a record growth in exports is the Lobkowicz Brewery which groups together seven medium-sized domestic breweries. Not only Lobkowicz, but actually all exported brands are becoming similar to Russian and affordable licensed beers produced in Russia with an increase of excise tax on all beers and a reduction in duty. This is undoubtedly positive information. On the other hand, the Russian government increased the excise tax on beer, categorizing this as alcohol, on which they apply more stringent restrictions and rules. This is mainly related to the evidence within different documents, state registration, sale bans after 10PM, etc. This will slightly complicate sales, but will not become a big problem, if dealt with properly. (Kütner, Vstup ..., 2013).

Czech leader and dominant player in the market, Pilsner Urquell and Heineken ČR have not experienced an increase in exports to Russia. Despite the increasing excise tax in Russia, exports of other brands of beer have managed to hold the same cost as in previous years due to its quality and popularity.

Cocoa

There has been further extension of the cocoa bean market due to the growth in popularity of chocolate and increasing wealth of the middle class population in Asia (particularly in China) in the short run. The producers can‘t expand the growing-fields and the number of producing companies cannot be increased, this can be an example of an application



Source: Czech Malt and Beer Association

Graph 1: Countries´ share in exports of beer produced in the Czech Republic.

of the model of monopolistic competition (see Figure 1). This consecutively leads to an increase in world prices.

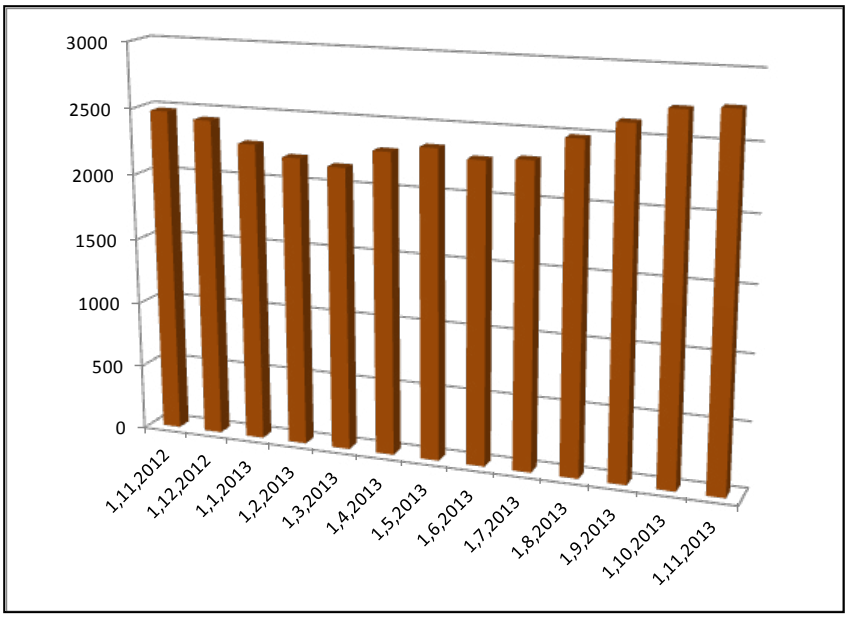
The world has been facing one of the biggest shortages of cocoa for the last few decades. This is due to a rapidly growing middle class population in Asia, which is increasingly enjoying chocolate. Meanwhile lack of cocoa has become a subject of interest for investors. Prices of cocoa raised by a quarter from last year‘s lows and has greatly exceeded most other commodities, and global stock, which managed to increase „only“ approximately 16 percent in the last year. Currently, producers of chocolate pay around $ 2,800 per tonne of cocoa, but according to the experts this year‘s prices will continue to rise by approximately 15 %.

This year, 7.2 million tons of chocolate has been consumed in the world in total. Demand for chocolate is huge. Much of the world‘s population is becoming middle class, which tends to spend more. This is particularly true for emerging markets and Asia. The driving force behind global demand will be China, where there is a huge untapped market. Sales of chocolate products doubled here in 2013. However, confectioners earn the most in Europe, where the average citizen consumes almost five kilograms of chocolate per year; the consumption of Europe exceeds Asian continent consumption eleven times (Index Mundi, 2014).

According to the International Cocoa Organization (ICCO), the cocoa shortage will last until 2018. This is because farmers can‘t cover growing demand in the short run, besides; natural conditions are not favoring the crop. Plantations of cocoa in West Africa are getting older and less fertile, about three-quarters of the world‘s supply of cocoa comes from this area. The effect of rising input prices are being felt by chocolate producers. Strong competition prevents them from fully passing on the more expensive cocoa in the final prices of their products, so profit margins are dropping. For example the Nestlé Company confirmed a reduction in margins in the confectionery segment for the first half of 2013.

