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Effects of Climate Change on the Production and Profitability of Cassava in the Niger Delta Region of Nigeria

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Abstract

Nigeria is the single largest producer of cassava in the world with the bulk of the cassava coming out from the Niger Delta region. Human, economic and agricultural activities are currently threatened in the region by vagaries in climatic factors. These vagaries affect the production and profitability of cassava. The study was therefore conducted to assess the effects of climate change on the production and profitability of cassava 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 the three highest cassava-producing states (Awka Ibom, Cross Rivers and Ondo) in the region. Data for the study were collected with the aid of well-structured questionnaires assisted with interview schedules. Data collected were analysed using descriptive statistics and regression model. The determinants of cassava profitability were farm size, farmers' experience in cassava cultivation, farmers' experience in adopting climate change coping strategies, number of climate change coping strategies adopted, costs of input materials in Naira and labour cost in Naira.

Keywords:

Climate change, cassava, production, profitability, Niger Delta .

Introduction

Nigeria is the world's largest producer of cassava with other top producers being Indonesia, Thailand, the Democratic republic of Congo and Angola. In the year 2010, Nigeria's production of cassava reached 37.5 million tonnes (Asante-Pok, 2013). The Nigerian Government facilitated the development of new disease-resistant cassava varieties by the joint efforts of International Institute for Tropical Agriculture (IITA), National Root Crops Research Institute (NRCRI), Root and Tuber Expansion Program (RTEP), and the Federal Ministry of Agriculture, in conjunction with State Agricultural Development Programs and cassava farmers.

The Presidential Initiative on Cassava, launched in 2003, brought cassava to the national limelight. The Initiative had as its goal the promotion of cassava as a viable foreign exchange earner and also the development of the production system to sustain the national demand. The Presidential Initiative focused its intervention on the development of production, processing, and marketing of the processed products (Sanni et al., 2009).

Cassava production in the Niger Delta region of Nigeria

Cassava as a crop originated from South America and it is extensively propagated as an annual crop in the tropical and sub-tropical regions for its edible starchy tuber as root. It is an annual crop that may often be left longer than 12 months and usually planted as a sole crop or in combination with other crops. Production is all year round activity and it does well in a warm, moist climate. Cassava is very tolerant and has the ability to grow on marginal land where other food crops cannot grow well, but for its high yield and productivity moderate climatic condition and best soil properties like a light, sandy loamy soil of medium fertility and good aerations or drainage are all crucial (Akanbi, Olabode, 2004). Hence, extreme weather conditions such as prolonged drought and excessive amount of rainfall that leads into flood may be detrimental to cassava outputs and critically affect its productivity.

Key traditional cassava products in the Niger Delta region of Nigeria

Traditional cassava products in the Niger Delta region include gari, lafun, fufun and apu. Gari is the most consumed and marketed of all cassava food products both within and outside the region. Gari is a partly gelatinised, roasted, free flowing granular flour with a slightly fermented flavor, creamy-white (or yellow, if from yellow-fleshed roots or fortified with red palm oil). Lafun is flour from fermented dried cassava that is later made into a stiff paste and eaten with sauce. Apu is a variant of lafun popularly consumed by people from Ondo State. A granular product made from partly gelatinised cassava starch, is also known as tapioca.

Key industrial cassava products in the Niger Delta region of Nigeria

High quality cassava flour (HQCF) is a major intermediate product. Development of HQCF is a key success in cassava processing, as it became the means to scale up industrial utilisation in the Niger Delta region and across Nigeria. The flour is being used either alone or as a composite in bakery products. Before this, Nigeria used to import over one million tonne of wheat annually. In the 1990s, after the depreciation of the naira, the high cost of wheat almost sent bakers out of business, thus compelling them to look for an alternative. To face this challenge, IITA developed a simple and appropriate process for producing HQCF that is suitable for baking. This was tested in the baking and confectionary industries; it was found successful and the cost implications were favorable (Sanni et al., 2009).

Cassava starch is used as an ingredient in manufactured foods (infant foods, confectionary, glucose, alcohol) and in non- food industries (glues, oil well drilling, adhesives, paper sizing and bonding, textile sizing and strengthening). It is also widely used as a thickening agent in soup and for laundry purposes. The traditional starch is used for clothes or consumed at a local level in the form of tapioca, often with special flavors (vanilla, banana). Some NGOs are encouraging this form of utilization as an income-generating activity as the product can be sold at weekly or seasonal village markets (Sanni et al., 2009).

Dried (split) roots are the cheapest form of storable cassava. They are typically popular in transitional and savanna areas where sun drying is relatively easier than in forest zones. Peeled roots or chips are often slightly molded or fermented to a certain degree, according to climatic conditions, local taste, and consumption habits. They are milled or pounded into (fermented) flour that does not comply with standards for replacing wheat. The fermentation alters the sensory characteristics of the roots in a way that is often appreciated by local consumers (Sanni et al., 2009).

Climate change in the Niger Delta of Nigeria

Basically, climatic condition as predetermined by the weather pattern and its elements over a long period of between 30 to 40 years is known as climate. This is different from weather which is the atmospheric condition within a very short period of time of at most two weeks. The classical period as determined by the World Meteorological Organization is 30 years which a number of changes in the variables that determine the predominant climatic pattern in the regions are known. The climatic elements include rainfall, temperature, sunshine intensity, relative humidity, atmospheric pressure, cloud cover, snow, dew, frost and wind (Ezekiel et al., 2012)

Human activities have exacerbated climate change with its attendant impacts on agriculture in many communities in the Niger Delta region. Marine resources, fisheries, forest resources and crop production and productivity may not be spared from the effects of vagaries in climatic factors. 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)

Global and regional climate changes are affecting all economic sectors to some degrees. Agricultural sector is perhaps the most sensitive and vulnerable. This is because agricultural production remains very dependent on climatic resources. Researches have revealed that that the earth is likely to warm by 0.2^{o}C per decade for the next two decades and to rise between 0.6oC and 4.0^{o}C by the end of the century depending on future emissions. The resultant effects of this is that climate variability will impact food production in several ways (Ezekiel et al, 2012).

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. Cassava remains key to the food economy of the people of the Niger Delta region. 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.

Although notable researches have been conducted in the region on climate change which include environmental degradation, vulnerability and mitigation of climate change impacts (Akinro et al., 2008), coastal management and adaptation to climate change (Etuonovbe, 2008), and Awareness of climate change and implications for achieving the MDGs in the Niger Delta region of Nigeria (Ajayi, 2014). However, there is literature dearth on researches on the effects of climate change on the production and profitability of cassava in the Niger Delta region. This necessitated this research work.

This research therefore attempts to answer such questions as what effects does climate change has on the production and profitability of cassava in the study area? What are the coping strategies to climate change effects in the study area and what are the determinants of profitability of cassava production in the study area? The study of the effects of climate change on the production and profitability of cassava in the Niger Delta region of Nigeria was therefore conducted with the following objectives which include to:

i. Examine the effects of climate change on the production and profitability of cassava in the study area.

ii. Investigate the coping strategies to climate change effects on the production and profitability of cassava in the study area and

iii. Examine the determinants of profitability of cassava production in the study area

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 consistingof the nine states of Abia, Akwa- Ibom, Bayelsa, Cross-River, Delta, Edo, Imo, Ondo and Rivers (Mba, Ogbuagu, 2013, Ajayi, 2014). 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 (Ajayi, 2014) 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 (Ajayi, 2014). Common crops popularly grown in the region include cassava, cocoyam, white yam, maize, garden egg, pepper, okra, melon, fruited pumpkin and oil palm (Mmom, 2009). Among these, oil palm and cassava remain the leaders in the food economy of the region while cassava is most diversely useful crop in the region serving as raw material to traditional and industrial food processors within and beyond the region.

Sampling technique, size and data collection

A multistage sampling technique was used for this study. In the first stage, three states of Akwa Ibom, Cross Rivers and Ondo were purposively selected from the nine (9) states that make up the Niger Delta region in Nigeria, being the highest cassava-producing states in the Niger Delta. In the second stage, using the delineation by the three (3) states' Agricultural Development Programmes (ADPs), two (2) cassava-producing Local Government Areas (LGAs) were randomly selected from each state giving total of six (6) cassava-producing LGAs. In the third stage, from each of the selected LGAs, 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 cassava farmers was carried out. At the community forum, fifteen (15) cassava famers 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, using Focus Group Discussion (FGD), and Key Informant Interviews

(KII) with the help of community leaders, a sampling frame of all cassava farmers was built up in each community. From this list, random samples of 30 cassava farmers were selected and interviewed using semi-structured interview schedules thus making a total sum of 360 cassava farmers from the study area.

Data collection

Rapid Rural Appraisal (RRA) (transect walks, identification and inspection of farm lands) was as data collection method. The RRA used had the advantage of encouraging the respondents to describe their relationship with their natural resources. The RRA also had the advantage of identifying of variables of importance to the cassava farmers 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 and regression model were used in the data analysis. The descriptive statistics used included means, percentages, frequencies and tables. The effects of climate change on cassava production in the study area was measured on three-point Likert-type scale of "high" (3), "moderate" (2) and "low". Climate change effects with mean scores of ≥ 2.5 were regarded "high", effects with mean responses from 1.5 to 2.49 were regarded "moderate" while those with mean less than 1.5 were regarded as "low". Also, the use of coping 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". Coping 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. Multiple regression analysis was used to isolate factors determining the profitability of cassava production as taken prosy by net farm income. The implicit form of the regression model is presented as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6 \ldots\ldots X_{11}, e)$$

Where, Y = Net farm income (profitability in Naira)

X_1 = age of cassava farmers

X_2 = sex of cassava farmers

X_3 = education of cassava farmers

X_4 = farm size (in hectares)

X_5 = fousehold size

X_6 = farmers experience in cassava cultivation

X_7 = farmers experience in adopting climate change coping strategies

X_8 = number of climate change coping strategies adopted

X_9 = cost of input materials (in Naira)

X_{10} = cost of labour (in Naira)

X_{11} = variety of cassava cultivated

e = error term

Three functional forms of the regression model were fitted to the data collected and the best fit was selected based on established criteria. The a priori expectation was that the coefficients of the independent variables should be greater than zero.

Results and discussion

Effects of climate change on cassava productivity in the study area

From the analysis of the respondents' perceived effects of climate change on cassava production in the study area as shown in Table 1, it is now very evident that climate change has effects on the cassava productivity in the Niger Delta region of Nigeria. These effects are responsible for the dwindling cassava production figures in Nigeria. Should the effects be adequately checked with necessary coping strategies by cassava farmers and policy makers, the present productivity of cassava in the Niger Delta region will improve and by extension snowball Nigeria into greater heights in cassava production and marketing providing more food, employment opportunities and foreign exchange for the nation in the global market should more international markets be created for the crop.

Coping strategies to the effects of climate change on cassava production in the study area

From the analysis of the respondents' coping strategies to the effects of climate change on cassava production in the study area as shown in Table 2,

Effects of climate change on cassava	High	Moderate	Low	High	Moderate	Low	Mean	Remarks
	Frequency			Percentage (%)				
High subseptivity to pests and diseases	240	80	40	66.67	22.22	11.11	2.56	High
Runof of soil nutrients due erosion	178	99	83	49.44	27.5	23.06	2.26	Moderate
Increased weed population	54	70	236	15	19.44	65.56	1.49	Low
Inadequate water supply/drought for nutrient circulation	211	127	22	58.61	35.28	6.11	2.52	High
Late maturing of cassava roots	165	145	50	45.83	40.28	13.89	2.32	Moderate
High temperature destroying soil nutrients	134	139	87	37.22	38.61	24.17	2.13	Moderate
Discoloration of cassava leaves	254	89	17	70.56	24.72	4.722	2.66	High
Discoloration of cassava roots	267	27	66	74.17	7.5	18.33	2.56	High
Reduced cassava roots	221	116	23	61.39	32.22	6.39	2.55	High
Reduced dry matter of cassava roots	67	26	267	18.61	7.22	74.17	1.44	Low
Reduced starch content of cassava roots	178	81	101	49.44	22.5	28.06	2.21	Moderate
Reduced water content of cassava roots	194	78	88	53.89	21.67	24.44	2.29	Moderate
Stunted growth of cassava plants	213	122	25	59.17	33.89	6.944	2.52	High

Source: Computed from field survey, 2014

Table 1: Effects of climate change on cassava production in the study area.

Coping strategies	Always	Rarely	Not at all	Always	Rarely	Not at all	Mean	Remarks
	Frequency			Percentage (%)				
Early and late planting	230	90	40	63.89	25.00	11.11	2.42	A
Soil and water conservation	187	90	83	51.94	25.00	23.06	2.41	A
Use of organic manures	213	83	64	59.17	23.06	17.77	2.51	H
Use of inorganic fertilizer	211	117	32	58.61	32.50	8.89	2.41	A
Planting pest and disease resistant cassava cuttings	187	103	70	51.94	28.61	19.44	2.38	A
Use of cassava cuttings that are well acclimated	134	129	97	37.22	35.83	26.94	1.99	A
Draining of wetland for cassava cultivation	122	120	118	33.89	33.33	32.78	1.86	A
Making of contour bund around farmland	67	26	267	18.61	7.22	74.17	2.10	A
Planting of trees	101	81	178	28.05	22.5	49.44	2.50	H
Minimum tillage system (zero/ minimum)	184	78	98	51.11	21.67	27.22	2.28	A
Use of irrigation system/water storage	79	89	192	21.94	24.72	53.33	1.89	A
Reforestation/ Afforestation	99	114	147	27.50	31.67	40.83	1.83	A
Use of chemicals like herbicide, insecticide	187	111	62	51.94	30.83	17.22	2.49	A
Increase in number of weeding	123	145	92	34.17	40.28	25.56	2.54	H
Use of early maturing cassava varieties	165	105	90	45.83	29.17	25.00	2.48	A
Protection of water sheds and mulching	89	66	205	24.72	18.33	56.94	2.51	H
Preservation of cassava cuttings for planting	212	92	56	58.89	25.56	15.56	2.51	H

Source: Computed from field survey, 2014

Table 2: Coping strategies to the effects of climate change on cassava production - beginning.

Coping strategies	Always	Rarely	Not at all	Always	Rarely	Not at all	Mean	Remarks
	Frequency			Percentage (%)				
Use of weather-resistant cassava variety	180	90	90	50.00	25.00	25.00	2.11	A
Reducing access to eroded/ erosion prone area	231	89	40	64.17	24.72	11.11	2.60	A
Mixed cropping practices	197	67	96	54.72	18.61	26.67	2.24	A
Use of recommended planting distance	267	76	21	74.17	21.11	5.83	2.36	A
Changing the timing of land preparation	193	90	77	53.61	25.00	21.39	2.33	A
Changing harvesting dates	201	90	69	55.83	25.00	19.17	2.27	A
Out migration from climate risk areas	79	67	216	21.94	18.61	60.00	2.48	A
Use of windbreaks/shelter belts	207	90	63	57.50	25.00	17.50	2.63	H

Source: Computed from field survey, 2014

Table 2: Coping strategies to the effects of climate change on cassava production - continuation.

use of organic manures; planting of trees; increase in number of weeding; protection of water sheds and mulching; preservation of cassava cuttings for planting; use of windbreaks/shelter belts were rated “high adopted ” coping strategies while the reaming coping strategies were rated “averagely adopted”. They include Early and late planting; soil and water conservation; use of inorganic fertilizer; planting pest and disease resistant cassava cuttings; use of cassava cuttings that are well acclimated; draining of wetland for cassava cultivation; making of contour bund around farmland; minimum tillage system (zero/ minimum); use of irrigation system/water storage; reforestation/ afforestation; Use of chemicals like herbicide, insecticide; Use of early maturing cassava varieties; use of weather-resistant cassava variety; reducing access to eroded/erosion prone area; mixed cropping practices; use of recommended planting distance; changing the timing of land preparation; changing harvesting dates and out migration from climate risk areas. Meanwhile, none of the coping strategies was poorly adopted by the respondents.

Regression results of determinants of cassava profitability in the study area

Table 3 shows the results of the regression analysis to examine the determinants of cassava profitability in the study area. The double-log functional form provided the best fit as shown in the regression model. Six of the independent variables; X_4, X_6, X_7, X_8, X_9 and X_{10} were significant at 5% level (i.e. 95% confidence interval). These variables were farm size, farmers’ experience in cassava cultivation, farmers’ experience in adopting climate change coping strategies, number of climate change coping strategies adopted, cost of input materials and cost of labour. The parameter estimates of each of these variables also carried signs, which conformed to a priori expectations. The results indicate that farm size, farmers’ experience in cassava cultivation, farmers’ experience in adopting climate change coping strategies, number of climate change coping strategies adopted positively influenced cassava net farm income (profitability) in the study area. Thus, the major determinants of cassava profitability were these four factors. All the explanatory variables together explained about 91% of the variations observed in cassava profitability. The positive effect of adoption of improved varieties of cassava on yield has been earlier observed by both (Dipeolu et al, 2004) and (Mafimisebi, 2005). The (CBN, 1999) also observed that adoption of improved variety was responsible for increase in production from 31 million tonnes in 1994 to 34 million tonnes in 1998.

The regression model is therefore given as:

$$5.274 = f(-0.006X_1 + 0.002X_2 + 0.003X_3 + 1.0230X_4 + 0.006X_5 + 0.007X_6 + 0.012X_7 + 0.015X_8 - 0.04X_9 - 0.046X_{10} + 0.002X_{11} + 0.01135)$$

Variables	Simple Log		Semi-Log		Double Log	
	Coefficients	T-value	Coefficients	T-value	Coefficients	T-value
Constants	3577.234 (4725.093)	0.757	807428.401 (1.357)	1.357	5.274 (0.110)	47.772
X_1	-60.498 (34.909)	-1.733	-7713.567 (-0.299)	-0.299	-0.006 (0.005)	-1.352
X_2	-698.924 (1014.861)	-0.689	1964.363 0(.079)	0.079	0.002 (005)	0.499
X_3	450.851 (533.548)	0.845	37514.570 (1.862)	1.862	0.003 (0.004)	0.807
X_4	134293.121 (2032.285)	66.080*	928356.192 (7.778)	7.778*	1.023 (0.022)	46.216*
X_5	406.309 (203.430)	1.997*	7714.022 (0.409)	0.409	0.006 (0.003)	1.65
X_6	61.431 (52.032)	1.181	12642.747 (0.723)	0.723	0.007 (0.003)	2.150*
X_7	-9.263 (110.466)	-0.084	35099.513 (1.292)	1.292	0.012 (0.005)	2.400*
X_8	-202.327 (242.199)	-0.835	11816.024 0(.452)	0.452	0.015 (0.005)	3.000*
X_9	-0.033 (0.023)	-1.478	-73538.809 (-1.018)	-1.018	-0.004 (0.013)	-3.067*
X_{10}	-0.011 (0.021)	-0.512	-80388.113 (-0.840)	-0.84	-0.046 (0.018)	-2.556*
X_{11}	340.086 (1114.042)	0.305	42773.952 (1.546)	1.546	0.002 (0.005)	0.482
	R2=0.89		R2=0.87		R2=0.91	
	SE=8155.62361		SE=61160.72031		SE=0.01135	
	F value=22293.9		F value=370.7		F value=17428.7	

Note: *means significant at 5% level
Values in parenthesis are *t* ratios
Source: Computed from field survey, 2014

Table 3: Regression results of determinants of cassava profitability in the study area.

Conclusion

The results of analysis show that high effects of climate change include high susceptibility to pests and diseases; inadequate water supply/drought for nutrient circulation; discoloration of cassava leaves; discoloration of cassava roots; reduced cassava roots and stunted growth of cassava plants while runoff of soil nutrients due erosion; late maturing of cassava roots; high temperature destroying soil nutrients; reduced starch content of cassava roots and reduced water content of cassava roots were "moderate" effects; increased weed population and reduced dry matter of cassava roots were of "low" effects. It is also needful to say that all the coping strategies to climate change effects on cassava productivity in by the farmers were either highly or averagely adopted with none being poorly adopted. This emphasizes the farmers' awareness level and commitment to prevent cassava production which is their economic source of living from the effects of climate change. The study further revealed that the determinants of cassava profitability were farm size, farmers' experience in cassava cultivation, farmers' experience in adopting climate change coping strategies, number of climate change coping strategies adopted, cost of input materials and cost of labour.

The study therefore recommends that more coping strategies should be adopted while encouraging high adoption of the strategies which have not been highly adopted. These should be done in search of new innovations for reducing climate change effects on cassava production and profitability in the study area. Also, combination and experience in several coping strategies have been found to reduce effects of climate change on cassava production with improved net farm income to cassava production in the study area.

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References

[1] Ajayi, J. O. Awareness of climate change and implications for attaining the Millennium Development Goals (MDGs) in Niger Delta Region of Nigeria, Agris on-line Papers in Economics and Informatics, 2014, Vol. 4, No 1, p. 3-11. ISSN 1804-1930.

[2] Akanbi, W. B., Olabode, O. S., Olaniyi, J. O., Ojo, A. O. Introduction to Tropical Crops. Published by Raflink Compter Eleyele, Ibadan, 2004.

[3] Akinro, A. O., Opeyemi, D. A., Ologunagba, I. B. Climate Change and Environmental Degradation in the Niger Delta Region of Nigeria: Its vulnerability, impacts and possible mitigations. Research Journal of Applied Sciences, 2008, Vol.,3, No.,3, p. 167-173. (Online) ISSN 1993-6079.

[4] Asante-Pok, A. Analysis of incentives and disincentives for cassava in Nigeria. Technical notes series, 2013, MAFAP, FAO, Rome.

[5] Bryceson, D. F. The Scramble in Africa: re-orienting rural livelihoods. World Development, 2002, Vol. 30, No 5, p. 725–739. ISSN 0305-750X.

[6] CBN. Statistical Bulletin and Statement of Accounts. Central Bank of Nigeria, Abuja. 1999.

[7] Cochrane, P. Exploring cultural capital and its importance in sustainable development. Ecological Economics. 2006, Vol. 57, p. 318–330. ISSN 0921-8009.

[8] Dipeolu, A. O., Ayinde, I. A., Adebayo, K., Oyewole, O. B., Sanni, L. O., Pearce, D. M., Wandschneider, T. S., White, J. L.,Westby, A. Viability Analysis of Cassava Processing in South West of Nigeria. Report submitted to the Department for International Development (DFID), Crop Harvest Research Programme (Project R7495), U.K. 2000.

[9] Ekins, P., Simon, S., Deutsch, L., Folke, C., De Groot, R. A framework for the practical application of the concepts of critical natural capital and strong sustainability. Ecological Economics. 2003, Vol. 44, p. 165–185. ISSN 0921-8009.

[10] Etuonovbe, A. K. Sustaining coastal Management/Adaptation of climatic change and sea level rise in the Niger Delta. Paper presented at Integrating Generations FIG Working, Week 2008 Stockholm, Sweden 14-19 June 2008. [Online] Available: http://www.fig.net/pub/fig2008/papers/ts03f/ts03f_06_ etuonovbe_2753.pdf. [Accessed 25 Novebmber 2014].

[11] Ezekiel, A. A., Olawuyi, S. O., Ganiyu, M. O., Ojedokun, I. K., Adeyemo, S. A. Effects of Climate Change on Cassava Productivity in Ilesa – East Local Government Area, Osun State, Nigeria, British Journal of Arts and Social Sciences. 2012, Vol. 10, No. 2. ISSN: 2046-9578.

[12] Mafimisebi, T. E. Determinants and uses of farm income from the cassava enterprise in Ondo State, Nigeria, Journal of Human Ecology, 2008, Vol. 24, No 2, p. 125-130. ISSN 0970-9274.

[13] Mba, P. N., Ogbuagu, R. A. Environmental and socio-economic impact of oil exploration in the Niger Delta region: a case study of Ibeno, Nigeria. Journal of Economics and Sustainable Development. 2012, Vol. 3, No. 9, p. 97-103. ISSN 2222-1700.

[14] Mmom, C. Impact of Poverty and changing Cropping Systems on Agro-crop diversity in the upper Niger Delta, Nigeria. Impact Assessment and Human Well-Being 29th Annual Conference of the International Association for Impact Assessment, 16-22 May 2009, Accra International Conference Center, Accra, Ghana.

[15] Nzeadibe, T. C., Ajaero, C. K. Assessment of socio-economic characteristics and quality of life expectations in rural communities of Enugu State, Nigeria. Applied Research in Quality of Life, 2010, Vol. 5, No. 4, p. 353- 371. ISSN:1871-2584, E-ISSN:1871-2576.

[16] Odoemenem, I. U., Otaanwa, L. B. Economic Analysis of Cassava Production in Benue State, Nigeria, Current Research Journal of Social Sciences. 2011, Vol. 3(5), p. 406-411. ISSN 2041-3246.

[17] Raupach, M. R., Haverd, V., Briggs, P. R. Sensitivities of the Australian terrestrial water and carbon balances to climate change and variability. Agricultural and Forest Meteorology. 2013, p. 227-291. ISSN 0168-1923.

[18] Reed, M. S., Podesta G., Fazey, I., Geeson, N., Hessel, R., Hubacek, K., Letson, D., Nainggolan, D., Prell, C., Rickenbach, M. G., Ritsema, C., Schwilch, G., Stringer, L. C., Thomas, A. D. Combining analytical frameworks to assess livelihood vulnerability to climate change and analyse adaptation options. Ecological Economics. 2013, Vol. 94, p.66-77. ISSN 0921-8009.

[19] Richter, A., Soest, D., Grasman, J. Contagious cooperation, temptation, and ecosystem collapse. Journal of Environmental Economics and Management. 2013, Vol. 66, p. 141-158, ISSN 0095-0696.

[20] Rosser, J. B. Complex ecologic–economic dynamics and environmental policy, Ecological Economics. 2001, Vol. 37, p. 23-37. ISSN 0921-8009.

[21] Sanni, L., Onadipe, O. O., P. Ilona, P., Mussagy, M. D., Abass, A., Dixon, A. G. O. Successes and challenges of cassava enterprises in West Africa: a case study of Nigeria, Bénin, and Sierra Leone. IITA, Ibadan, Nigeria, 2009. p. 19.

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The Law of One Price of Central European Countries – Analysis of Feed Barley

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Anotace

Článek se zabývá platností zákona jedné ceny na mezinárodním trhu krmného ječmene v rámci vybraných středoevropských zemí, jmenovitě České republiky, Německa, Rakouska, Slovenska, Polska a Maďarska. K analýze jsou využity měsíční ceny od června 1995 do prosince 2012. Kointegrace cen je zkoumána pro jednotlivé páry zemí. Platnost zákona jedné ceny je ověřena na základě testování modelu vektorové korekce chyby. Výsledky poukazují na platnost zákona jedné ceny pro většinu zkoumaných zemí. U všech párů s výjimkou Slovenska byla nalezena kointegrace. U kointegrovaných párů byl zákon jedné ceny potvrzen u 8 z 10 párů na 5 % hladině významnosti. Dominantním trhem na zkoumaném mezinárodním trhu je Německo, které jednosměrně určuje ceny ostatních zemí. Rakousko zaujímá pozici druhého dominantního trhu. Země původní Visegrádské čtyřky, konkrétně Česká republika, Polsko a Maďarsko jsou charakteristické vzájemnou provázaností cen.

Klíčová slova

Zákon jedné ceny, ječmen, evropské země, Johansenův test, model vektorové korekce chyby, cenová provázanost.

Abstract

The paper examines the validity of the Law of One Price (LOP) in the international market for feed barley among selected Central European markets, namely the Czech Republic, Germany, Austria, Slovakia, Poland and Hungary. Monthly prices over the period June 1995 to December 2012 are used. Each country pair is tested for cointegration, and the hypothesis of LOP is tested in the Vector Error Correction model. The results show that the LOP holds for the majority of markets. Cointegration was confirmed among all pairs of countries except for pairs with Slovakia. For cointegrated country pairs, the LOP holds for 8 out of 10 pairs at a 5 % level of significance. Germany has a dominant position within the investigated international trade and determines the prices of other countries. Austria is the second most dominant market. Countries of the original Visegrad group, namely the Czech Republic, Poland and Hungary, are characterized by simultaneous price relationships.

Key words

Law of One Price, barley, European countries, Johansen test, Vector Error Correction model, price interdependence.

Introduction

Prices and price policy are significant factors which determine the functioning of the market. The level of prices leads to the allocation of resources and interconnects markets horizontally and vertically. The horizontal point of view is focused on price transmission among spatially separated markets, such as different countries, where the Law of One Price is being analysed. From an international point of view, the Law of One Price (LOP) is an economic law which states that, after adjustment for transaction and transportation costs, an identical good from two countries must have the same price when the prices are expressed in the same currency (Biondo, 2010, Holman, 2011, Vavra and Goodwin, 2005). The identical price of a good in separated markets appears as a result of arbitrage. A trader buys the product in the market with the lower price and sells it in the market with the higher price, and profits from the temporary difference. As a result of this behaviour, the demand for the particular good grows in the cheaper market, and consequently the price increases as well. Conversely, the price in the second market is pushed down, which leads to price convergence until the point where the prices are equal. If prices are not entirely equal, it is a sign of barriers on the international market (Holman, 2007).

Studies focused on Law of One Price analysis can be classified into two main groups. The first group investigates the law in aggregated markets such as different countries. Publications belonging to this group include Vataja (2000), Spreen, Kilmer and Pitta (2007), and Bakucs et al. (2012). The second group analysed the LOP at the desegregated level which includes, for example, the analysis of price relations within one country but in several territorial markets, such as regions or cities. Among publications from this field we can mention authors such as Ahmadi-Esfahani (2006), Syrovátka (2010), Iregui and Otero (2011), and Bubáková (2012).

Ahmadi-Esfahani (2006) showed that the LOP does not hold in most Chinese wholesale food markets. The author analysed food markets in Beijing, Nanjing, Shanghai, and Shenzhen during the period 1993 to 1999 using a cointegration approach. Syrovátka (2010) analysed the price interactions between the Czech and world wheat markets over the period 1995 to 2010. The results of cointegration analysis showed that there is no long-run relationship between Czech and world wheat prices. Following analysis of short-term dynamics suggested that Czech prices are affected from 50 % by world prices and from another 50 % by other factors. Iregui and Otero (2011) examined 54 food products in 13 major Columbian cities. Based on the panel data set, the results show that the LOP is valid for most products, and market integration is more common for cities or markets with similar population and economic size. Bubáková (2012) explored empirically the validity of the LOP among regions of the Czech Republic over the period 2002 to 2008. The study was focused on pork prices. Time series with a two-week data period frequency and a cointegration approach were used. The estimations suggested that the LOP is valid in the investigated regions. Vataja (2000) analysed the LOP of 10 commodity groups in the international market, namely lead, maize, newsprint, rice, rubber, sugar, tin, wheat, wool, and zinc. The LOP was confirmed for 14 cases out of 17 examined bilateral trades. Moreover, the estimations suggested that a full two-thirds of the deviations from the long-run relationship are eliminated within one year. Spreen, Kilmer and Pitta (2007) demonstrated the importance of product homogeneity for LOP testing. As an example, authors discussed the homogeneity issue for fruits and vegetables. These commodities have additional packing costs, such as heavier boxes or chemical treatments, for international markets in comparison with the domestic market. These additional costs are reflected in the final price in the international market and cause price differences in LOP studies. Authors confirmed the existence of this problem by analysing the FOB prices of fresh grapefruits for markets in Florida, Japan, the European Union and Canada. Bakucs et al. (2012) focused on crop markets, analysing the relationships of wheat prices between Germany and Hungary. According to the results, the LOP holds for only 27 % of observations in a five-year period.

Among most recent publications we can mention authors such as Smutka, et. al (2013) or Lajdová and Bielik (2015). Smutka, et. al (2013) analysed the relationships between Czech food prices and prices of global and EU market. Results show that Czech food market reacts sensitively to changes in food prices. The examination was performed over the period 2006-2012. Authors also highlight the rise in food prices over the last decade. Lajdová and Bielik (2015) examined dairy sector and its prices in Slovakia. They analysed cointegration of milk prices, however they focused more on asymmetric reactions among prices and shown an existence of imperfect market structure.