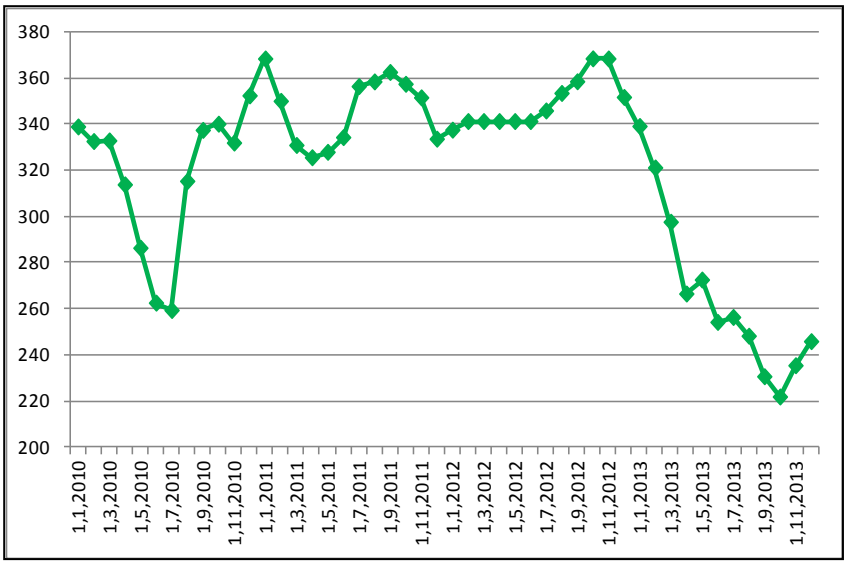
Tea

Production of black tea may be an example of a reduction in the size of the market due to the failure of an important customer (Egypt) in the long run in the model of monopolistic competition (see Figure 2). Low prices of tea undoubtedly threaten the economies of the largest exporters. Except for tourism and gardening it is the only product in Kenya that brings hard currency to the country, the same applies to Malawi, Uganda and Tanzania. The situation of tea producers is also aggravated by the fact that last year’s crops were above expectations. The price of black tea fell to a three-year low due to the political upheaval in Egypt. Armed



Source: Index mundi, 2014

Graph 2: The development of the price of cocoa beans (USD per metric ton).



Source: Index mundi, 2014

Graph 3: The development of price of tea best pekoe fannings (US cents per kilogram).

interventions do not favor social rituals, thus the demand of the world's fifth largest importer of tea is rapidly decreasing. One of the ingredients used for preparing one of the most popular beverages lost more than a third of its value in the last year.

The wholesale price of medium quality black tea Pekoe Fanning, which is mass-produced in tea bags, dropped to 2.64 dollars per kilogram at the last auction in Mombasa, Kenya. This figure is approximately 34 percent less than in 2012 and the lowest value since mid-2010. Merchants say that if the crisis in Egypt continues, tea prices will continue to fall. Except politics, the stronger dollar, in which tea is bought, does not favor the local tea drinkers (Index mundi, 2014).

„We see no reason for optimism," said Dutch tea merchant Van Rees who is cited in the analysis by the Financial Times. However Czech tea lovers will not profit. Decline in prices is related only to teas of medium and low quality. „The perception of quality could be different because of the various reasons. Firstly, the consumer could be influenced by his/her vision or his/her experience of a low quality product" (Horská, Ürgeová, Prokeinová, 2011). Tea of high quality, which is sold in specialized tea shops are faced with an increase in the price of labor at the location of harvest and increased costs for health checks on inputs into the EU, so a price reduction can't be expected here (see Graph 3).

The happiness of tea (bag) consumers may also be premature because the raw ingredient itself constitutes only a fraction of the total costs and a decline in prices of tea is negligible in the final price of the product. If the price decrease would continue, we can at least have the hope that prices of ordinary tea will rise a little slower than expected.

Conclusion

The firms' behavior in the monopolistic competition may be very heterogeneous and cannot be covered in a single model. Also, as mentioned study by Prášilová, Severová, Kopecká, Svoboda (2011) "the agricultural producers face (by clustering their firms into big trade cooperatives) a split between frequent fragmentation of production (also given by landscape sustainable development) and the oligopoly power of supranational food chain stores, which take over a notable part of their production". The mentioned analysis describes the impacts of the firms entering international trade. In the sectors where increasing returns to scale apply it is valid that both heterogeneity of the goods the country produces and the extent of their production are influenced by the market size. Countries carry on trade among each other and thus create thus integrated global market that is bigger than any national market. By doing so, the countries get rid of their limitations. Each of them can specialize in production of a narrower spectrum of goods than if it were not for international trade,

it can also purchase goods it cannot manufacture itself from other countries. Thus each country can extend the spectrum of goods available to its consumers. The result is that international trade offers additional opportunities of mutual benefits, namely also in cases where the countries do not differ in their sources and technologies. Let's suppose there are two countries and each of them has a market extent approximately for one million hectoliters of beer on average. When carrying on trade with each other, they may create combined market of two million hectoliters of beer. In this combined market, greater possibility of choice is achieved; more types of beer are produced under lower average costs compared to the situation, in which the national markets would be separated.

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The Regional Efficiency of Mixed Crop and Livestock Type of Farming and Its Determinants

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Anotace

Smíšená rostlinná a živočišná výroba představuje významnou část zemědělské produkce České republiky. Jsou tedy na místě otázky týkající se faktorů určujících její produkční efektivnost. Cílem článku je vyhodnotit produkční efektivnost a její determinanty ve smíšené výrobě v regionech EU. Metoda DEA v podmínkách variabilních výnosů z rozsahu (DEAVRS) identifikuje efektivní a neefektivní regiony včetně efektivnosti z rozsahu. V dalším kroku jsou pomocí dvouvýběrového t-testu vyhodnoceny rozdíly ekonomických a strukturálních ukazatelů mezi efektivními a neefektivními regiony. Výzkum odhalil, že substituce práce kapitálem či službami pozitivně ovlivňuje čistou přidanou hodnotu na AWU. Významnými ekonomickými determinanty produkční efektivnosti smíšených farem jsou rostlinná produkce na hektar, živočišná produkce na dobytčí jednotku, produktivita energie a kapitálu. Zemědělské podniky v neefektivních regionech hospodaří extenzivněji a produkují více nekomoditních výstupů (veřejného zboží) než efektivní regiony.