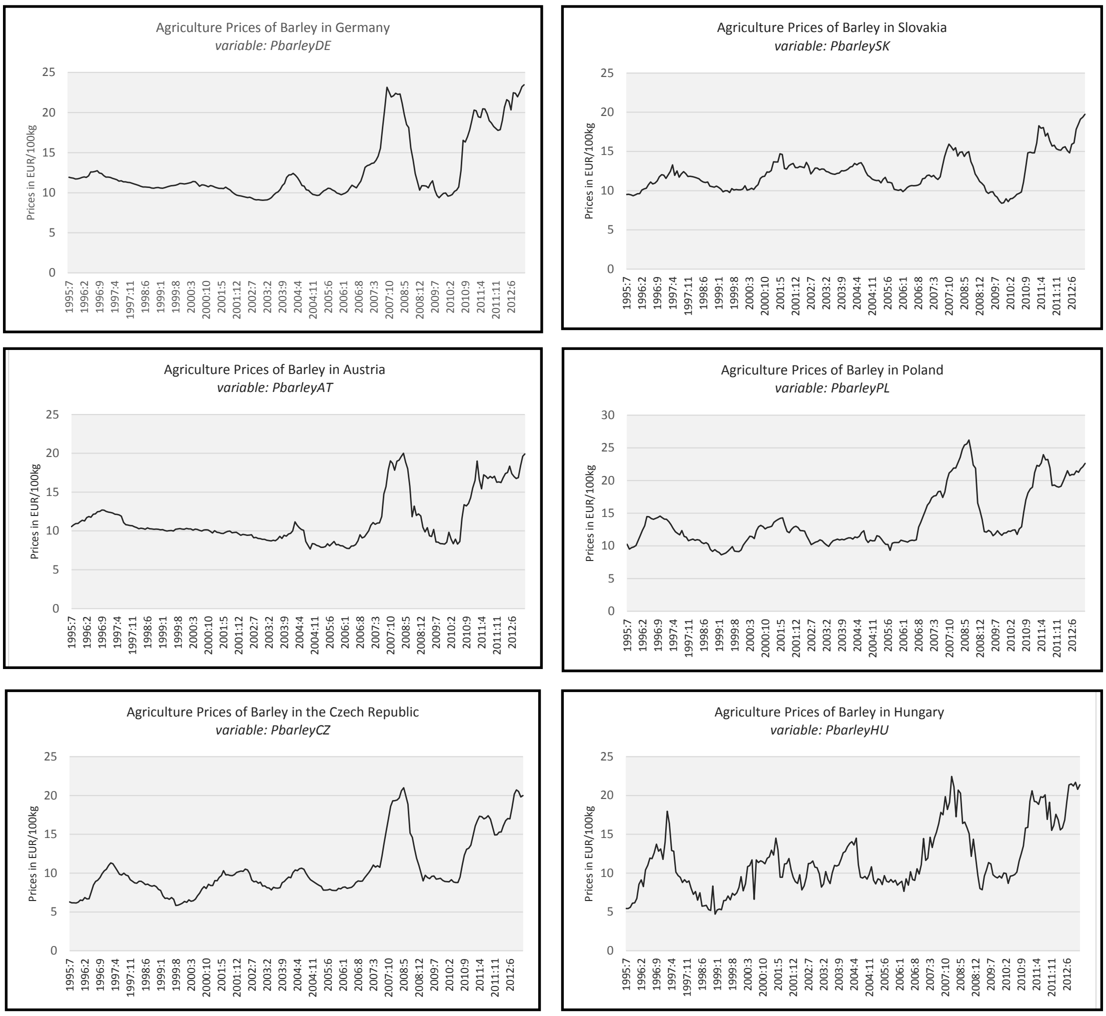
Materials and methods

Time series of the agricultural prices of feed barley (variable Pbarley) were used for analysis. The investigated markets are: the Czech Republic (CZ), Germany (DE), Austria (AT), Slovakia (SK), Poland (PL) and Hungary (HU). Particular markets are labelled by stated shortcuts, e.g. the variable PbarleyDE is the agriculture price of barley in Germany. The time series of prices have a monthly frequency and cover the period from July 1995 to December 2012 (210 observations). Prices are expressed in the same units, namely in EUR/100 kg. The analysis began in July 1995 because of the unavailability of Austrian prices before this date. The data were obtained from the statistical offices of particular countries (see in source of Figure 1). The time series of prices have been seasonally adjusted because of the presence of statistically significant seasonality at a 5 % level of significance. The time series used for analysis can be seen in Figure 1.

Analysis of the LOP is used for each pair of examined countries and contains the following steps.

The first step is to test the non-stationarity of the time series. The order integration, I(d), is determined using the Augmented Dickey-Fuller (ADF) test, from the authors Dickey and Fuller (1979), Phillips-Perron (PP) test (1988) and Kwiatkowski-Philips-Schmidt-Shin (KPSS) test (1992). Specification of a test, i.e. whether to use a constant and trend, is determined based on its statistical significance. The optimal lags of the ADF and PP tests were chosen based on automatic selection of a Schwarz information criterion (1978).

If the time series are not stationary and have the same order of integration, cointegration is evaluated according to the Johansen test (1988 and 1991). The lag for the cointegration test is based on information criteria such as the Schwarz (SIC) (1978), Akaike (AIC) (1974) and Hannan-Quinn (H-Q) (1979) information criterion. Vector Autoregressive (VAR) models with lags determined by these information criteria are estimated. Then, the final lag is determined based on the best results of autocorrelation testing of the VAR model with a particular lag. When the optimal lag has been determined, the cointegration is analysed and Vector Error Correction (VEC) models are estimated. Several specifications of the VEC model are considered. Specifications differ with regard to the presence of constants and trends in the short-run and long-run relationships. Three fundamental specifications are used in the analysis (see in Table 1). Type 1 considers a constant in the long-run relationship, which reflects the value



Source: Český statistický úřad, Štatistický úrad Slovenskej republiky, Glowny Urzad Statystyczny, Statistischer Monatsbericht, BMELV and Statisches Bundesamt, Statistical Database of Statistics Austria, Központi Statisztikai Hivatal

Figure 1: Prices of feed barley in selected countries, units EUR/100 kg; period 1995:07 to 2012:12.

of transaction costs between prices. Type 2 contains a constant in the long-run relationship as well as in short-run relationships. Type 3 has a trend in the long-run relationship which allows for a change in transaction costs over time.

If cointegration exists among several VEC models for one country pair, the best model is chosen according to the LR test. After selection of the best specification of the VEC model, the LOP is evaluated based on hypotheses testing. Consider now just two countries, where one is the exporting country with price Pit and the other is the importing country with price Pjt. In this case, only one cointegration vector can exist and, for example, with respect to the Type 5 VEC model, this vector can be expressed by the equation:

$$\alpha\,[P_{jt} + \mu + \delta\, t + \gamma_1 P_{it}], \tag{1}$$

where α is the error correction factor, t is a deterministic trend with parameter δ, μ is a constant of the cointegration vector, and the parameter γ_1 represents the relationships between prices P_{jt} and P_{it}. The Law of One Price is evaluated based on testing of cointegration vector (1), namely:

$$\begin{aligned} H_0 &: \gamma_1 = -1 \\ H_1 &: \gamma_1 \neq -1 \end{aligned} . \tag{2}$$

If the parameter γ_1 is equal to -1 in the cointegration vector, the Law of One Price is confirmed and the long-run relationship can be expressed by:

$$\alpha\,[P_{jt} + \mu + \delta\, t - 1P_{it}]. \tag{3}$$

Cointegration vector (3) can be rewritten as a relationship:

$$P_{jt} = -\mu - \delta\, t + 1P_{it}, \tag{4}$$

which expresses the exact dependency of price in the importing country on price in the exporting country and, of course, dependency on transaction costs expressed by the estimated part ($-\mu$ - δt).

The LR test is used to verify hypotheses (2). The type of cointegration vector (i.e. whether the vector contains a constant and trend) is determined in the previous step.

For the analysis and estimates, EViews, version 4, was used.

Results and discussion

First of all, the order of integration for a particular time series must be determined. Three test were performed, namely the ADF, PP and KPSS tests. The results of integration order testing are shown in Table 2. Test statistics are evaluated at a 5 % level of significance.

According to the performed tests, the time series are non-stationary and integrated of the order I(1) for barley prices in the Czech Republic, Slovakia, Poland, Austria and Hungary at a 5 % level of significance. The KPSS test suggests an order of integration equal to I(2) only in the case of German prices. However, based on other tests such as ADF and PP we can conclude that the time series is I(1), like the prices of other countries.

Since the time series of prices are non-stationary and integrated of the same order, we can test the cointegration. The long-run relationship is analysed between each pair of countries. As a first step, an adequate number of lags was selected. For the number of lags used in the cointegration test, see Appendix A1. A summarization of the cointegration test results is shown in Tables 3, 4 and 5. Table 3 contains the results of pairs for which cointegration was confirmed in just

VEC model type	Long-run relationship		Short-run relationship		VEC model specification
	constant	trend	constant	trend	
Type 1	YES	NO	NO	NO	$\Delta Y_t = \alpha \cdot [BY_{t-1} + \mu] + \sum_{s=1}^{S} \Gamma_s \Delta Y_{t-s} + u_t$
Type 2	YES	NO	YES	NO	$\Delta Y_t = \alpha \cdot [BY_{t-1} + \mu] + c + \sum_{s=1}^{S} \Gamma_s \Delta Y_{t-s} + u_t$
Type 3	YES	YES	YES	NO	$\Delta Y_t = \alpha \cdot [BY_{t-1} + \mu + \delta \cdot t] + c + \sum_{s=1}^{S} \Gamma_s \Delta Y_{t-s} + u_t$

Source: own elaboration based on Charemza and Deadman (1997)

Table 1: Specifications of VEC models for cointegration testing.

TEST	Data	Type 1)	Test. stat.	Critical value	P-value	Reject H_0	Conclus.
	PbarleyCZ						
ADF	Original	C	-3.14	-3.432	0.0999	NO	**I(1)**
	Diferences	A	-7.437	-1.942	0.0000	YES	
PP	Original	B	-1.52	-2.875	0.5168	NO	**I(1)**
	Diferences	A	-7.385	-1.942	0.0000	YES	
KPSS	Original	C	4.007	0.146	x	YES	**I(1)**
	Diferences	B	0.372	0.463	x	NO	
	PbarleySK						
ADF	Original	B	-1.049	-3.432	0.7355	NO	**I(1)**
	Diferences	A	-11.002	-1.942	0.0000	YES	
PP	Original	B	-1.376	-2.875	0.5935	NO	**I(1)**
	Diferences	A	-11.239	-1.942	0.0000	YES	
KPSS	Original	C	6.904	0.146	x	YES	**I(1)**
	Diferences	B	0.254	0.463	x	NO	
	PbarleyPL						
ADF	Original	C	-3.419	-3.432	0.0517	NO	**I(1)**
	Diferences	A	-6.456	-1.942	0.0000	YES	
PP	Original	B	-1.682	-2.8752	0.4387	NO	**I(1)**
	Diferences	A	-9.932	-1.942	0.0000	YES	
KPSS	Original	C	4.051	0.146	x	YES	**I(1)**
	Diferences	B	0.276	0.463	x	NO	

TEST	Data	Type 1)	Test. stat.	Critical value	P-value	Reject H0	Conclus.
	PbarleyDE						
ADF	Original	C	-2.144	-3.432	0.5181	NO	**I(1)**
	Diferences	A	-8.146	-1.942	0.0000	YES	
PP	Original	C	-2.164	-3.432	0.5068	NO	**I(1)**
	Diferences	A	-8.427	-1.942	0.0000	YES	
KPSS	Original	C	13.385	0.146	x	YES	**I(2)**
	Diferences	B	0.554	0.463	x	YES	
	PbarleyAT						
ADF	Original	C	-1.623	-3.432	0.7807	NO	**I(1)**
	Diferences	A	-11.942	-1.942	0.0000	YES	
PP	Original	C	-1.732	-3.431	0.7337	NO	**I(1)**
	Diferences	A	-12.051	-1.942	0.0000	YES	
KPSS	Original	C	22.564	0.146	x	YES	**I(1)**
	Diferences	B	0.247	0.463	x	NO	
	PbarleyHU						
ADF	Original	C	-3.0467	-3.432	0.1222	NO	**I(1)**
	Diferences	A	-17.009	-1.942	0.0000	YES	
PP	Original	C	-3.115	-3.432	0.1055	NO	**I(1)**
	Diferences	A	-16.952	-1.942	0.0000	YES	
KPSS	Original	C	3.643	0.146	x	YES	**I(1)**
	Diferences	B	0.043	0.463	x	NO	

Note: CZ = Czech Republic, SK = Slovakia, PL = Poland, DE = Germany, AT = Austria, HU = Hungary
ADF test, PP test: H0: non-stationarity, KPSS test: H0: stationarity

1) Type A, B and C refer the specification of the test, i.e. Type A: model without constant and trend, Type B: model with the constant, Type C: model with constant and trend

Source: own calculations, EViews, ver. 7

Table 2: Results of the ADF, PP and KPSS unit root tests.

Country pair	**CZ, PL**		**CZ, DE**		**CZ, AT**		**PL, AT**	
Number of cointeg. vectors:	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value
None	26.107	0.007	22.924	0.021	26.948	0.037	29.565	0.017
At most 1	7.959	0.084	4.597	0.331	7.315	0.313	12.507	0.0502
Result	1 cointegration vector		1 cointegration vector		1 cointegration vector		1 cointegration vector	
Model specification	Type 1		Type 1		Type 3		Type 3	

Note: evaluation at a 5 % level of significance
Source: own calculations, EViews 7

Table 3: Results of the Johansen cointegration test; cointegration confirmed for one model specification.

one specification of the VEC model. Table 4 shows the pairs for which more specifications of the VEC model led to a cointegrated vector. Finally, Table 5 reflects countries for which cointegration was not found with any model specification. Tables 3 and 4 show the final results; however, all types of the VEC model have been tested, and overall results for these countries are attached in Appendix A2.

Cointegration was confirmed among all pairs of countries except for pairs with Slovakia. In the case of Slovakian prices, the Trace statistic leads to the null order of the matrix Π for each pair, and thus modelling of these relationships would be a spurious regression.

The VEC model with a constant in the long-run relationship (i.e. Type 1) will be used for the country pairs Czech Republic-Poland and Czech Republic-Germany. The price relationship between pairs Czech Republic-Austria and Poland-Austria will be examined based on the model with a constant and trend in the long-run relationship and a constant in the short-run relationship (Type 3). Testing of the cointegration of prices for other pairs of countries also led to confirmation of a long-run relationship; however, more types of VEC model are suitable for modelling (see in Table 5). One specification of the VEC model should be used for final LOP testing. The decision concerning which type of VEC model is best is based on the LR

Country pair	CZ, HU				PL, DE			
Number of cointeg. vectors:	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value
None	26.122	0.007	32.141	0.007	29.348	0.002	36.078	0.002
At most 1	6.531	0.154	12.323	0.054	4.591	0.331	10.306	0.114
Result	1 cointeg. vector		1 cointeg. vector		1 cointeg. vector		1 cointeg. vector	
Model specification	Type 1		Type 3		Type 1		Type 3	
Country pair	**PL, HU**				**DE, HU**			
Number of cointeg. vectors:	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value
None	25.248	0.009	31.261	0.01	20.623	0.045	26.508	0.042
At most 1	6.296	0.169	11.83	0.065	5.127	0.270	10.949	0.090
Result	1 cointeg. vector		1 cointeg. vector		1 cointeg. vector		1 cointeg. vector	
Model specification	Type 1		Type 3		Type 1		Type 3	
Country pair	**DE, AT**							
Number of cointeg. vectors:	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value		
None	31.914	0.001	31.384	0.000	47.489	0.000		
At most 1	3.208	0.543	2.792	0.095	6.679	0.379		
Result	1 cointeg. vector		1 cointeg. vector		1 cointeg. vector			
Model specification	Type 1		Type 2		Type 3			
Country pair	**AT, HU**							
Number of cointeg. vectors:	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value		
None	21.275	0.036	20.397	0.008	26.158	0.046		
At most 1	1.67	0.842	0.875	0.349	3.7	0.785		
Result	1 cointeg. vector		1 cointeg. vector		1 cointeg. vector			
Model specification	Type 1		Type 2		Type 3			

Note: evaluation at a 5 % level of significance
Source: own calculations, EViews 7

Table 4: Results of the Johansen cointegration test; cointegration confirmed for more model specifications.

test. The LR test compares whether the restricted version with a smaller number of parameters is better than the unrestricted wider version. The results of LR tests and selection of a final model for LOP testing is shown in Table 6. The procedure starts with the most general version of the VEC model and continues to the more specific versions, until the best model is found.

As we can see in Table 6, model of Type 3 with constants and trend will be used only for pair Germany-Austria. Type 3 is also used for pairs Poland-Austria and Czech Republic-Austria as was stated in Table 4. For other pairs, the most suitable model is specification with only the constant in the long-run relationship. Adequate specification of models are used to test the hypothesis of the LOP. The results of LR tests for this part are placed in Table 7. The LOP is evaluated at a 5 % and 1 % level of significance.

The LOP holds for the majority of country pairs. The LOP was rejected only between the Czech Republic and Austria and between Germany and Austria, at a 5 % level of significance. However, if we consider a 1 % level of significance, i.e. we need more evidence to reject the validity of the LOP, the null hypothesis cannot be rejected and the LOP is valid. The results suggest that the market for feed barley is highly integrated. Only in two cases of country pairs, the prices are not exactly equal over the long term, but are very close to each other.

The estimation of the VEC model was used not just for LOP hypothesis testing but also for evaluation of the price direction between countries, i.e. the power of markets. We can use the error correction factor α and test whether this parameter is statistically significant in particular equations. If error correction factor α is

Country pair	CZ, SK						SK, PL					
Number of cointeg. vectors:	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value
None	10.377	0.603	9.499	0.321	15.072	0.569	12.552	0.401	11.699	0.172	17.82	0.356
At most 1	3.253	0.535	2.374	0.123	5.35	0.547	4.259	0.375	3.406	0.065	4.087	0.730
Result	0 cointeg. vector		0 cointeg. vector		0 cointeg. vector		0 cointeg. vector		0 cointeg. vector		0 cointeg. vector	
Model specification	Type 1		Type 2		Type 3		Type 1		Type 2		Type 3	
Country pair	SK, DE						SK, AT					
Number of cointeg. vectors:	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value
None	11.338	0.510	10.533	0.242	16.884	0.424	10.009	0.639	9.155	0.351	13.804	0.674
At most 1	4.123	0.394	3.875	0.049	6.403	0.411	3.856	0.434	3.623	0.057	5.531	0.522
Result	0 cointeg. vector		0 cointeg. vector		0 cointeg. vector		0 cointeg. vector		0 cointeg. vector		0 cointeg. vector	
Model specification	Type 1		Type 2		Type 3		Type 1		Type 2		Type 3	
Country pair	**SK, HU**											
Number of cointeg. vectors:	Trace stat.	P-value	Trace stat.	P-value	Trace stat.	P-value						
None	13.934	0.294	13.157	0.109	18.157	0.334						
At most 1	4.685	0.32	3.909	0.048	5.686	0.501						
Result	0 cointeg. vector		0 cointeg. vector		0 cointeg. vector							
Model specification	Type 1		Type 2		Type 3							

Note: evaluation at a 5 % level of significance
Source: own calculations, EViews 7

Table 5: Results of the Johansen cointegration test; cointegration not confirmed.

Country Pair	Types of VEC model	Log-lik. unres. ver.	Log-lik. restr. ver.	LR stat	(p)	Critical val. χ^2 $\alpha = 0.05$	Evaluation	Conclusion
CZ, HU	Type. 3 vs. Type 1	-475.964	-476.378	**0.8268**	3	7.81473	**Not reject H_0**	**Type 1**
PL, DE	Type. 3 vs. Type 1	-337.681	-338.406	**1.45**	3	7.81473	**Not reject H_0**	**Type 1**
PL, HU	Type. 3 vs. Type 1	-555.074	-555.568	**0.9864**	3	7.81473	**Not reject H_0**	**Type 1**
DE, AT	Type. 3 vs. Type 2	-330.297	-336.405	**12.2172**	1	3.84146	**Reject H_0**	**Type 3**
DE, HU	var. 4 vs. var. 2	-507.002	-507.319	**0.6342**	3	7.81473	**Not reject H_0**	**Type 1**
AT, HU	Type. 3 vs. Type 2	-572.909	-574.378	**2.9374**	1	3.84146	**Not reject H_0**	**Type 2**
	Type 2 vs. Type 1	-574.378	-574.775	**0.7944**	2	5.99146	**Not reject H_0**	**Type 1**

Note: For pair DE and AT, the comparison between Type 2 and 1 was not consider, because wider specification was determined as the most suitable
Source: own calculations, EViews 7

Table 6: Selection of the final model for LOP testing for countries in Table 4.

statistically significant, for example in the equation $\Delta PbarleyCZ_t = \alpha\ (PbarleyCZ_{t-1} - 1PbarleyDE_{t-1} + 1.99)$, then the long-run relationship affects prices in the Czech Republic, and thus the Czech market is influenced by German prices. The particular α is referred to as $\alpha_{PbarleyCZ}$, because it belongs to the equation of Czech prices. Then, we evaluate the statistical significance of the second equation of the particular VEC model. In this example it is $\Delta PbarleyDE_t = \alpha_{PbarleyDE}\ (PbarleyCZ_{t-1} - 1PbarleyDE_{t-1} + 1.99)$. If the $\alpha_{PbarleyDE}$ is statistically significant, then prices in Germany are affected by the long-run relationship and thus both markets are simultaneously dependent. However, if the $\alpha_{PbarleyDE}$ is not statistically significant, the effect of the long-run relationship is zero and German barley prices are unaffected by Czech prices over the long term. In such a case the German market is exogenous and is unaffected by Czech prices, i.e. only a one-sided effect exists, namely Germany is the dominant market which determines the price level. The estimated long-run relationships of the VEC model and αtesting are summarized in Tables 8 and 9. Table 8 contains country pairs for which the LOP was confirmed; Table 9 shows results for country pairs for which the LOP was rejected at a 5 % level of significance. The one-sided and simultaneous

Country Pair	Log-lik. unres. ver.	Log-lik. restr. ver.	LR stat	Evaluation 1)	Conclusion
CZ, PL	-288.706	-290.538	**3.664**	No reject H_0	**LOP valid**
CZ, DE	-266.39	-266.458	**0.1364**	No reject H_0	**LOP valid**
CZ, AT	-292.365	-295.171	**5.6116**	Reject H_0 at 5 %	**LOP rejected**
				No reject H_0 at 1 %	**LOP valid**
CZ, HU	-476.378	-476.394	**0.0328**	No reject H_0	**LOP valid**
PL, DE	-338.406	-339.515	**2.2168**	No reject H_0	**LOP valid**
PL, AT	-368.051	-368.418	**0.7346**	No reject H_0	**LOP valid**
PL, HU	-555.568	-555.786	**0.4368**	No reject H_0	**LOP valid**
DE, AT	-330.297	-332.408	**4.2220**	Reject H_0 at 5 %	**LOP rejected**
				No reject H_0 at 1 %	**LOP valid**
DE, HU	-507.319	-507.513	**0.389**	No reject H_0	**LOP valid**
AT, HU	-574.775	-575.296	**1.0422**	No reject H_0	**LOP valid**

Note: For pair DE and AT, the comparison between Type 2 and 1 was not consider, because wider specification was determined as the most suitable
Source: own calculations, EViews 7

Table 7: Results of the Law of One Price testing for country pairs.

effects are already distinguished in the tables.

As we can see, simultaneous effects appear in the case of the Czech market with the Polish, Hungarian and Austrian markets and also between Poland and Hungary. Other country pairs have a dominant market, i.e. in general, country A affects prices of country B, however country B is not able to affect prices in country A. The dominant markets from these pairs are Germany and Austria.

The constant in the long-run relationship captured the effect of transaction costs. Table 9 shows the results of unrestricted versions of the VEC models, which are better than restricted versions. The estimated parameters of prices show the final effect of price changes. In particular, in the case of German and Austrian prices, an increase in feed barley prices in Germany by 1 EUR/100kg leads to an increase in prices in Austria by 0.906 EUR/100 kg. The estimated parameter is very close to the number one. In the case of Austrian and Czech prices, an increase in the Czech prices of feed barley by 1 EUR/100kg leads to an increase in Austrian prices by 1.41 EUR/100kg. Simultaneously, an increase in Austrian prices by 1 EUR/100 kg will lead to an increase in Czech prices by 0.71 EUR/100kg. The overall summarization of LOP testing and VEC model estimations corresponds with Figure 2. In Figure 2, a full black arrow represents relationships among countries in which LOP was confirmed. A dashed grey arrow indicates a situation where cointegration was detected, but the LOP was not confirmed at a 5 % level of significance. If a country pair has both black and grey arrows, the results of LOP testing depend on the level of significance. This level is mentioned next to these arrows. Finally, the arrows also show the direction of the relationships, i.e. a one-sided effect is represented by a simple one-headed arrow (→) and a simultaneous relationship is displayed as a double-headed arrow (↔).

As we can see in Figure 2, the LOP was confirmed for eight country pairs from ten cointegrated pairs at a 5 % level of significance. If we consider a 1 % level of significance, we can detect a confirmation of the LOP for ten out of ten cointegrated country pairs. For these cases, six one-sided relationships were detected. Specifically, it was found that German feed barley prices affect prices in the Czech Republic, Poland, Austria and Hungary. These markets do not have the power to influence the price of barley in Germany, i.e. Germany is the dominant market. The second most dominant market is Austria, because it has the power to influence prices in Hungary and Poland and not be influenced by these markets. A simultaneous price relationship for Austria was found only in the case of trade with the Czech Republic. Moreover, the Austrian LOP was not confirmed, twice, at a 5 % level of significance. These facts support the idea that Austria is partially independent of price changes in Germany or other countries.

Countries of the original Visegrad Group (except Slovakia) have simultaneous relationships for barley prices. Therefore, Czech, Polish and Hungarian markets are closely connected to each other, and changes in one market are reflected in the others. These linkages could be

Country Pair	Long-run estimated relationship	Error correction coefficient α
One-side price effect among country pairs		
CZ, DE	$PbarleyCZ_{t-1} = -1.9998 + PbarleyDE_{t-1}$	$\alpha_{dPbarleyCZ} = -0.0884$ [−4.2658] $\alpha_{dPbarleyDE} = -0.0254$ [−0.9055]
PL, DE	$PbarleyPL_{t-1} = 1.2542 + PbarleyDE_{t-1}$	$\alpha_{dPbarleyPL} = -0.1239$ [−4.6129] $\alpha_{dPbarleyDE} = 0.0073$ [−0.2865]
PL, AT	$PbarleyPL_{t-1} = 0.2148 + 0.0221t + PbarleyAT_{t-1}$	$\alpha_{dPbarleyPL} = -0.1297$ [−3.7811] $\alpha_{dPbarleyAT} = 0.0286$ [0.6948]
AT, HU	$PbarleyHU_{t-1} = 0.4369 + PbarleyAT_{t-1}$	$\alpha_{dPbarleyHU} = -0.1561$ [−3.5927] $\alpha_{dPbarleyAT} = 0.0338$ [1.5614]
DE, HU	$PbarleyHU_{t-1} = -0.8955 + PbarleyDE_{t-1}$	$\alpha_{dPbarleyHU} = -0.1926$ [−3.7330] $\alpha_{dPbarleyDE} = 0.0165$ [0.7458]
Simultaneous price effect among country pairs		
CZ, PL	$PbarleyPL_{t-1} = 3.2325 + PbarleyCZ_{t-1}$	$\alpha_{dPbarleyPL} = -0.0664$ [−2.2218] $\alpha_{dPbarleyCZ} = 0.0415$ [1.8940][1)]
CZ, HU	$PbarleyHU_{t-1} = 1.0483 + PbarleyCZ_{t-1}$	$\alpha_{dPbarleyHU} = -0.1504$ [−2.3947] $\alpha_{dPbarleyCZ} = 0.0580$ [2.8291]
PL, HU	$PbarleyPL_{t-1} = 2.1944 + PbarleyHU_{t-1}$	$\alpha_{dPbarleyPL} = -0.0765$ [−2.9281] $\alpha_{dPbarleyHU} = 0.1524$ [2.7195]

Note: LOP evaluated at a 5 % level of significance, [ ] refers t-ratio
1) simultaneous relationship at a 10 % level of significance
Source: own calculations, EViews 7

Table 8: Estimated long-run relationships for country pairs with confirmed LOP, restricted VEC models.

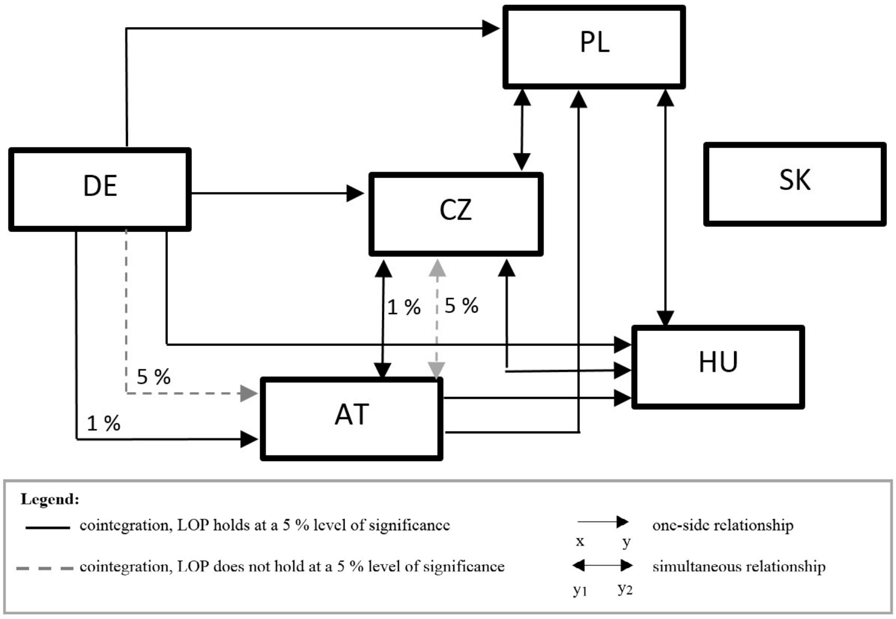
Country Pair	Long-run estimated relationship	Error correction factor α
On-side of price effect among country pairs		
DE, AT	$PbarleyAT_{t-1} = 0.8081 - 0.0098t + 0.9060\,PbarleyDE_{t-1}$ [t-stat] [25.4070]	$\alpha_{dPbarleyAT} = -0.3286$ [−5.8410] $\alpha_{dPbarleyDE} = -0.0177$ [−0.3423]
Simultaneous price effect among country pairs		
CZ, AT	$PbarleyAT_{t-1} = 0.3348 - 0.0358t + 1.4145PbarleyCZ_{t-1}$ [t-stat] [9.8146]	$\alpha_{dPbarleyAT} = 0.0864$ [2.8941] $\alpha_{dPbarleyCZ} = 0.0806$ [4.2535]

Note: LOP evaluated at a 5 % level of significance, [ ] refers t-ratio; in both cases, LOP was rejected at a 5 % level of significance, however at a 1 % level we cannot reject LOP
Source: own calculations, EViews 7

Table 9: Estimated long-run relationships for country pairs with unconfirmed LOP at a 5 % level of significance, unrestricted VEC models.

due to long-term cooperation since 1991, as well as the fact that those countries participated in the Central European Free Trade Agreement (CEFTA) before entrance to the EU.

However, it was not confirmed that Slovakia has any price relationship with the analysed countries. The performed tests did not show any cointegration with the others. There are three possible reasons for this situation. The first reason could be that the Slovakian market does not react to prices changes in other countries for this particular commodity. This explanation is not very plausible because trade among the analysed countries is a common practise. Slovakia is also a member of regional agreements that have been made. Specifically, Slovakia is



Source: Tables 7, 8 and 9

Figure 2: Price relationships among selected Central European countries, prices of barley.

currently a member of the EU along with the other investigated countries, and before entrance to the EU in 2004, the country was a member of CEFTA together with the Czech Republic, Poland and Hungary. The second reason, which is more likely to be true, is that the relationship between prices is non-linear. The VEC model analysed linear relationships and thus cointegration can be rejected despite the fact that there is some. The suggested next step in the analysis is to analyse price relations based on non-linear models, such as the Threshold autoregression model or the Threshold cointegration model. The last reason for obtaining this result of no cointegration is related to the representativeness of the Slovakian data set. There is a risk of an error occurring during the collection of data or their later publication. In conclusion, based on the performed analysis, we cannot prove the LOP or a long-run relationship of the analysed countries with Slovakia. However, we cannot reject any connections among prices, because deeper analysis must be done.

In connection with the discussion of other author's results, it is difficult to find relevant publications. The LOP of barley is not analysed frequently. The analyses of barley LOP are often out of date, such as Rogoff, Froot and Kim (2001) who analysed barley prices until the beginning of the 90s. One recent paper was found from authors Goychuk and Mayers (2013). These authors confirmed cointegration of barley prices not just between European countries, but also among markets such as: Australia-Ukraine, Ukraine-France, Australia-Canada and Australia-France over the period 2004-2010. The LOP was confirmed for majority of country pairs. Thus the results of this paper are consistent with mentioned publication.

Conclusion

The Law of One Price for barley prices was confirmed in the majority of cases. The results of cointegration tests and VEC models show that prices of feed barley are equal over the long term among country pairs such as Czech Republic-Poland, Czech Republic-Germany, Czech Republic-Hungary, Poland-Germany, Poland-Austria, Poland-Hungary, Germany-Hungary and Austria-Hungary at 5 % and 1 % levels of significance.

The LOP does not hold between the pairs Czech Republic-Austria and Germany-Austria at a 5 % level of significance. However, the hypothesis was not rejected at a 1 % level of significance. The prices for these country pairs have a long-term relationship. The prices are not exactly equal to each other, but they do not differ too much.

Slovakia is the only market where prices seem to be separated from other markets. The Johansen tests did not show any cointegration with other analysed countries. There are three possible reasons for this situation – no actual long-run relationship, the existence of non-linear relationships, or a problem with the representativeness of the data. In general, it is not possible to confirm cointegration or LOP for Slovakian prices, but a connection among prices should not be strictly rejected. Detailed research is needed first.

Transaction costs are constant for the majority of countries. A trend behaviour for transaction costs was detected among the country pairs Austria-Poland, Austria-Czech Republic and Austria-Germany. Based on the results, we can assume that the trending costs are a feature of the Austrian market. The transaction costs of Austrian exports into Germany, the Czech Republic and Poland are increasing over time.

Evaluation of the existence of simultaneous effects suggests the following. Germany is the most dominant market, because that market influences the feed barley prices of all other countries (except Slovakia, which is not cointegrated with anything). The second most dominant market is Austria, which is also able to influence prices in Poland and Hungary. If we compare results for the two main groups of countries, namely the Visegrad group, containing the Czech Republic, Poland and Hungary, and the group of Germany and Austria, who participated in the EU much sooner than the Visegrad group, the differences are clear. Germany and Austria behave as dominant markets which influence the Visegrad group. The Visegrad group is characterized by simultaneous price relationships. The power of Germany and subsequently Austria is not just due to their earlier entrance into the EU, but rather to their economically strong position.

The frequent confirmation of the LOP shows that the market for feed barley does not suffer from barriers to international trade, and that the international market of Central European countries behaves as a free market.

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References

[1] Ahmadi-Esfahani, F. Z. Testing the law of one price in the Chinese wholesale food markets. Agribusiness. 2006, Vol. 22, No.. 4, p. 569-589. ISSN 1520-6297.

[2] Akaike, H. A new look at the statistical model identification. IEEE Transactions on Automatic Control. 1974, Vol.19, No. 6, p. 716-723. ISSN 0018-9286.

[3] Bakucs, L. Z., Brummer, B., von Cramon-Taubadel, S., Imre, F. Wheat market integration between Hungary and Germany. Applied Economics Letters. 2012, Vol. 19, No. 8, p. 785-788. ISSN 1350-4851.