Klíčová slova

Rostlinná a živočišná produkce, technická efektivnost, důchod, regiony EU, substituce vstupů

Abstract

The mixed crop and livestock farming represents significant share in agricultural output in the Czech Republic. So, it raises questions about determinants of its production efficiency. The aim of the article is to evaluate production efficiency and its determinants of mixed crop and livestock farming among the EU regions. The DEA method with variable returns to scale (DEAVRS) reveals efficient and inefficient regions including the scale efficiency. In the next step, the two-sample t-test determines differences of economic and structural indicators between efficient and inefficient regions. The research reveals that substitution of labor by capital/contract work positively affects income indicator Farm Net Value Added per AWU. The significant economic determinants of production efficiency in mixed type of farming are crop output per hectare, livestock output per livestock unit, productivity of energy and capital. Agricultural enterprises in inefficient regions have more extensive structure and produce more non-commodity output (public goods).

Key words

Crop and livestock production, technical efficiency, income, EU regions, input substitution .

Introduction

The production efficiency is one of the key prerequisites for the competitiveness of enterprises in every business. The assessment of production efficiency in agriculture is limited by weather conditions and by large variability of farms not only within the member states but also among EU regions. Nevertheless, the identification of production efficiency and its main determinants can reveal the weaker regions and show ways how to improve their farming performance in new Common Agricultural Policy after 2013.

The goal of the paper is to evaluate the production efficiency of mixed type of farming among the FADN EU regions and to determine which structural and economic factors significantly affect the farming performance. Production efficiency of other types of farming will be considered in future research. The mixed type farming has been very important part of the Czech agriculture for a long time. The structure of today's Czech agriculture is rooted in its history. Family farms are not as important as in western states of the European Union. The bigger part of the agricultural area (about 70 percent) is

used by large holdings of legal persons. There was 6 245 farms with combined crop and livestock production in 2010, out of 22 864 agricultural holdings. The Czech farms with mixed production are large with 454.6 ha of utilized agricultural area on average in 2010 (CZSO, 2011).

The paper is organized as follows. After literature review about production efficiency in agriculture, the material and methods are described. The paper puts emphasis on Central European countries. The results describe and discuss the most important findings about determinants of production efficiency of mixed crop and livestock type of farming amongst EU regions. The conclusions indicate the purpose and the main findings.

Many researchers consider the agricultural production efficiency in the Czech Republic. Juřica et al. (2004), Jelínek (2006), Medonos (2006), Davidova and Latruffe (2007), Boudný et al. (2011) and Čechura (2010, 2012) concern the technical efficiency in Czech conventional farming. Žídková et al. (2011) deals with factors affecting efficiency of the farms in the Czech Republic, the subject of the analysis is the development of the investments in agriculture. Malá (2011) aims at the efficiency of Czech organic farming and its determinants. Čechura (2012) identifies the key factors determining the efficiency of input use and the total factor productivity (TFP) development. He concludes that the developments in the individual branches are characterized by idiosyncratic factors, as well as the systemic effect, especially in the animal production. The most important factors which determine both technical efficiency and TFP are those connected with institutional and economic changes, in particular an increase in the imports of meat (Svatoš, Smutka, 2012) and increasing subsidies. Machek and Špicka (2013) also apply TFP approach in agriculture. They estimate Total Factor Productivity of Agricultural Sector Based on Firm-Level Accounting Data. The results of the analysis suggest that the agricultural TFP growth does not necessarily move in the same direction as the growth of the economy.

The production efficiency in Central European Countries has been studied by Gorton and Davidova (2004). The results did not prove less efficiency of corporate farms than family farms. The best corporate farms tend to perform as well as the best family farms. The Central European Countries in transition with well-established small family farms are less inefficient compared to larger cohorts as against countries with large corporate farms. Bojnec and Latruffe (2011) consider size-efficiency relationship of family farms during transition period in Slovenia. Using DEA method and FADN data, they suggest that family labor is more crucial than any other production factor in the country‘s farming economy. Moreover, the correlation coefficients between size and efficiency have always the same sign whatever the efficiency measure.

Bakucs et al. (2010) evaluate technical efficiency of Hungarian farms before after EU accession. They conclude that increase of subsidies in post-accession period contributes to lower efficiency of Hungarian farms. Due to an increasing scarcity of labor on farms, authors recommend promoting a farming system that uses labor and it is competitive.

Latruffe et al. (2004) analyze technical efficiency and its determinants for a panel of Poland specialized crop and livestock production before EU accession. Authors compare DEA with Stochastic Frontier Analysis (SFA). They find out that livestock farms are more technically efficient than crop farms. Large farms are more efficient than small farms. The key determinants of efficiency are a degree of downstream market integration and soil quality.

Błażejczyk-Majka, Kala and Maciejewski (2012) use FADN data to find out whether a higher specialization and a bigger economic size class of farms determine a higher technical efficiency at the same scale for the farms from the new and old countries of the EU. Results recorded for mixed farms in relation to the pure technical efficiency indicate a bigger efficiency of the farms from the “old” EU regions (EU-15) in comparison to the farms from the “new” regions, except for the biggest farms.