[4] Bubáková, P. Agricultural Prices of Pork at the Regional Level and the Law of One Price. Acta Oeconomica Pragensia. 2012, Vol.1, p. 39-51. ISSN 0572-3043.

[5] Biondo, A. E. The law of one price: survey of a failure. Theoretical and Practical Research in Economic Fields (TPREF). 2010, Vol. I, No. 2(2), p. 167-181. ISSN 2068-7710.

[6] Dickey, D., Fuller, W. Distribution of the Estimators for Autoregressive Time Series With a Unit Root. Journal of the American Statistical Association. Part 1. 1979, Vol. 74, No. 366, p. 427-431. ISSN 0162-1459.

[7] Goychuk, K., Meyers, W. H. Short-and long-run relationships between Ukrainian barley and world feed grain export prices. In 2013 Annual Meeting, February 2-5, 2013, Orlando, Florida (No. 143085). 2013. Southern Agricultural Economics Association.

[8] Hannan, E. J., Quin, G. G. The determination of the order of an autoregression. J.R. Statistic. Soc. Series. 1979, Vol.41, p. 190-195. ISSN 1467-9868.

[9] Holman, R. Mikroekonomie: středně pokročilý kurz. 2. ed. Prague: C. H. Beck. 2007. ISBN 978-80-7179-862-0.

[10] Holman, R. Ekonomie. 5. ed. Prague: C. H. Beck. 2011. ISBN 978-80-7400-006-5.

[11] Charemza W. W., Deadman D. F. New Directions in Econometric Practice: General to Specific Modelling, Cointegration, and Vector Autoregression. 2nd ed. Lyme: Edward Elgar. 1997, 344 p. ISBN 1-85898-603-6.

[12] Iregui, A. M., Otero, J. Testing the law of one price in food markets: evidence for Colombia using disaggregated data. Empirical Economics. 2011, Vol. 40, No. 2, p. 269-284. ISSN 0377-7332.

[13] Johansen, S. Statistical Analysis of Cointegration Vectors, Journal of Economic Dynamics and Control. 1988, Vol.12, p. 231-254. ISSN 0165-1889.

[14] Johansen, S. Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models, Econometrica. 1991, Vol. 59, p. 1551-80. ISSN 1468-0262.

[15] Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., Shin, Y. Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root. Journal of Econometrics. 1992, Vol. 54, No. 1-3, p. 159-178. ISSN 0304-4076.

[16] Lajdová, Z., Bielik P. The evidence of asymmetric price adjustments. Agriculture Economics. 2015, Vol. 61, No. 3, p. 105-115. ISSN 0139-570X.

[17] Phillips, P. C. B., Perron, P. Testing for a Unit Root in Time Series Regression. Biometrika. 1988, Vol. 75, p. 335-346. ISSN 0006-3444.

[18] Rogoff, K., Froot, K., Kim, M. The law of one price over 700 years. 2001. Working paper No. 174. International Monetary Fund. 42 s.

[19] Spreen, T. H., Kilmer, R. L., Pitta, C. R. Nonhomogeneous products and the law of one price. Agribusiness. 2007, Vol. 23, No. 3, p. 407-420. ISSN 1520-6297.

[20] Schwarz, G. Estimating the dimension of a model. Annals of Statistics. 1978, Vol. 6, No. 2, p. 461-464. ISSN 0090-5364.

[21] Smutka, L., Steininger, M., Maitah, M., Rosochatecká, E., Belova, A., Nassir, S. Retail food prices in the Czech Republic – the influence of selected factors. Acta univ. agric. et sil-vic. Mendel. Brun. 2013, Vol. LXI, No. 2, p. 481–492. ISSN 1211-8516.

[22] Syrovátka, P. Analysis of price interactions between Czech and world wheat markets. Acta univ. agric. et sil-vic. Mendel. Brun. 2010, Vol. LVIII, No. 6, p. 533–542. ISSN 1211-8516.

[23] Vataja, J. Should the Law of One Price Be Pushed Away? Evidence from International Commodity Markets. Open Economies Review. 2000, Vol. 11, No. 4, p. 399-415. ISSN 0923-7992.

[24] Vavra, P., Goodwin, B. K. Analysis of Price Transmission Along the Food Chain. OECD Food, Agriculture and Fisheries Working Papers, No. 3, OECD Publishing. 2005. ISSN 1815-6797.

Appendix

Country Pair	Final Lag*	Information criterion derming particular lag	Country Pair	Final Lag*	Information criterion derming particular lag	Country Pair	Final Lag*	Information criterion derming particular lag
CZ, SK	2	SIC, AIC, H-Q	SK, PL	4	SIC, H-Q	PL, AT	8	AIC
CZ, PL	6	AIC	SK, DE	3	AIC	PL, HU	4	AIC
CZ, DE	3	H-Q	SK, AT	5	AIC	DE, AT	2	AIC
CZ, AT	5	H-Q	SK, HU	4	AIC	DE, HU	5	AIC
CZ, HU	3	AIC, H-Q	PL, DE	5	H-Q	AT, HU	2	AIC, H-Q

Note: *lag with best results of autocorrelation testing
Shortcuts: AT = Austria, CZ = Czech Republic, DE = Germany, HU = Hungary, PL = Poland, SK = Slovakia

Source: own calculations, EViews 7

Figure A1: Determination of lag for Johansen test, information criteria and testing of autocorrelation of VAR model .

Specification of the model:	Type 1			Type 2			Type 3		
CZ, PL									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	26.107	0.007	**1 cointeg. vector**	25.652	0.001	**2 cointeg. vectors**	37.71	0.001	**2 cointeg. vectors**
At most 1	7.959	0.084		7.871	0.005		13.848	0.03	
CZ, DE									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	22.924	0.021	1 cointeg. vector	22.312	0.004	**2 cointeg. vectors**	35.463	0.002	**2 cointeg. vectors**
At most 1	4.597	0.331		4.396	0.036		13.212	0.038	
CZ, AT									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	13.722	0.309	**0 cointeg. vectors**	12.914	0.118	**0 cointeg. vectors**	26.948	0.037	**1 cointeg. vector**
At most 1	4.501	0.343		4.274	0.039		7.315	0.313	
CZ, HU									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	26.122	0.007	**1 cointeg. vector**	25.522	0.001	**2 cointeg. vectors**	32.141	0.007	**1 cointeg. vector**
At most 1	6.531	0.154		5.941	0.015		12.323	0.054	
PL, DE									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	29.348	0.002	**1 cointeg. vector**	28.912	0.000	**2 cointeg. vectors**	36.078	0.002	**1 cointeg. vector**
At most 1	4.591	0.331		4.155	0.042		10.306	0.114	
PL, AT									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	19.764	0.058	**0 cointeg. vector**	19.357	0.012	**2 cointeg. vector**	29.565	0.017	**1 cointeg. vector**
At most 1	7.002	0.126		6.782	0.009		12.507	0.050	
PL, HU									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	25.248	0.009	**1 cointeg. vector**	24.740	0.002	**2 cointeg. vectors**	31.261	0.010	**1 cointeg. vector**
At most 1	6.296	0.169		5.853	0.016		11.830	0.065	
DE, AT									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	31.914	0.001	**1 cointeg. vector**	31.384	0.000	**1 cointeg. vector**	47.489	0.000	**1 cointeg. vector**
At most 1	3.208	0.543		2.792	0.095		6.679	0.379	
DE, HU									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	20.623	0.045	**1 cointeg. vector**	20.052	0.010	**2 cointeg. vector**	26.508	0.042	**1 cointeg. vector**
At most 1	5.127	0.270		4.731	0.030		10.949	0.090	
AT, HU									
H_0: Num. of coint. vectors	Trace stat.	P-value	Result	Trace stat.	P-value	Result	Trace stat.	P-value	Result
None	21.275	0.036	**1 cointeg. vector**	20.397	0.008	**1 cointeg. vector**	26.158	0.046	**1 cointeg. vector**
At most 1	1.670	0.842		0.875	0.349		3.700	0.785	

Note: Evaluation at a 5 % level of significance. Results for Slovakia were shown in Table 5;
Shortcuts: AT = Austria, CZ = Czech Republic, DE = Germany, HU = Hungary, PL = Poland, SK = Slovakia

Source: own calculations, EViews 7

Figure A2: Results of Johansen test for particular specifications of VEC models and country pairs.

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Comparison of Technology and Technical Efficiency in Cereal Production among EU Countries

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Anotace

Článek prezentuje výsledky analýzy produkce obilovin v rámci jednotného trhu EU. Analýza je založena na odhadu multiple output distance (vzdálenostní) funkce pro jednotlivé členské země v prvním kroku a následném odhadu metafrontier multiple output distance funkce v druhém kroku. Komparativní analýza ukazuje na vysokou technickou efektivnost producentů obilovin v analyzovaných zemích. Z výsledků plyne, že mezi zeměmi EU neexistují výrazné rozdíly v technické efektivnosti, přestože značnou rozdílnost vykazují v produkčních technologiích i v determinantech technické efektivnosti.

Klíčová slova

Obiloviny, vzdálenostní funkce, technická efektivnost, technologie, metafrontier analýza, SFA.

Abstract

The paper presents the analysis of cereal production in the EU. The analysis provides the comparison of production technologies and technical efficiency among EU countries using the country specific multiple output distance function models in the first step and metafrontier approach in the second step to determine the level and development of technical efficiency. The results show the high technical efficiency of cereal producers in the analyzed countries. On average, the differences in technical efficiency among the analyzed countries are not pronounced; however, the technologies used as well as the determinants of technical efficiency differ significantly.

Key words

Cereal production, multiple output distance function, technical efficiency, technology, metafrontier analysis, SFA.

Introduction

Cereal production is one of the most important sectors of plant production in European agriculture as well as worldwide. The size of crop production is not substitutable in many European countries. The same holds true for the Czech Republic, where cereals are cultivated on around 50 % of arable land. The share of cereal production in plant production is about 45 % and in gross agricultural production about 20 % (MA-CZ, 2014). Production has been gradually increasing worldwide during the analysed period (2004–2011) and in subsequent years. European countries followed this trend as well (Jansson and Heckelei, 2011). According to FAO estimates, world cereal production increased by 9 % in the period 2004–2011 (AMIS database, 2015). However, this increasing trend can be changed by negative factors in important production regions (e. g. Ukraine).

As far as European cereal production is concerned, significant differences among the EU countries can be found not only in the volume of production but also in crop systems (extensive vs. intensive) (Tiffin and Renwick, 1996). In this regard, the paper aims to address two research questions. The first question deals with the production technology. Specifically, the paper provides a comparison of cereal production technologies among the EU countries. The second question is related to technical efficiency. The paper identifies the differences and developments in the efficiency of inputs use.

The technical efficiency of crop production has been analysed in a number of studies (e.g. Aciti and Podinovsky, 2015; Baráth and Ferto, 2015;

Dhehibi et al., 2014; Batten and Hossain, 2014; Blazejczyk-Majka et al., 2012; Skevas et al., 2012; Odeck, 2007; Hadley and Irz, 2007). Moreover, the studies focused on the analysis of technical efficiency of cereal production can be found (e.g. Wouterse, 2010; Baranyai, 2009). However, these studies usually analyzed technical efficiency of specific plant (e.g. wheat in Hussain et al. (2012), maize in Ndlovu et al. (2014)) in one country. Only a few studies compared the technical efficiency of cereal producers from more than one country. Latruffe et al. (2012) compared technical efficiency of farms in cereal sector in France and Hungary and found out that Hungarian technology is more productive. Barnes and Revoredo-Giha (2011) used matafrontier analysis to compare technical efficiency of specialized farms in 11 European Union countries, namely Belgium, Denmark, France, Germany, Hungary, Ireland, Italy, Netherlands, Poland, Spain and the UK. They found out that COP farms in France are the most technically efficient. On the other hand the lowest mean of technical efficiency was observed in Italy.

Since a systematic overall assessment of the EU cereal production is missing the paper tries to complement the research by conducting a metafrontier analysis of the comparative assessment of technology and technical efficiency differences among EU member countries.

The paper is organized as follows: the Materials and methods section presents the estimation strategy and describes the data set; the Results and discussion section presents the results of country-specific multiple output distance models and a stochastic metafrontier multiple output distance function, discusses and compares estimated technology and compares technical efficiency and its development; and the Conclusions section contains concluding remarks.

Materials and methods

The research questions will be addressed by: (1) estimation of a country-specific multiple output distance function, and (2) calculation of an efficient output level which will be used in a metafrontier approach to determine the technical efficiency level and development.

We assume that the production process can be well approximated by a translog multiple output distance function (ODF) (Coelli and Perelman, 1996):

$$-lny_{1it} = \alpha_0 + \sum_{m=2}^{3}\alpha_m ln\, y^*_{mit} + \tfrac{1}{2}\sum_{m=2}^{3}\sum_{n=2}^{3}\alpha_{mn} lny^*_{mit} lny^*_{nit} + \sum_{k=1}^{5}\beta_k ln\, x_{kit} + \frac{1}{2}\sum_{k=1}^{5}\sum_{l=1}^{5}\beta_{kl} lnx_{kit} lnx_{lit} + \frac{1}{2}\sum_{k=1}^{5}\sum_{m=2}^{3}\gamma_{km} lnx_{kit} lny^*_{mit} + \delta_t t + \tfrac{1}{2}\delta_{tt}t^2 + \sum_{m=2}^{3}\alpha_{mt} t lny^*_{mit} + \sum_{k}^{5}\beta_{kt} t ln\, x_{kit} + u_{it} + v_{it} \quad (1)$$

where we assume that $v_{it} \sim N(0,\sigma_v^2)$, $u_{it} \sim N^+(0,\sigma_u^2)$, and that they are distributed independently of each other, and of the regressors (Kumbhakar and Lovell, 2000).

Heterogeneity in technology is captured using a Fixed Management model. Álvarez et al. (2003 and 2004) specified the Fixed Management model as a special case of the Random Parameters model in the following form:

$$-lny_{1it} = \alpha_0 + \sum_{m=2}^{3}\alpha_m ln\, y^*_{mit} + \tfrac{1}{2}\sum_{m=2}^{3}\sum_{n=2}^{3}\alpha_{mn} lny^*_{mit} lny^*_{nit} + \sum_{k=1}^{5}\beta_k ln\, x_{kit} + \frac{1}{2}\sum_{k=1}^{5}\sum_{l=1}^{5}\beta_{kl} lnx_{kit} lnx_{lit} + \frac{1}{2}\sum_{k=1}^{5}\sum_{m=2}^{3}\gamma_{km} lnx_{kit} lny^*_{mit} + \delta_t t + \tfrac{1}{2}\delta_{tt}t^2 + \sum_{m=2}^{3}\alpha_{mt} t lny^*_{mit} + \sum_{k}^{5}\beta_{kt} t ln\, x_{kit} + \alpha_{m*} m^*_i + \tfrac{1}{2}\alpha_{m*m*} m^{*2}_i + \delta_{tm*} m^*_i t \quad (2)$$

Álvarez et al. (2004) showed that u_{it} can be estimated according to Jondrow et al. (1982) as (3) with simulated mi* according to the relation (4).

$$E\left[u_{it}\middle|\varepsilon_{it}, m_i^*\right] = \frac{\sigma\lambda}{(1+\lambda^2)}\left[\frac{\phi\left(-\left(\varepsilon_{it}\middle|m_i^*\right)\lambda/\sigma\right)}{\Phi\left(-\left(\varepsilon_{it}\middle|m_i^*\right)\lambda/\sigma\right)} - \frac{\left(\varepsilon_{it}\middle|m_i^*\right)\lambda}{\sigma}\right], \quad (3)$$

where $\lambda = \frac{\sigma_u}{\sigma_v}$, $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\varepsilon_{it} = v_{it} + u_{it}$.

$$\hat{E}\left[m_i^*\middle|\mathbf{y}_i, \mathbf{X}_i, \boldsymbol{\delta}\right] = \frac{\frac{1}{R}\sum_{r=1}^{R} m^*_{i,r}\hat{f}\left(\mathbf{y}_{1i}\middle|\mathbf{y}^*_{mit}, \mathbf{x}_{it}, t, m^*_{i,r}; \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}, \boldsymbol{\delta}\right)}{\frac{1}{R}\sum_{r=1}^{R}\hat{f}\left(\mathbf{y}_{1i}\middle|\mathbf{y}^*_{mit}, \mathbf{x}_{it}, t, m^*_{i}; \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}, \boldsymbol{\delta}\right)} \quad (4)$$

FMM is estimated using the maximum simulated likelihood method in the econometric software LIMDEP 9.0.

The metafrontier analysis will be conducted using the same model specification as for the individual countries. We will calculate the efficient output based on the parameter estimates of a country multiple output distance function and will use them in the estimation of a stochastic metafrontier multiple output distance function.

The ODF will be estimated on the basis of the panel data set drawn from the FADN database provided by the European Commission. The data set contains data on 24 EU member countries (Cyprus, Malta and Luxembourg are missing) and covers the period from 2004 to 2011, except for Austria (2005–2011), Bulgaria and Romania (2008–2011).

The following variables are used: y_1 cereal production, y_2 other plant production, y_3 animal production, x_1 labour, x_2 land, x_3 capital, x_4 specific material and x_5 other material. Labour is represented by the total labour measured in AWU. Land is the total utilised land. Capital is the sum of contract work and depreciation. Specific material in cereal production is represented by the costs of seeds, plants, fertilisers and crop protection. Outputs as well as inputs (except for labour and land) are deflated by country price indices on each individual output and input (2005 = 100). The country price indices are taken from the EUROSTAT database.

The multiple output distance function is estimated only for specialized producers. Specialisation is defined when cereal production accounts for at least 50 % of total plant production.

Results and discussion

1. Individual country estimates

Tables 1 and 2 provide selected first-order parameter estimates of the multiple output distance function (equation 2) for 24 EU member countries.

Instead of discussing each country estimate separately, we will evaluate and compare the results for all member countries together. This strategy helps us to better understand the common and individual specifics of cereal production in EU member countries, as far as technology, heterogeneity and efficiency are concerned.

Table 1 shows the estimated parameters conventionally discussed in the distance function, i.e. first-order parameters on outputs and inputs of the multiple output distance function. Almost all parameters are significant, even at a 1 % significance level. This also holds true for the majority of other fitted parameters. As far as theoretical consistency is concerned, the monotonicity requirements for outputs imply: $\beta_{y2} > 0$, $\beta_{y3} > 0$ and $\beta_{y2} + \beta_{y3} < 1$; and for inputs: $\beta_q < 0$ for q = x_1, x_2, x_3, x_4, x_5. Table 1 shows that these conditions are met. Moreover, convexity in inputs also holds true for almost all countries (evaluated on the sample mean), i.e. $\beta_{qq} + \beta_q^2 - \beta_q > 0$ for q = x_1, x_2, x_3, x_4, x_5.

Since all variables are normalised in logarithm by their sample mean, the first-order parameters of outputs represent the shares of outputs y_2 and y_3 in the total output, and parameters of inputs can be interpreted as elasticities of production on the sample mean. As far as the shares of outputs are concerned, the countries differ significantly in their production structure. Since we are analysing specialized cereal companies (i.e. with a share of cereal production in total plant production exceeding 50 %), the parameters on y_2 are lower than 0.5, except for the Netherlands, where we did not distinguish between specialized and non-specialized due to the low number of observations of specialized companies. The estimates show that agricultural companies in most member countries are highly specialized in cereal production, with a share exceeding 40 % of the total production. Austria, Belgium, Germany, France, the Netherlands, and Slovenia are exceptions. In these countries animal production is more pronounced. As far as the structure of plant production is concerned, specialized crop companies have a share of cereal production higher than 70% in most cases. Other production types play a more significant role in Bulgaria, the Czech Republic, Germany, the Netherlands and Romania.

The production elasticities of the individual countries share some common patterns. The highest elasticity is for material inputs, i.e. specific and other materials, and the lowest is for capital. However, the differences among the countries in the value of all elasticities are highly pronounced. The sum of the elasticity of material inputs is in the interval -0.4 to -0.9. The interval for labour elasticity is from -0.04 to -0.24. The lowest land elasticity is in Slovakia (-0.05) and the highest is in Denmark (-0.60). Capital elasticity in the majority of countries does not exceed -0.1. Moreover, the estimates of capital elasticity are quite low (lower than |0.05|) in some countries, which could be connected with capital market imperfections, including limited access to capital and the use of old machinery by many farmers in these countries. Thus, we can already

EU member country		Other plant production	Animal production	Labour	Land	Capital	Specific material	Other material	RTS
		y_2	y_3	x_1	x_2	x_3	x_4	x_5	
Austria	Coeff.	0.0862	0.6522	-0.0752	-0.1303	-0.0497	-0.1506	-0.6982	-1.1039
		***	***	***	***	***	***	***	
Belgium	Coeff.	0.1072	0.7871	-0.1413	-0.0001	-0.0489	-0.1246	-0.6471	-0.962
		***	***	***		***	***	***	
Bulgaria	Coeff.	0.334	0.1036	-0.0632	-0.2879	-0.0704	-0.3247	-0.2064	-0.9526
		***	***	***	***	***	***	***	
Czech Republic	Coeff.	0.3278	0.1769	-0.0923	-0.1369	-0.0302	-0.3891	-0.3673	-1.0159
		***	***	***	***	***	***	***	
Germany	Coeff.	0.2132	0.3979	-0.0489	-0.2032	-0.0471	-0.2012	-0.6076	-1.1081
		***	***	***	***	***	***	***	
Denmark	Coeff.	0.1909	0.2343	-0.0959	-0.5992	-0.0273	-0.0653	-0.3208	-1.1085
		***	***	***	***	**	***	***	
Estonia	Coeff.	0.2108	0.0895	-0.0625	-0.2843	-0.0673	-0.3188	-0.2648	-0.9976
		***	***	***	***	***	***	***	
Spain	Coeff.	0.0265	0.2152	-0.1453	-0.1308	-0.0269	-0.2686	-0.3644	-0.9361
		***	***	***	***	***	***	***	
Finland	Coeff.	0.0781	0.4491	-0.1436	-0.258	-0.0261	-0.1061	-0.6117	-1.1455
		***	***	***	***	***	***	***	
France	Coeff.	0.0775	0.5255	-0.097	-0.1494	-0.1148	-0.1766	-0.5538	-1.0916
		***	***	***	***	***	***	***	
Great Britain	Coeff.	0.1695	0.2661	-0.1924	-0.1202	-0.0335	-0.4099	-0.436	-1.192
		***	***	***	***	***	***	***	
Greece	Coeff.	0.0604	0.3934	-0.236	-0.0911	0.0333	-0.1994	-0.3078	-0.801
		***	***	***	***	***	***	***	
Hungary	Coeff.	0.2345	0.1174	-0.0416	-0.2732	-0.0542	-0.209	-0.3915	-0.9696
		***	***	***	***	***	***	***	
Ireland	Coeff.	0.1743	0.3398	-0.0355	-0.4049	-0.1057	-0.3256	-0.2745	-1.1462
		***	***	**	***	***	***	***	
Italy	Coeff.	0.2057	0.1199	-0.047	-0.3779	-0.0712	-0.214	-0.206	-0.9161
		***	***	***	***	***	***	***	
Lithuania	Coeff.	0.1915	0.1017	-0.0833	-0.2413	-0.0765	-0.3776	-0.2151	-0.9937
		***	***	***	***	***	***	***	
Latvia	Coeff.	0.1828	0.1362	-0.007	-0.2077	-0.0948	-0.2743	-0.4082	-0.992
		***	***		***	***	***	***	
Netherlands	Coeff.	0.6746	0.0754	-0.1216	-0.2544	-0.1066	-0.2947	-0.5124	-1.2898
		***	***	***	***	***	***	***	
Poland	Coeff.	0.1243	0.4206	-0.0597	-0.2655	-0.0485	-0.1469	-0.5359	-1.0565
		***	***	***	***	***	***	***	
Portugal	Coeff.	0.066	0.2362	-0.0626	-0.1225	-0.0372	-0.2416	-0.3481	-0.812
		***	***		***	**	***	***	
Romania	Coeff.	0.3563	0.1209	-0.0203	-0.4598	0.026	-0.2004	-0.1856	-0.8402
		***	***	***	***	***	***	***	
Sweden	Coeff.	0.118	0.2388	-0.072	-0.2028	-0.0159	-0.0184	-0.8786	-1.1876
		***	***	***	***			***	
Slovenia	Coeff.	0.1153	0.505	-0.0158	-0.2384	-0.0582	-0.1084	-0.6908	-1.1116
		***	***		***	***	***	***	
Slovakia	Coeff.	0.2407	0.0912	-0.2036	-0.0454	-0.0464	-0.4551	-0.2791	-1.0295
		***	***	***	**	***	***	***	

Note: ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Source: own calculation

Table 1: First-order parameters of the multiple output distance functions.

EU member country		Alpha_m	Time	Labour	Land	Capital	Specific material	Other material	Alpha_mm
			t	x_1	x_2	x_3	x_4	x_5	
Austria	Coeff.	-0.2754	-0.0019	0.0119	0.0105	-0.0485	0.0006	0.0751	-0.0668
		***		*		***		***	***
Belgium	Coeff.	-0.192	-0.0083	0.1298	-0.0377	-0.0949	0.0117	0.0664	0.0768
		***	***	***	***	***		***	***
Bulgaria	Coeff.	-0.0959	-0.0052	-0.001	-0.1935	-0.057	0.2111	-0.0034	0.2898
		***			***	***	***		***
Czech Republic	Coeff.	-0.0309	-0.008	-0.0732	-0.2059	-0.0762	0.0675	0.2417	-0.1914
		***	***	***	***	***	***	***	***
Germany	Coeff.	-0.2377	-0.0028	-0.015	-0.0778	-0.0152	0.0413	0.0901	0.0397
		***	***	***	***	***	***	***	***
Denmark	Coeff.	-0.1044	0.0032	-0.0893	-0.1377	0.076	0.0313	0.1432	-0.3931
		***	*	***	***	***	***	***	***
Estonia	Coeff.	-0.1769	-0.0105	0.0388	-0.0525	0.0128	-0.0081	0.0226	0.0067
		***	**	**	**				
Spain	Coeff.	-0.3758	0.0159	-0.0645	-0.0818	0.0011	0.0718	-0.0108	-0.0953
		***	***	***	***		***	**	***
Finland	Coeff.	-0.0032	0.0068	-0.0686	0.0534	0.0258	0.0079	-0.223	-0.4836
			***	***	***	***		***	***
France	Coeff.	-0.2246	-0.0044	-0.0324	-0.015	-0.0032	0.008	0.0632	0.0494
		***	***	***	***		***	***	***
Great Britain	Coeff.	-0.2389	0.0091	-0.034	-0.0288	-0.0471	0.0632	0.0544	-0.0346
		***	***	***	***	***	***	***	***
Greece	Coeff.	-0.3394	0.0124	-0.1157	-0.1071	0.0418	0.1692	-0.1031	0.0734
		***	***	***	***	***	***	***	***
Hungary	Coeff.	-0.2094	-0.0122	-0.0185	-0.0485	0.0072	0.0563	-0.0091	-0.0499
		***	***	***	***		***		***
Ireland	Coeff.	-0.1844	0.0051	-0.0621	0.0138	0.0022	0.0358	0.055	0.0055
		***		***			**	***	
Italy	Coeff.	-0.2163	0.0065	-0.042	-0.1488	-0.0137	0.1425	0.0076	0.0084
		***	***	***	***	**	***	*	
Lithuania	Coeff.	-0.142	0.0109	-0.0213	-0.1637	-0.0524	0.1372	0.0549	0.0221
		***	***		***	***	***	***	**
Latvia	Coeff.	-0.0349	-0.0136	0.0883	0.2044	-0.0326	0.0122	-0.152	-0.2586
		***	***	***	***	***		***	***
Netherlands	Coeff.	-0.0722	0.0099	0.1844	-0.2183	-0.1071	-0.0037	-0.0666	0.3714
		***	***	***	***	***		***	***
Poland	Coeff.	-0.1336	-0.0068	0.0092	-0.0345	-0.0529	-0.0497	0.0407	0.2232
		***	***	***	***	***	***	***	***
Portugal	Coeff.	-0.0741	-0.0311	0.2429	0.0316	-0.077	0.0719	0.0457	0.224
		***	***	***	**	***	***	**	***
Romania	Coeff.	-0.2142	0.0234	-0.0353	-0.0281	0.0212	0.0075	0.0122	0.0362
		***	***	***	***	***		**	***
Sweden	Coeff.	-0.256	-0.0065	0.0934	-0.144	-0.0061	-0.0039	0.0844	-0.0871
		***	**	***	***			***	***
Slovenia	Coeff.	-0.182	0.0174	0.0155	-0.0678	-0.0257	0.077	0.0342	0.0186
		***	***		***		***	**	
Slovakia	Coeff.	-0.0959	-0.0212	-0.0111	-0.3302	0.0362	0.2205	0.0756	-0.1704
		***	***		***	***	***	***	***

Note: ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Source: own calculation

Table 2: Parameters on unobservable fixed management.

conclude that technology differs significantly among the countries.

As far as economies of scale are concerned, there is no indication of economies of scale (the sum of the elasticities is about one) for the average farm in the Czech Republic, Estonia, Lithuania, Latvia, Sweden, and Slovakia. Increasing returns to scale were found for the average farm in Austria, Germany, Denmark, France, Great Britain, Ireland, the Netherlands, Poland, and Slovakia. On the contrary, decreasing returns to scale were estimated for the average farm in Belgium, Bulgaria, Spain, Greece, Hungary, Italy, Portugal, and Romania. That is, these results already suggest that the impact of scale efficiency (SE) on productivity change will be quite large in most member countries (similarly to Wang et al. (2012), Wouterse (2010), Tozer and Villano (2013), and others).

Table 2 provides the parameter estimates on unobservable management. Since the coefficients on unobservable management are highly significant in the majority of cases, we can conclude that the chosen specification well approximates the estimated relationship and that heterogeneity among companies is an important characteristic of farmers with cereal specialisation in almost all member countries.

Unobservable management contributes positively to production in all member countries (positive Alpha_m). However, the positive impact of unobservable management accelerates for some countries (negative Alpha_mm) and decelerates for others (positive Alpha_mm). Unobservable management also has a different impact on production elasticities in individual countries. That is, if the coefficient is positive, increasing management leads to an increase in production elasticity, and vice versa. In terms of the relation between unobservable management and technical efficiency, a positive coefficient indicates the positive impact of a given input on technical efficiency, and vice versa. Since the impact of unobservable management on production elasticities differs among the countries and no common pattern can be identified, we concentrate only on the role of technological change. Technological change has a positive impact on technical efficiency in almost half of the analysed countries, namely in Denmark, Spain, Finland, Great Britain, Greece, Ireland, Italy, Lithuania, the Netherlands, Romania, and Slovenia. In the other countries, technological change makes a negative contribution to the development of technical efficiency. A similar conclusion was reached by Latruffe and Nauges (2014).

2. Metafrontier analysis

Table 3 provides parameter estimates of a stochastic metafrontier multiple output distance function for cereal production in 24 EU member states (Cyprus, Luxembourg and Malta are missing). As expected, the first-order parameters standardly discussed in a production function estimate as well as the parameters on unobservable fixed management are highly significant, even at a 1 % significance level. This also holds for the majority of second-order parameters.

As far as theoretical consistency of the estimate is concerned, we can conclude that monotonicity requirements as well as requirements on convexity in outputs and quasi convexity in inputs are met, evaluated on the sample mean.

Since the share of other plant production is 7 % and the share of animal production is 52 % for the analysed sample, cereal production dominates plant production in EU; however, more than half of the output is created by animal production. This holds true for the sample mean. As expected, the highest elasticities of production are for material inputs and land. On the other hand, the lowest elasticity was estimated for capital. These estimates correspond to the values estimated for individual countries.

Since the sum of production elasticities is -0.979, slightly decreasing returns to scale were estimated for the EU member countries. Since the sum is close to one, the impact of scale efficiency on a productivity change in the EU will not be large, on average. However, as concluded in the previous section, the impact might be large for individual countries since the returns to scale differ significantly among the countries.

The parameters on unobservable management are highly significant, which again suggests that the chosen specification well approximates the estimated relationship and that heterogeneity among firms is an important characteristic of farmers with cereal specialisation in EU member countries. Unobservable management contributes positively to production, and the impact accelerates over time. An increase in management has a positive impact on the production elasticities of material inputs and a negative impact on other inputs. The impact of technological change on technical efficiency is not pronounced (the coefficient is almost zero).

Technological change makes a significant positive contribution ($\beta_T < 0$) to production, and the impact of technical change is accelerating over time ($\beta_{TT} < 0$). Moreover, the biased technological change is pronounced. The technological change is labour- and land-saving and capital- and material-using. This direction of the technological change corresponds to our expectations. The adoption of innovations leads to a situation where labour become scarcer and capital more abundant.

The parameter λ is highly significant and equals about one. That is, the variation in u_{it} is almost equal to the variation in the random component v_{it}. The estimates indicate that efficiency differences among cereal producers are important reasons for variations in production. However, the estimate did not reveal significant differences among countries, and not even among regions. The results show that cereal producers in EU member countries greatly exploit their production possibilities (evaluated on the sample mean). The averages of technical efficiency calculated on the regional level (NUTSII) are in the interval 0.89 to 0.92.