Hussien (2011) calculates the production efficiency of the mixed crop-livestock farmers in two districts of north eastern Ethiopia. He concludes that the production efficiency of mixed crop-livestock farming is determined by farm size, livestock ownership, labor availability, off/non-farm income participation, total household assets, total household consumption expenditure and improved technology adoption.

Materials and methods

The geographic scope

The FADN RICA provides structural and economic data in standard results. Complete data for 2011 are available in 101 EU regions. The analysis focuses

on mixed crop and livestock type of farming (code 80 in TF14 FADN grouping) which comprises farms with prevailing combined field crops-grazing livestock and various crops and livestock type of farming. FADN use special weighting system. The individual weight is equal to the ratio between the numbers of holdings, of the same classification cell (FADN region x type of farming x economic size class), in the population and in the sample.

The FADN regions with available data on mixed crop and livestock farming represent 25 EU member states. Table 1 gives information about state affiliation of the analyzed regions.

The quantitative methods

Analysis of economic efficiency of mixed farming respects the view on efficiency in utilization of production factors (Coelli et al, 1998; Fried, Lovell, Schmidt, 2008). To determine the level of the production efficiency of farms, the Data Envelopment Analysis method (DEA) is applied. Production unit is efficient when there isn't any other unit maintaining the same level of outputs with lower level of inputs, respectively, when there isn't any other unit achieving the higher level of outputs with the same level of inputs. Units with the highest efficiency are located on the efficient frontier. The purpose of the DEA method is to construct a non-parametric envelopment frontier over the data points such that all observed points lie on or below the production frontier. The technical efficiency (TE) estimates vary between 0 (0%) and 1 (100 %). The model assumes variable returns to scale (DEAVRS method). The issue of returns to scale concerns what happens to units' outputs when they change the amount of inputs that they are using to produce their outputs. Under the assumption of variable returns to scale a unit found to be inefficient has its efficiency measured relative to other units in the data-set of a similar scale size only. The results distinguish among increasing, constant (effective) and decreasing returns to scale.

Undifferentiated member states (FADN regions)	Austria, Czech Republic, Denmark, Estonia, Ireland, Lithuania, Luxembourg, Latvia, The Netherlands, Slovakia, Slovenia
FADN regions within member states	
Belgium	Vlaanderen, Wallonie
Bulgaria	Severozapaden, Severen tsentralen, Severoiztochen, Yugozapaden, Yuzhen tsentralen, Yugoiztochen
Finland	Etela-Suomi
France	Champagne-Ardenne, Picardie, Haute-Normandie, Centre, Basse-Normandie, Bourgogne, Nord-Pas-de-Calais, Lorraine, Alsace, Franche-Comté, Pays de la Loire, Bretagne, Poitou-Charentes, Aquitaine, Midi-Pyrénées, Rhônes-Alpes, Auvergne
Germany	Schleswig-Holstein, Niedersachsen, Nordrhein-Westfalen, Hessen, Rheinland-Pfalz, Baden-Württemberg, Bayern, Saarland, Brandenburg, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt, Thueringen
Greece	Makedonia-Thraki, Ipiros-Peloponissos-Nissi Ioniou, Thessalia, Sterea Ellas-Nissi Egaeou-Kriti
Hungary	Közép-Magyarország, Közép-Dunántúl, Nyugat-Dunántúl, Dél-Dunántúl, Észak-Magyarország, Észak-Alföld, Dél-Alföld
Italy	Piemonte, Lombardia, Veneto, Friuli-Venezia, Emilia-Romagna, Toscana, Marche, Umbria, Lazio, Abruzzo, Molise, Campania, Basilicata
Poland	Pomorze and Mazury, Wielkopolska and Slask, Mazowsze and Podlasie, Malopolska and Pogórze
Portugal	Norte e Centro, Ribatejo e Oeste, Alentejo e do Algarve
Romania	Nord-Est, Sud-Est, Sud-Muntenia, Sud-Vest-Oltenia, Vest, Nord-Vest, Centru, Bucuresti-Ilfov
Spain	Aragón, Cataluna, Baleares, Castilla-León, Castilla-La Mancha, Extremadura, Andalucia
Sweden	Slattbygdslan
United Kingdom	England-North, England-East, England-West, Scotland

Source: author based on FADN database

Table 1. Regions represented by mixed crop and livestock farming.

Six inputs and two outputs per weighted average farm are used for efficiency calculation. Indicators are linked with FADN standard results codes.

- Outputs in EUR: Crop output (SE135), Livestock output (SE206).
- Land input (SE025 - utilized agricultural area in ha).
- Labour input (SE011 - actual working time in hours per year).
- Material costs (SE281 - seeds and plants, fertilisers, crop protection, other crop specific costs. feed for grazing livestock, feed for pigs & poultry, other livestock specific costs in EUR).
- Energy costs (SE345 - motor fuels and lubricants, electricity, heating fuels in EUR).
- Capital costs (SE360 depreciation, SE375 rent paid, SE380 interest paid, SE340 machinery & building current costs, SE390 taxes and other charges on land and buildings in EUR)
- Contract work (SE350 - costs linked to work carried out by contractors and to the hire of machinery in EUR).