Means for random parameters				Coefficient on unobservable fixed management			
Variable	**Coef.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coef.**	**SE**	**P [|z|>Z*]**
Const.	-0.1763	0.0015	0.0000	**Alpha_m**	-0.3633	0.0006	0.0000
Time	-0.0036	0.0002	0.0000	**Time**	-0.0009	0.0003	0.0004
X1	-0.0751	0.0011	0.0000	**X1**	-0.0168	0.0010	0.0000
X2	-0.2274	0.0011	0.0000	**X2**	-0.0415	0.0009	0.0000
X3	-0.0352	0.0009	0.0000	**X3**	-0.0200	0.0007	0.0000
X4	-0.1259	0.0010	0.0000	**X4**	0.0404	0.0008	0.0000
X5	-0.5157	0.0010	0.0000	**X5**	0.0418	0.0008	0.0000
				Alpha_mm	-0.0493	0.0007	0.0000
Variable	Coef.	SE	P [|z|>Z*]	**Variable**	Coef.	SE	P [|z|>Z*]
TT	-0.0039	0.0002	0.0000	**X13**	0.0038	0.0013	0.0034
Y2	0.0743	0.0008	0.0000	**X14**	0.0037	0.0015	0.0156
Y3	0.5212	0.0005	0.0000	**X15**	0.0441	0.0014	0.0000
Y2T	0.0033	0.0003	0.0000	**X23**	-0.0133	0.0010	0.0000
Y3T	0.0035	0.0002	0.0000	**X24**	-0.0059	0.0011	0.0000
Y22	0.0274	0.0011	0.0000	**X25**	0.0264	0.0013	0.0000
Y33	0.1281	0.0003	0.0000	**X34**	0.0221	0.0009	0.0000
Y23	-0.0213	0.0005	0.0000	**X35**	0.0054	0.0011	0.0000
X1T	0.0036	0.0004	0.0000	**X45**	0.0011	0.0012	0.3752
X2T	0.0103	0.0004	0.0000	**Y2X1**	0.0114	0.0013	0.0000
X3T	-0.0071	0.0003	0.0000	**Y2X2**	-0.0288	0.0010	0.0000
X4T	-0.0015	0.0004	0.0000	**Y2X3**	-0.0007	0.0009	0.4109
X5T	-0.0078	0.0004	0.0000	**Y2X4**	0.0000	0.0010	0.9661
X11	-0.0045	0.0022	0.0398	**Y2X5**	0.0196	0.0011	0.0000
X22	0.0500	0.0017	0.0000	**Y3X1**	-0.0266	0.0007	0.0000
X33	-0.0239	0.0007	0.0000	**Y3X2**	0.0414	0.0006	0.0000
X44	-0.0355	0.0010	0.0000	**Y3X3**	0.0145	0.0006	0.0000
X55	-0.0917	0.0018	0.0000	**Y3X4**	0.0155	0.0005	0.0000
X12	-0.0469	0.0017	0.0000	**Y3X5**	-0.0300	0.0008	0.0000
Sigma	0.1641	0.0007	0.0000				
Lambda	0.9925	0.0173	0.0000				

Note: ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Source: own calculation

Table 3: Parameter estimates – metafrontier.

3. Development of technical efficiency

Table 4 provides the development of technical efficiency. The development of technical efficiency is rather stochastic in many EU member countries. The average percentage change is positive for Austria, Belgium, Estonia, France, Hungary, Italy, Lithuania, Latvia, Portugal, Slovenia, and Slovakia. However, positive but very weak trends were estimated only for Belgium, Bulgaria, Portugal, and Romania. Despite the rather stochastic development of technical efficiency, one common pattern for most countries can be observed. Technical efficiency experienced a drop in most EU member countries in the years 2008 and 2009 and an increase in the years after that. However, the decrease was stronger than the increase. That is, the majority of countries experienced a drop in technical efficiency between 2008 and 2011.

Factors determining the development of technical efficiency were also rather specific for each member country. The positive impact of technical change on the development of technical efficiency was pronounced in Spain, Great Britain, Greece, Italy, Lithuania, the Netherlands, Romania, and Slovenia. In other countries, technical change either contributed negatively to the development of technical efficiency or the impact was rather small. The management and scale effects varied significantly among the countries and contributed mainly to the rather stochastic development of technical efficiency. However, the management effect was much more pronounced than the scale effect.

The question of stability can be analysed using the Spearman's rank correlations of technical efficiency in the analysed EU member countries. Since the order of farmers in all countries changes dramatically, leapfrogging appears to be a common phenomenon for all member countries. That is, catching-up and falling-behind processes are important characteristics of cereal producers in all countries. This also holds true even if we take into consideration the character of the data. Since we have an unbalanced panel, the values are affected to some extent by the entry and exit of producers to and from the sample.

EU member country	2004	2005	2006	2007	2008	2009	2010	2011	Average change	Trend function	R2
Austria	NA	0.461	-1.867	2.717	1.019	-0.723	-2.286	1.622	0.135	y = 0.248 - 0.028t	0.000
Belgium	-0.042	-0.279	0.257	-0.391	-0.237	0.354	-0.046	2.014	0.204	y = -0.653 + 0.191t	0.360
Bulgaria	NA	NA	NA	-0.614	-0.006	-1.004	1.48	-0.105	-0.05	y = -0.801 +0.250t	0.180
Czech Republic	0.108	0.247	-0.196	0.574	-0.968	0.002	0.103	-0.104	-0.029	y = 0.140 - 0.038t	0.040
Germany	3.446	1.668	3.839	-0.55	-2.437	-1.675	-0.603	-6.094	-0.301	y = 4.872 - 1.150t	0.740
Denmark	-1.78	0.504	1.257	3.721	-4.052	-7.06	3.009	0.916	-0.436	y = -0.365 - 0.016t	0.000
Estonia	-0.338	3.911	-6.119	5.208	-4.262	3.622	-1.467	1.106	0.208	y = 0.048 + 0.035t	0.000
Spain	3.28	-14.073	2.29	5.556	1.117	-4.376	0.6	3.879	-0.216	y = -3.062 + 0.632t	0.060
Finland	2.325	0.128	-6.188	6.593	-3.786	-8.878	2.746	3.211	-0.481	y = -0.526 + 0.010t	0.000
France	-0.856	1.029	1.457	1.22	-1.551	-3.224	2.362	-0.152	0.036	y = 0.095 - 0.088t	0.010
Great Britain	0.145	-0.415	1.068	1.481	-1.941	-5.551	2.449	0.373	-0.299	y = 0.315 - 0.062t	0.010
Greece	-0.672	0.343	-0.45	1.441	1.421	-1.267	-1.718	0.696	-0.026	y = 0.146 - 0.038t	0.010
Hungary	2.437	2.025	-0.393	-2.819	5.684	-2.197	-3.031	-0.519	0.148	y = 2.446 - 0.511t	0.170
Ireland	-0.458	-2.021	3.32	4.927	-4.632	-7.589	2.176	2.498	-0.222	y = -0.190 - 0.007t	0.000
Italy	-0.012	0.195	0.334	5.556	-3.737	-5.658	1.798	2.087	0.07	y = 0.315 - 0.054t	0.000
Lithuania	7.018	3.657	-17.848	6.55	5.27	-0.545	0.992	-0.316	0.597	y = 1.349 - 0.167t	0.000
Latvia	5.836	-0.853	-0.785	2.058	-3.328	1.879	-4.538	1.87	0.267	y = 2.602 - 0.519t	0.150
Netherlands	-2.033	3.726	-0.146	-2.782	-0.862	0.586	4.218	-2.762	-0.007	y = -0.086 + 0.018t	0.000
Poland	0.156	0.009	-0.105	-0.055	-0.895	-0.014	1.762	-1.119	-0.033	y = 0.007 - 0.009t	0.000
Portugal	3.113	-10.765	1.622	0.092	5.628	-2.325	2.763	4.392	0.565	y = -3.200 + 0.837t	0.160
Romania	NA	NA	NA	-0.778	-0.039	-0.796	0.857	-0.285	-0.208	y = -0.773 + 0.188t	0.190
Sweden	1.425	-0.804	-7.594	7.116	3.73	-5.972	-4.231	2.818	-0.439	y = -0.123 - 0.070t	0.000
Slovenia	-4.641	2.215	-2.367	8.155	0.474	-4.09	-5.561	7.842	0.253	y = -1.657 + 0.424t	0.040
Slovakia	0.83	-1.048	2.636	4.246	-0.435	0.771	-3.303	-1.009	0.336	y = 2.180 - 0.410t	0.180

Source: own calculation

Table 4: Development of technical efficiency (% change) .

Conclusion

In the conclusion we focus on the research questions raised in the introduction. That is, we deal with the differences in cereal production technology among the EU countries and with the differences in technical efficiency and its development. The results showed that agricultural companies in the majority of EU countries are highly specialized in cereal production. However, there exist countries where animal production is more pronounced (Austria, Belgium, Germany, France, the Netherlands and Slovenia) or where other plant production also plays a significant role (Belgium, Bulgaria, the Czech Republic, Germany, the Netherlands and Romania). A comparison of the production elasticities of the individual countries showed that there are some common patterns – the highest elasticity for material inputs and the lowest for capital. However, the differences among the countries are highly pronounced in the value of all elasticities. Thus, we can conclude that technology differs significantly among the countries.

As far as technical efficiency is concerned, no significant differences among EU countries and, even more so, among regions, were revealed by the estimate. On average, cereal producers in EU member countries greatly exploit their production possibilities. However, the Spearman's rank correlations of technical efficiency show that catching-up and falling-behind processes are important characteristics of cereal producers in all EU countries.

The development of technical efficiency is rather stochastic in many EU member countries and, in addition, factors which determined the development of technical efficiency (namely technical change, management and scale effect) were rather specific for each member country. However, we can make a cluster of countries where technical change had a positive impact on the development of technical efficiency – Spain, Great Britain, Greece, Italy, Lithuania, the Netherlands, Romania, and Slovenia. In other countries, technical change either contributed negatively to the development of technical efficiency or the impact was rather small.

This has important implications for the efficiency of Common Agricultural Policy and its goal of improving the competitiveness of European agriculture. As far as the technical efficiency is concerned the results suggest that cereal producers made improvements to move near to the production frontier only in six old and two new member states. Despite the fact that cereal producers highly exploit their production possibilities on average there is a space for improvements, especially by the adoption of innovations.

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References

[1] Atici, K. B., Podinovski, V. V. Using data envelopment analysis for the assessment of technical efficiency of units with different specialisations: An application to agriculture. Omega, 2015, Vol. 54, p. 72-83. ISSN 0305-0483.

[2] AMIS database by FAO, AMIS 2015. [Online]. Available: http://www.amis-outlook.org/home/en/ [Accessed: 18 Feb. 2015].

[3] Álvarez, A., Arias, C., Greene, W. Accounting for unobservables in production models: management and inefficiency. Economic Working Papers at Centro de Estudios Andaluces E2004/72, Centro de Estudios Andaluces. 2004, p. 18. [Online] Available: http://EconPapers.repec.org/RePEc:cea:doctra:e2004_72. [Accessed: 18 Feb. 2015].

[4] Álvarez, A., Arias, C., Greene, W. Fixed Management and time invariant technical efficiency in a random coefficient model. Working Paper, Department of Economics, Stern School of Business, New York University, 2003, p. 10. [Online] Available: http://www.eco.uc3m.es/temp/alvarez_pinilla.pdf [Accessed: 18 Feb. 2015].

[5] Baranyai, Z., Kodenko, J., Belovecz, M., Végh, K. Technological challenges of Hungarian cereal production - Analysis of the situation and alternatives. Cereal Research Communications. 2009, Vol. 37, p. 457-460. ISSN 0133-3720.

[6] Baráth, F., Ferto, I. Heterogeneous technology, scale of land use and technical efficiency: The case of Hungarian crop farms. Land Use Policy. 2015, Vol. 42, p. 141-150. ISSN 0264-8377.

[7] Barnes, A. P., Revoredo-Giha, C. A Metafrontier Analysis of Technical Efficiency of Selected European Agricultures. Paper provided by European Association of Agricultural Economists in its series 2011 International Congress, August 30-September 2, 2011, Zurich, Switzerland.

[8] Batten, A., Hossain, I. Stochastic frontier model with distributional assumptions for rice production technical efficiency. Journal of Agricultural Science and Technology. 2014, Vol. 16, No. 3, p. 481-496, ISSN 1680-7073.

[9] Blazejczyk-Majka, L., Kala, R., Maciejewski, K. Productivity and efficiency of large and small field crop farms and mixed farms of the old and new EU regions. Agricultural Economics. 2012, Vol. 58, No. 2, p. 61-71. ISSN 0139-570X.

[10] Coelli, T., Perelman, S. Efficiency Measurment, Multiple-output Technologies and Distance Fucntions: With Application to European Railways, CREPP 96/05, Université de Liége. 1996, p. 31. [Online] Available: http://orbi.ulg.ac.be/handle/2268/35665 [Accessed: 18 Feb. 2015].

[11] Dhehibi, B., Alimari, A., Haddad, N., Aw-Hassan, A. Technical efficiency of Kenya's smallholder food crop farmers: do environmental factors matter? Environment, Development and Sustainability, 2014, p. 1-12. ISSN 1387-585X.

[12] Hadley, D., Irz, X. Productivity and farm profit - A microeconomic analysis of the cereal sector in England and Wales. Applied Economics. 2008, Vol. 40, No. 5, p. 613-624. ISSN 0003-6846.

[13] Hussain, A., Saboor, A., Khan, M. A., Mohsin, A. Q., Hassan, F., Anwar, M. Z. Technical efficiency of wheat production in Punjab (Pakistan): A cropping zone wise analysis. Pakistan Journal of Life and Social Sciences, 2012, Vol. 10, No. 2, p. 130-138. ISSN 1727-4915.

[14] Jondrow, J., Knox Lovell, C. A., Materov, I. S., Schmidt, P. On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model, Journal of Econometrics, 1982, Vol. 19, p. 233-238. ISSN 0304-4076.

[15] Kumbhakar, S. C., Lovell, C. A. K. Stochastic Frontier Analysis, Cambridge: University Press. 2000, p. 333. ISBN 0-521-48184-8.

[16] Jansson, T., Heckelei, T. Estimating a primal model of regional crop supply in the European Union. Journal of Agricultural Economics. 2011, 62, No. 1, p. 137-152. ISSN 1477-9552.

[17] Latruffe, L., Nauges, C. Technical efficiency and conversion to organic farming: The case of France. European Review of Agricultural Economics. 2014, Vol. 41, No. 2, p. 227-253. ISSN 1464-3618.

[18] Latruffe, L., Fogarasi, J., Desjeux, Y. Efficiency, productivity and technology comparison for farms in Central and Western Europe: The case of field crop and dairy farming in Hungary and France. Economic Systems. 2012, Vol. 36, No. 2, p. 264-278. ISSN 0939-3625.

[19] Ministry of Agriculture. Situation and Outlook Report – Cereals, Ministry of Agriculture (MA-CZ), since 2014. ISBN 978-80-7434-191-5.

[20] Ndlovu, P. V., Mazvimavi, K., An, H., Murendo, C. Productivity and efficiency analysis of maize under conservation agriculture in Zimbabwe. Agricultural Systems. 2014, Vol. 124, p. 21-31. ISSN 0308-521X.

[21] Odeck, J. Measuring technical efficiency and productivity growth: A comparison of SFA and DEA on Norwegian grain production data. Applied Economics. 2007, Vol. 39, No. 20, p. 2617-2630. ISSN 0003-6846.

[22] Skevas, T., Lansink, A. O., Stefanou, S. E. Measuring technical efficiency in the presence of pesticide spillovers and production uncertainty: The case of Dutch arable farms. European Journal of Operational Research. 2012, Vol. 223, No. 2, p. 550-559. ISSN 03772217.

[23] Tiffin, R., Renwick, A. Estimates of production response in the UK cereal sector using nonparametric methods. European Review of Agricultural Economics. 1996, 23, No. 2, p. 179-194. ISSN 1464-3618.

[24] Tozer, P. R., Villano, R. Decomposing productivity and efficiency among Western Australian grain producers. Journal of Agricultural and Resource Economics. 2013, Vol. 38, No. 3, p. 312-326. ISSN 1068-5502.

[25] Wang, X., Hockmann, H., Bai, J. Technical efficiency and producers' individual technology: Accounting for within and between regional farm heterogeneity. Canadian Journal of Agricultural Economics, 2012, Vol. 60, No. 4, p. 561-576. ISSN: 1744-7976.

[26] Wouterse, F. Migration and technical efficiency in cereal production: Evidence from Burkina Faso. Agricultural Economics. 2010, Vol. 41, No. 5, p. 385-395. ISSN 1805-9295.

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Benefits of Using Traffic Volumes Described on Examples in the Open Transport Net Project Pilot Regions

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Anotace

Článek popisuje cíle projektu Open Transport Net v souvislosti s rozvojem pilotních regionů. Zkoumá potenciál dopravních intenzit a jejich možné využití pro rozvoj regionálních dopravních infrastruktur. V úvodu je krátce představen projekt Open Transport Net. Následují popisy zjištěných problémů v pilotních regionech a možnost využití dopravních intenzit k dosažení kvalitnějších výsledků. Základy výpočtu dopravních intenzit a jejich vizualizace jsou popsány a demonstrovány na příkladech.

Klíčová slova

Doprava, otevřená data, prostorová data, pilotní regiony, aplikace, dopravní intenzity.

Abstract

The paper describes the goals of the Open Transport Net project in the pilot regions for regional development and the motivation to use traffic volumes in order to reach the project objectives. In the introduction, a short overview of the Open Transport Net project is provided. It is followed by descriptions of the identified problems in the pilot regions and incentives to use traffic volumes for achieving good quality results. The basics of traffic volumes as well as their visualisation are further described and demonstrated including several examples.

Key words

Transport, open data, spatial data, pilot regions, applications, traffic volumes.