Efficiency scores were calculated separately for each region. The technical efficiency (TE) score divides the sample into two groups - efficient with TE = 1.0 and inefficient with TE < 1.0. The statistical procedure tests the differences of structural and economic indicators between the two groups. The Farm Net Value Added (FNVA) per AWU (Annual Work Unit) represents the main income indicator in agriculture. According to the FADN definition, the FNVA is the remuneration to the fixed factors of production (work, land and capital), whether they be external or family factors. As a result, holdings can be compared irrespective of their family/non-family nature of the factors of production employed. Since it covers costs on external factors, it is convenient for comparison of the different farm structures within the EU-27. The economic indicators also include modified FNVA per AWU which is defined as the remuneration to paid and unpaid work only.

Statistical procedures for assessment of differences between efficient and inefficient groups are selected depending on the features of the two groups. The skewness, kurtosis and omnibus normality are tested. Since the choice of appropriate statistical tests varies by the normality and variance assumptions of the sample, some researchers recommend against using a preliminary test on variances. If the two sample sizes are approximately equal, the equal-variance t-test can be used. If the ratio of the two sample sizes (larger sample size over the smaller sample size) is equal to or greater than 1.5, it is possible to use the unequal-variance t-test (Ott, 1984). The results of DEA indicate 56 efficient regions and 45 inefficient regions, so the prerequisite for equal-variance t-test is fulfilled.

The two-sample t-test compares the distribution between two groups – inefficient regions (μ_1) and efficient regions (μ_2). The null and alternative hypotheses are: H0: mean μ_1 = mean μ_2, HA: mean μ_1 > mean μ_2 (Diff > 0) or mean μ_1 < mean μ_2 (Diff < 0). So, the one-sided test of hypotheses is applied depending on the subjective assumptions about the efficiency determinants. The statistical analysis is processed automatically by software StataSE 12. Table 2 contains basic descriptive statistics of farms.

The sample contains regions with relatively small size as well as regions with very large farms with more than 1 000 hectares on average. Mixed farms have extensive and intensive stocking intensity. So, the paper also evaluates if the intensity affects production efficiency.

Variable	Mean	Standard Deviation	Min	Max
Crop output (EUR)	85 430.39	146 197.79	773.00	842 498.00
Livestock output (EUR)	76 855.08	115 856.65	2 481.00	648 570.00
Utilized agricultural area (ha)	106.30	177.40	0.93	1 116.69
Labour input (AWU)	2.43	3.69	0.76	29.19
Economics size (ESU*)	139.29	227.80	4.60	1 244.30
Livestock units per 100 ha	72.72	42.87	23.30	274.05
Stocking intensity (LU/ha of forage crops)	1.43	1.13	0.32	10.22

Note: * ESU (Economic Size Unit) = 1 ESU is 1 000 EUR of standard output.
Source: author

Table 2. Basic descriptive statistics of farms (N = 101).

Results and discussion

Results in table 3 confirm the theoretical assumption about returns to scale.

As the business grows, a company initially increases the scale efficiency. After achieving the optimum size the scale efficiency gradually decreases. The Czech Republic, Slovakia, regions in former East Germany (Brandenburg, Sachsen, Sachsen-Anhalt, Thueringen), three regions in France (Champagne-Ardenne, Bourgogne, Pays de la Loire), two regions in Italy (Toscana, Umbria), region Közép-Dunántúl in Hungary and region Yugoiztochen in Bulgaria had decreasing returns to scale in 2011. It means that output increases by less than that proportional change in inputs. Nevertheless, not all of regions with decreasing returns to scale have large average farms, e. g. regions in Italy and Bulgaria. Efficient mixed type of farming with decreasing returns to scale is typical for the Czech Republic, Slovakia, France (Champagne-Ardenne, Pays de la Loire) and Germany (Brandenburg, Sachsen, Thueringen).

All regions with efficient returns to scale are fully technically effective (TE = 1.0). The optimum-sized regions are in "old" EU member states - in France, Germany, Italy, Belgium, the Netherlands, Denmark, Greece, Spain, and Portugal. The optimal average size of farms in "new" member states are in Lithuania, Bulgaria (Severen tsentralen, Severozapaden, Yuzhen tsentralen) and Romania (Bucuresti-Ilfov).

Table 4 contains economic indicators and the results of two-sample t-test. The economic indicators cover input and output variables including current subsidies.

The average size of efficient farms is significantly higher than in inefficient regions. It is consistent with Latruffe et al. (2004) and Hussien (2011). The farms in efficient regions use more labor input which indicates higher farming intensity. Regarding the production, the test proves that the efficient regions have significantly higher crop output per hectare and livestock output per livestock unit. The inefficient regions have higher share of other output. The more efficient input-output ratio of efficient regions has positive impact on the significantly favorable share of intermediate consumption to total output. It means that efficient regions spend less specific costs and overhead costs per one unit of output. Simultaneously, the efficient regions spend more specific crop costs per hectare which, on the other side, generate higher crop output per hectare. Efficient regions produce more intensively than extensive regions.

The hypotheses about partial factor productivity verify if the efficient regions have higher productivity of all production factors than inefficient units. The table 4 shows that efficient regions have significantly higher total output per energy costs, capital costs (at $\alpha = 0.01$), labor and contracting work (at $\alpha = 0.1$) than inefficient regions. On the contrary, material productivity is not significantly higher in the efficient regions. The input productivity raises a question about substitution among inputs. Table 5 provides possible answer.

The correlation matrix in table 5 indicates lower correlation between contract work and labor and between capital costs and labor. There could be capital-labor substitution or contract work-labor substitution among regions. The substitution between capital/contract work can be quantified as follows:

$$LC_{sub} = \frac{TO/LI}{TO/(CC+CW)}, \text{ where}$$

LC_{sub} is substitution between capital/contract work, TO is total output, LI denotes labor input (actual working time in hours per year), CC denotes capital costs (depreciation, rent paid, interest paid, machinery & building current costs, taxes and other charges on land and buildings) and CW means contract work (costs linked to work carried out by contractors and to the hire of machinery).

Indicator	Inefficient regions	Efficient regions	Total	Average UAA (ha)	Average ESU
Number of regions with decreasing returns to scale	6	7	13	364.1	452.3
Number of regions with efficient returns to scale	0	37	37	85.5	139.2
Number of regions with increasing returns to scale	39	12	51	55.7	59.6
Total	45	56	101	106.3	139.3

Source: author

Table 3. Distribution of the returns to scale.

Indicator	Unit	Inefficient regions (μ_1), N = 45	Efficient regions (μ_2), N = 56	H_0 ($\mu_1 - \mu_2$)	T-Statistic	P-value	Sig.
Utilized agricultural area	ha/farm	77.73	129.26	Diff < 0	-1.459	0.0739	*
	SD	107.88	216.11				
Economic size	ESU/farm	89.17	179.56	Diff < 0	-2.012	0.0235	**
	SD	149.52	269.74				
Labour input (hours per year)	hours/farm	3,713.35	6,104.19	Diff < 0	-1.610	0.0553	*
	SD	3,127.42	9,550.14				
Crop output	EUR/ha	760.33	986.04	Diff < 0	-2.572	0.0058	***
	SD	285.30	529.74				
Livestock output	EUR/LU	975.51	1,094.84	Diff < 0	-1.869	0.0323	**
	SD	254.12	362.59				
Other production in Total input	%	6.460	3.876	Diff > 0	2.839	0.0027	***
	SD	5.151	3.999				
Total output per Total input	EUR/EUR	1.060	1.212	Diff < 0	-3.401	0.0005	***
	SD	0.151	0.267				
Total output per Total intermediate consumption	EUR/EUR	1.558	1.729	Diff < 0	-2.506	0.0069	***
	SD	0.297	0.372				
Total output per Working hour	EUR/hour	27.77	36.29	Diff < 0	-1.522	0.0656	*
	SD	23.56	31.04				
Total output per Material costs	EUR/EUR	2.660	2.953	Diff < 0	-1.269	0.1037	-
	SD	0.612	1.445				
Total output per Energy costs	EUR/EUR	10.86	14.95	Diff < 0	-4.925	0.0000	***
	SD	3.16	4.79				
Total output per Capital costs	EUR/EUR	3.348	4.588	Diff < 0	-3.876	0.0001	***
	SD	0.829	2.011				
Total output per Contracting work	EUR/EUR	27.61	35.95	Diff < 0	-1.433	0.0776	*
	SD	11.97	37.51				
Specific crop costs per hectare	EUR/ha	229.04	284.96	Diff < 0	-1.997	0.0243	**
	SD	94.44	167.61				
Specific livestock costs per LU	EUR/LU	563.38	560.11	Diff < 0	0.078	0.5311	-
	SD	212.34	206.59				

Source: author

Table 4. Differences in economic indicators.

	Land	Labour	Material	Energy	Capital	Contract
Land	1.000	0.937	0.964	0.975	0.931	0.921
Labour	0.937	1.000	0.904	0.949	**0.838**	**0.839**
Material	0.964	0.904	1.000	0.985	0.978	0.941
Energy	0.975	0.949	0.985	1.000	0.948	0.907
Capital	0.931	**0.838**	0.978	0.948	1.000	0.955
Contract	0.921	**0.839**	0.941	0.907	0.955	1.000

Note: All correlation coefficients are statistically significant at $\alpha = 0.01$
Source: author

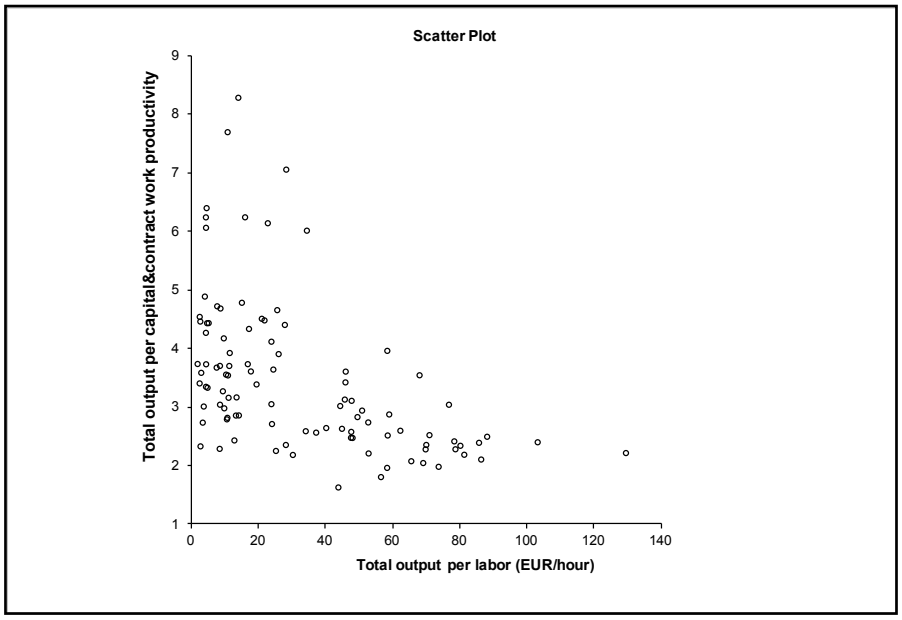
Table 5. Pearson correlation among input variables.

The analysis reveals that the substitution between capital/contract work and labor significantly affects the key income indicator FNVA per AWU. Figure 1 shows correlation between capital/ contract work productivity and labor productivity. The Spearman's rank correlation coefficient between labor productivity (numerator) and capital/contract work productivity (denominator) is -0.5915 (p-value = 0.0000). Pearson correlation coefficient is -0.5000 (p-value = 0.0000).

The higher is the LC_{sub} indicator, the more labor is substituted either by capital or by contract work. Regions in Western and Northern Europe have highest LC_{sub} indicator, so they use more capital or contract work. In 1st/top/ quartile of LC_{sub} (> 19.12) there are regions in Denmark, France, Sweden, Finland, Benelux, Germany and United Kingdom. On the contrary, regions in Central, Southern and Eastern Europe have lowest LC_{sub} indicator (< 2.45). Thus, they use more labor forces on farm. In 4th/bottom quartile of LC_{sub} there are regions in Poland, Lithuania, Spain, Bulgaria, Greece, Romania and Portugal.

Table 6 contains results of linear regression analysis between FNVA/AWU (in thousands EUR) as dependent variable y and indicator LCsub as independent variable x. The LC_{sub} indicator can be used as valuable determinant of farm income level for mixed type of farming because it explains a variability of FNVA per AWU by 73.7 %. Figure 2 visually presents the regression. Table 7 presents the differences in FNVA/AWU and subsidies.

The differences in FNVA per AWU differ between efficient and inefficient regions. Effective regions are characterized by a higher income per AWU and per hectare. On the contrary, inefficient regions receive significantly higher current subsidies per total output because they produce less total output per average farm. Total current subsidies per hectare do not significantly differ. An important finding is that inefficient regions receive more rural development subsidies than efficient regions. Production function includes only commodity outputs and production of the non-commodity outputs (public goods) actually leads



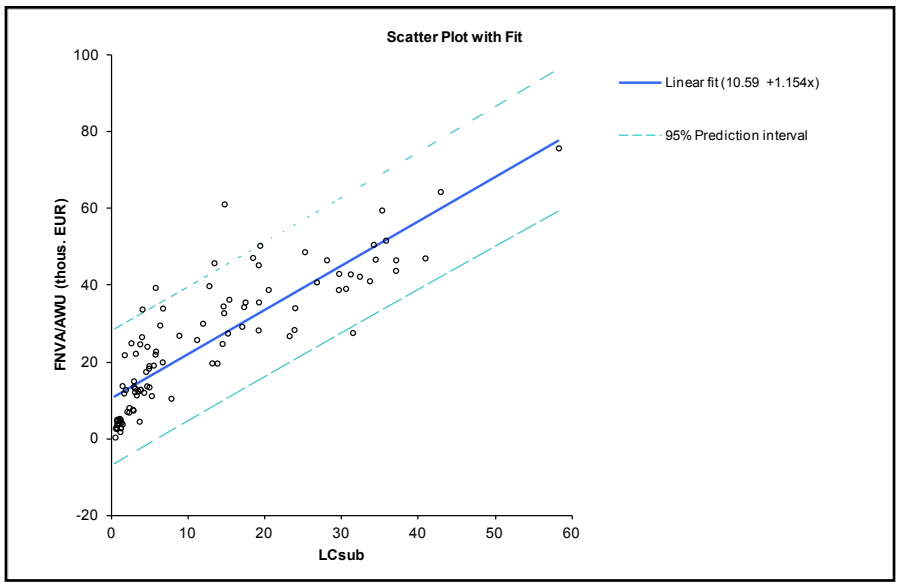
Source: author

Figure 1. Relations between labor productivity and capital/contract work productivity.

Regression	Adj. R^2	p-value	Standard error	Breusch-Pagan $\chi 2$ (p-value)
y = 10.59072 + 1.15361x	0.73740	0.0000	8.74687	0.02 (0.8928)

Note: There isn't any heteroskedasticity in linear regression model.
Source: author

Table 6. Regression between income indicators FNVA/AWU (thous. EUR) and LC_{sub}



Source: author

Figure 2. Regression line.

Indicator	Unit	Inefficient regions (μ_1), N = 45	Efficient regions (μ_2), N = 56	H_0 ($\mu_1 - \mu_2$)	T-Statistic	P-value	Sig.
Total current subsidies per Total output	EUR/EUR	0.266	0.188	Diff > 0	3.958	0.0001	***
	SD	0.109	0.090				
Total current subsidies per hectare	EUR/ha	361.13	346.74	Diff > 0	0.476	0.3177	-
	SD	146.47	154.66				
Rural development subsidies* per Total output	EUR/EUR	0.057	0.025	Diff > 0	3.458	0.0004	***
	SD	0.063	0.023				
Rural development subsidies* per hectare	EUR/ha	79.39	45.00	Diff > 0	2.510	0.0069	***
	SD	88.27	46.95				
Farm net value added (FNVA) per AWU	EUR/ AWU	20 839.18	27 755.79	Diff < 0	-2.057	0.0212	**
	SD	14 250.73	18 589.26				
Farm net value added (FNVA) per hectare	EUR/ha	594.66	986.32	Diff < 0	-3.713	0.0002	***
	SD	235.39	674.83				
LCsub	x	11.26	12.97	Diff < 0	-0.670	0.2523	-
	SD	11.35	13.79				

Note: *Rural development subsidies = environmental subsidies + LFA payments + other RD subsidies
Source: author

Table 7. Differences in income indicator FNVA/AWU and subsidies.

to a decrease in technical efficiency, since agricultural enterprises spend higher costs and/or achieve lower production (Boudný et al., 2011). Differences in rural development subsidies indicate that inefficient regions farm more extensively and produce more public goods.

The efficiency of mixed type of farms does not significantly depend on crop structure. There are significant differences in livestock structure. Efficient regions have higher share of dairy cows per total livestock units. The stocking density per hectare of feed crops and the number of livestock units per 100 hectares are significantly higher in efficient regions. Efficient regions also

Indicator	Unit	Inefficient regions (μ_1), N = 45	Efficient regions (μ_2), N = 56	H_0 ($\mu_1 - \mu_2$)	T-Statistic	P-value	Sig.
Cereals in UAA	%	45.24	44.86	Diff < 0	0.138	0.5547	-
	SD	12.92	14.44				
Other field crops in UAA	%	11.13	11.18	Diff < 0	-0.033	0.4869	-
	SD	5.32	8.35				
Forage crops in UAA	%	36.44	35.24	Diff > 0	0.466	0.3213	-
	SD	12.56	13.17				
Setaside land per Total agricultural area	%	1.133	0.947	Diff > 0	0.552	0.2910	-
	SD	1.548	1.784				
Dairy cows per Total LU	%	14.02	20.05	Diff < 0	-2.168	0.0163	**
	SD	11.32	15.63				
Other cattle per Total LU	%	55.77	55.04	Diff > 0	0.144	0.4429	-
	SD	25.99	24.87				
Pigs per Total LU	%	25.35	17.24	Diff > 0	1.923	0.0287	**
	SD	22.89	19.48				
Poultry per Total LU	%	3.497	6.947	Diff < 0	-1.934	0.0280	**
	SD	6.190	10.595				
Number of LU per 100 hectares	LU/100 ha	59.99	82.95	Diff < 0	-2.762	0.0034	***
	SD	24.08	51.37				
Stocking intensity	LU/ha f.c.	1.127	1.672	Diff < 0	-2.458	0.0079	***
	SD	0.459	1.427				
Yield of wheat	t/ha	4.801	5.239	Diff < 0	-1.142	0.1282	-
	SD	1.754	2.018				
Milk yield	kg/cow	5,996.53	6,128.90	Diff < 0	-0.312	0.3781	-
	SD	1,734.24	2,193.62				
Debt ratio	%	14.83	16.28	Diff < 0	-0.449	0.3272	-
	SD	14.75	17.21				
Share of hired labour	%	17.88	26.08	Diff < 0	-1.783	0.0388	**
	SD	18.56	25.97				
Share of rented UAA	%	57.70	59.23	Diff < 0	-0.295	0.3844	-
	SD	24.01	27.62				

Source: author

Table 8. Structural determinants of production efficiency in EU regions.

have significantly lower share of pigs and higher share of poultry than inefficient regions. The wheat yield and milk yield are higher in efficient regions but the differences are not statistically significant. It indicates the assumption about production inefficiency of extensive farming. The conclusion is consistent with Boudný et al. (2011).

The share of hired external factors does not significantly differ between efficient and inefficient regions except of hired labor. Higher share of hired labor in efficient regions is related to larger average farms in efficient group of regions. The use of external capital and rented utilized agricultural area is slightly higher in efficient regions but not significantly.

Conclusions

The aim of the paper is to assess the production efficiency of mixed type of farming among the FADN EU regions in 2011 and to determine structural and economic determinants of production efficiency. The analysis of 101 EU regions with available data on mixed crop and livestock farming is processed by DEA method and t-test

of statistical hypotheses. The research reveals some significant determinants of regional production efficiency and income level:

- The analysis of technical efficiency of mixed crop and livestock farms reveals 56 efficient regions and 45 inefficient regions in 2011. There are generally larger farms in efficient regions on average. In the Central Europe, mixed type of farming in the Czech Republic, Slovakia and three regions in Hungary is technically efficient. All four regions in Poland are inefficient with increasing returns to scale.
- The theoretical assumptions about scale efficiency are verified. All regions with optimal returns to scale are efficient. Decreasing returns to scale are typical for regions with largest farms on average, such as the Czech Republic, Slovakia and regions in former East Germany.
- Crop output per hectare and livestock output per livestock unit are key output determinants of production efficiency. On the input side, the efficient regions have higher land productivity, labor productivity, energy productivity, capital productivity and productivity of contract work than inefficient regions. Efficient regions have significantly higher FNVA per AWU and hectare.
- The results prove substitution between labor and capital/contract work. The proposed indicator LCsub, as the share of labor productivity to capital/contract work productivity, significantly determines the FNVA per AWU in mixed type of farming.
- Subsidies on rural development are significantly higher per total output as well as per hectare in inefficient regions. The inefficient regions provide more public goods for rural development which are generally produced with higher costs and/or lower production. Moreover, the structural indicators show that the higher farming intensity significantly increases the production efficiency.

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