Introduction

Transport is one of the key issues addressed by EU policy[1]. Europe's population and visitors are reliable on transport and its efficient operation. In order to make it efficient, safe, trusted and sustainable, thorough planning must take place. This is true for example while constructing a new motorway, modifying a road junction, adding an extra connection to a bus line or integrating a train schedule with an online tourist portal. See for examples Yusoff et al. (2014) describing Web-GIS based road management or Zhang, Feng and Gao (2011) describing planning requirements in road network maintenance. A necessary precondition for such planning is the ability to analyse information from the past, combine it with dynamic data coming from sensors such as mobile phones as described for example by Goodchild (2011), and to use the generated knowledge for real-time applications and future planning.

The transport also plays a key role in regional development. E.g. Rietveld (1989) states that the importance of transportation infrastructure can be analysed via its impact on interregional trade flows. Regional agencies often order or even directly perform traffic counts and consequent traffic analyses, see e. g.[2,3] . Many studies talking about the influence of transport infrastructure on regional development can be found on google scholar[4]. Looking at first 10 results, all these publications are highly cited (approx.

[1] See the European Commission's website related to transport at http://ec.europa.eu/transport/index_en.htm

[2] http://www.wmsrdc.org/trafficcounts.html

[3] http://tamcmonterey.org/programs/trafficcounts/index.html

[4] https://scholar.google.cz/scholar?q=Impact+of+Transport+Infrastructure+Investment+on+Regional+Development

100+ citations). To mention one reference in particular, there is publication by OECD (2002) called Impact of Transport Infrastructure Investment on Regional Development. Looking in these sources, there can be seen a necessity of available data related transportation and traffic. Opening of such a data is main issue addressed by European project Open Transport Net.

The EU co-funded project Open Transport Net (OTN)[5], which started in February 2014. Partially OTN aims to support the use of transport data for regional development and public good in general. The main issues that are addressed by this project include:

- supporting the reuse of spatial data in the transport domain,
- combining spatial and non-spatial data from various sources,
- publishing data to enable easy access and data integration with other applications,
- analysing aggregated data and providing new services and visualisations through web interfaces.

The project tackles some technical challenges with data integration and aligning data and services to existing standards. See for example studies of Janečka et al. (2011), Janečka et al. (2013) or Charvat et al. (2014) for best practice examples how to deal with technical and data harmonisation issues during spatial data infrastructure (SDI) development. In addition, the involvement of end users and stakeholders is intensive; social validation makes a valuable contribution to the sustainability of the final results. These results should include:

- data hub for transport data integration and sharing,
- a set of end user applications addressing the main problems in regions and cities,
- validation of these applications in real world scenarios.

OTN focuses on open data that are freely provided by public administration and other organisations. The project started by modelling and visualising traffic volume data that should support transport applications in the OTN pilot areas: regions in the Czech Republic, Belgium, UK and in France. This paper contains the description of user requirements from the pilot regions and a detailed overview of the traffic volume modelling and visualisation process. Ruston, Mareels and Vaysse (2014) describe in detail the project vision.

Characteristics of and user requirements of the pilot regions

The OTN project identified the main problems and goals of the OTN pilots through co-design workshops and Ruston & Lievens (2014) comprehensively developed these workshops in pilot scenarios which are introduced below.

Belgium

In some Belgium regions, there will be major roadworks carried out between 2014 and 2022. Many roads will be closed. Therefore, there is a need to take some measures that would alleviate the impact of the temporally imposed restrictions (road closures) on transport infrastructure. Such measures can include improvement of public transportation: establishing new public transport links/changing the route of existing links and reducing the time interval between connections. The logic behind is quite simple: the capacity of the public transportation vehicle is generally bigger than the private transportation vehicle, so by making more frequent public transport connections that have reasonably big coverage to bring people where they need, there will be no need for people to use their private transport and thus it will help to prevent transport congestions on roads (because in a public transportation vehicle the ratio of its area and number of passengers that can fit in it is smaller than in a private transportation vehicle).

Together with re-planning public transport some additional measurements could be taken. The number of parking spaces at the edges of the city could be increased. Many people who are commuting to work from other settlements by their private transport and wish later to switch to the public transport should have enough space to park the vehicle when they enter the city. Also infrastructure for cycling could be improved. This can be done through extending the bicycle track networks and creating more places where people could borrow bicycles (this can be classical bike renting places but also some bike sharing systems).

The main OTN project objective in this pilot region will be thus to provide all necessary analytical tools to accomplish these planning tasks.

[5] See the project website at http://www.opentransportnet.eu/

There will be some additional minor tasks such as to provide pilot city with visualisation of traffic flows, ongoing roadworks on the map, to create routing web service that will take into account some deduced information from the traffic model as well as live information collected from platform's users' mobile phones or from some external APIs (live information about weather conditions), to create intermodal journey planner that will compute the optimal route from one point to another using the traffic means selected by user.

United Kingdom

In UK, the main objective is to identify accident-prone segments on motorways. In the future, there can be some steps taken towards decreasing the number of accidents on those segments; for example by setting a new speed limit for cars, put additional traffic lights or restrict the number of parking places. In identifying those segments statistical datasets about traffic accidents from governmental agencies as well as live data from sensors and VGI (volunteered geographical information) will be used. All data about traffic accidents will be merged together and combined with other related datasets; for instance with data about parking lots, speed limits on motorways, traffic volumes (eventually congestions) on motorways. The combination of data will enable deeper analysis. This database of traffic accidents in the city and related data will be maintained by the OTN project and will be available for anyone interested for download.

Furthermore, certain functions such as routing, geocoding, reverse geocoding, finding closest amenity of the certain type will be available for use through restful API. The same basic functions will be available for all the pilots and will use the data stored in the project database. These data can be of a great help to those who want to develop web-applications on top of the OTN data hub.

France

The national average of time lost in traffic jams in France is 35 hours per a year (Ruston et al. 2014). The government is naturally trying to take some steps to reduce the number of hours its citizens are wasting in traffic jams. For now the city has quite rich public transport network. In addition, there have been established 11 Velib' and 12 Autolib' docks for bicycle and electric-car sharing correspondingly. The role of the OTN in improving the transport situation and commutation from countryside to large cities is mainly relying in launching application that would help users to make more efficient journey plan based on the real-time data about the traffic situation as well as some additional information related to traffic such as current weather conditions. This real-time data can be acquired from data volunteers or from the public and private data providers. In cases when real-time data is missing traffic modelling based on statistical data can be performed in order to estimate the traffic volume at different road segments and take this information in consideration while computing journey plan or routing.

Furthermore, to make transportation of the citizens more efficient the journey plan can include some extra information except just the public transportation routes such as the information about parking lots and Velib'/Autolib' docks. So the user can see for example opportunities to go certain portion of the trip by car then park car in a certain place where there are free parking slots and switch to public transport or for instance go by public transport to certain place and then switch to bicycle in the place of Velib' dock through the intermodal journey planner.

The solution will rely a lot on VGI as well on developing some ways to effectively and promptly share the information between the users of the platform. One such way can be sending to user an SMS notification if there is a traffic accident on the route he has selected in intermodal journey planner. Also all major accidents inputted by users can be twitted through Twitter social network.

The Czech Republic

The Liberec Region in the Czech Republic will utilise the OTN project for routing rescuers during emergency situations such as flooding. At first, the road network should be extended by field and forest tracks. Then some sources of real time traffic data will be connected to the project database. Possible sources of real time data include:

- weather and hydrological conditions at various hydrometeorological stations throughout the country from the Czech Hydrometeorological Institute,
- actual data about the traffic conditions (ongoing road-works, traffic accidents, traffic jams etc.) from the Road and Motorway Directorate of Czech Republic,
- volunteered geographic information (VGI).

All these data need to be taken into account to provide rescuers with as precise routing as possible. The cost of delay in an emergency situation can be high.

Materials and methods

Traffic volumes and their prediction

In addition to the routing functionality, which is essential for almost any transport application, there is a need to predict traffic volumes. This should improve the quality of the transport applications in the pilot regions. Martolos and Šindlerová (2013) designed a methodology for traffic volume predictions.

In Belgium, there is a need to take some measures, which were already mentioned above such as change in public transport, arrange more parking lots and improve cycling infrastructure. In order to avoid traffic jams that could happen as a result of multiple road closures due to planned roadworks, there is a strong need to assess traffic volumes and their redistribution over the network. Calculating traffic volumes using short measurements is helpful in these situations. The workflow was described by Martolos and Bartoš (2012).

In United Kingdom, there is a need to analyse factors influencing the location of traffic accidents. An example of such factor can be high traffic volumes at certain road segments. In France and the Czech Republic the need of the traffic modelling is not so obvious because the pilots are mainly dealing with real time data. However, the traffic volumes models can be used to assess the situation on the transport network and to improve quality of the routing service.

In order to compute traffic volumes there is a need to have a well described traffic network. Such a traffic network has to be topologically clean and consistent – to allow routing (see for example the INSPIRE Data Specification on Transport Network[6]). Good to know the traffic volumes is particularly true in densely populated areas with big traffic. It is a parameter of a road network which describes the amount of vehicles which go through a network segment in a time period. Together with an information about the maximum capacity of network segments, it can be forecasted where the volume of traffic is going to cause traffic disruptions and traffic jams. We can distinguish three types of traffic volumes:

- daily traffic volume (different for each day from Monday to Sunday),
- annual average of daily traffic volume,
- peak traffic volume – in the busiest hour of the day.

A long term predictions can be made calculating the traffic volumes 10, 20 or even 30 years into the future.

Input data and parameters

In general, there are three basic types of data necessary for traffic volume calculation:

- Traffic generators - demographic data about places that are usually represented as points. These points can be cities, city districts or building blocks – it depends on the granularity of the data and the desired level of detail. These data are used for estimation of traffic flows in the network. Distinguishing between different types of places such as living, industrial, service or shopping place is useful for estimation of traffic flows direction changes in time.
- Road network - well defined and topologically correct road network is the fundamental constraining graph structure, which describes the allowed movements between different places.
- Calibration measurements - physical measurements of traffic volumes (traffic censes) at particular spots of the traffic network are used for calibration of calculated volumes.

Process of traffic volume calculation

There exist several tools for traffic modelling, for example EMME, CUBE, PTV VISUM, SATURN, TRANSCAD or OmniTrans. All of them are based on similar principles:

- First of all, the road network topology and consistency have to be checked (deleting pseudo-nodes, cleaning gaps and overlaps). Then junctions are computed and turns defined.
- Then, as the places do not have to lie exactly on a network segment, a connector from each place to the nearest network part (junction or segment) is created. The defined crossing with the network represents a point, in which the people enter the network and generate the traffic.

The two above described points are usually

[6] D2.8.I.7 INSPIRE Data Specification on Transport Networks – Guidelines - http://inspire.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_TN_v3.0.pdf

realised in a geographic information system (GIS). The following steps are calculated in a transport engineering software:

- Using the demographic data about traffic generators, various types of traffic volumes are calculated, see for example the work of McShane at el (1990) for more details. This step produces relative volumes – it can be visualised which road segment has higher traffic volume then the other.
- Afterwards, those relative volumes are calibrated on absolute values from traffic censuses.
- The final step is an export from a transportation software to a GIS, where the data can be visualised or used together with the rest of geographic data.

Results and discussion

Traffic volumes in OTN

The above described peak and daily traffic volumes are useful for crisis management (Liberec Region), ordinary routing (France), road safety analysis (UK) and redirecting of traffic flows (Belgium). Furthermore, regional network reconstructions as well as regional and urban planning can take advantage of long term traffic volume predictions. Therefore, various types of traffic volumes are going to be calculated in the OTN project as a unifying theme which naturally interconnects all four pilots. As the project is still in an early phase (started in February 2014), only a demonstration of traffic volume calculation was prepared.

Traffic network ready for traffic volume calculation

Basic settlement units (source ArcČR 500[7]) and a road network from the Road Databank of the Czech Republic were used for the demonstration. The road network is topologically correct with well-defined junctions. First of all, the connectors were calculated (see Figure 1).

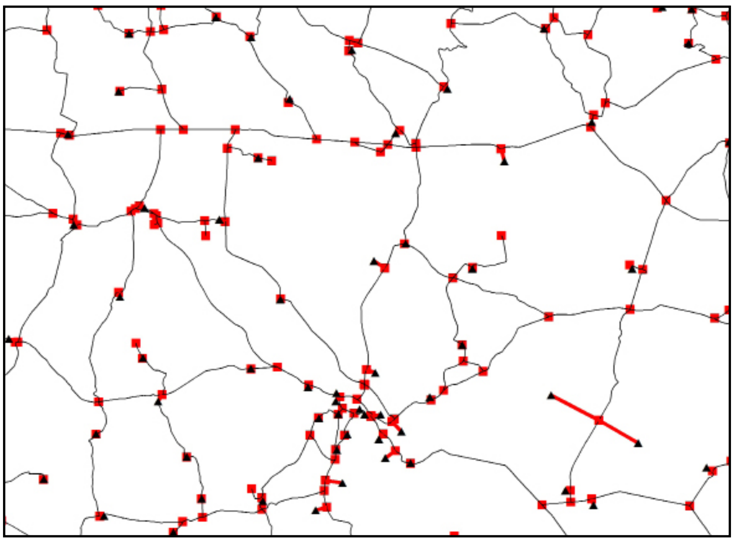
Traffic volumes calculated on the road network

The prepared data were imported into the OmniTrans software. Then the annual and daily volumes were calculated. See Figure 2 for comparison of volumes for different days of a week as an example of time variability of the volumes.

The difference of the traffic volume in an average day hour and a peak hour can be portrayed to see, which road segments are heavily affected by traffic peaks (Figure 3).

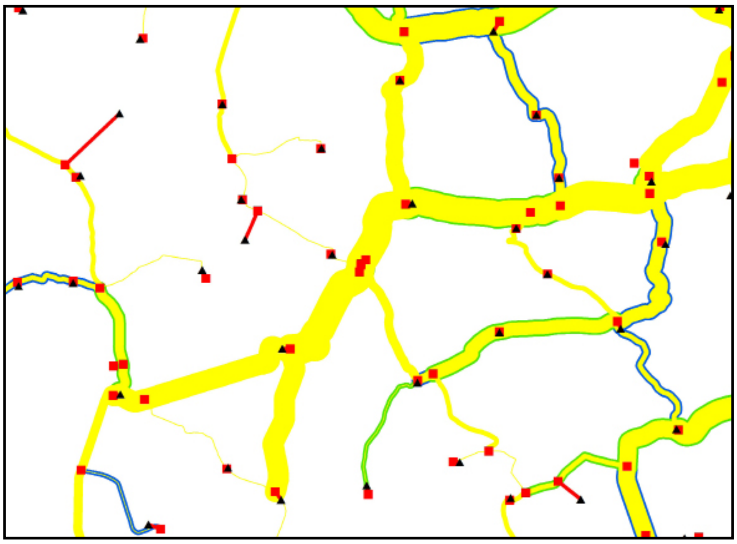
Other visualisations can be created. For example a visualisation comparing calculated traffic volumes with the maximum traffic capacity of each segment can detect potential traffic delays and traffic jams. Using long term traffic volumes predictions in urban planning can dramatically improve the quality of live in a city or a region.

[7] ARCDATA PRAHA - http://www.arcdata.cz/produkty-a-sluzby/geograficka-data/arccr-500/



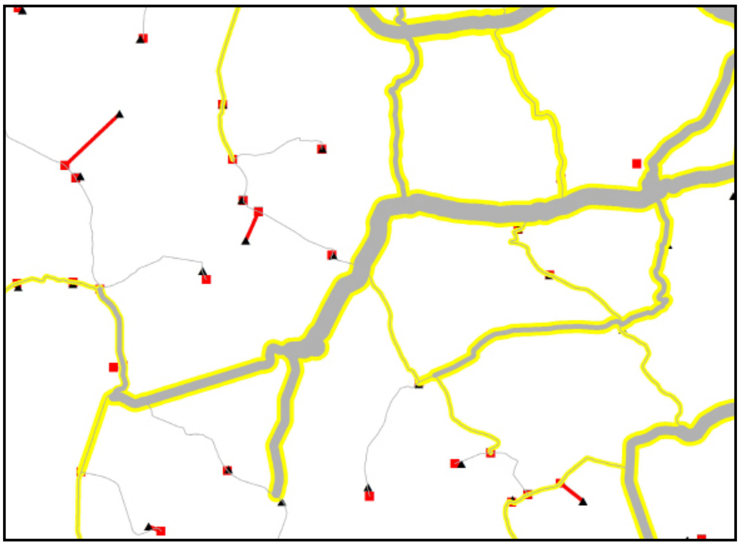
Source: own laboration

Figure 1: Road network (black lines), places (black triangles) and connectors (red lines).



Source: own laboration

Figure 2: Saturday (yellow), week day (green), Friday (blue) traffic volumes displayed using the line segment width..



Source: own laboration

Figure 3: Average hourly traffic volume (grey) and peak (yellow) traffic. The thicker line, the heavier peak traffic.

Conclusion

The article described the main goals of the OTN project in the pilot regions and basics of using traffic volumes. Including traffic volumes into computations could significantly improve the quality of the results of certain operations (for example routing computation, modelling traffic redirection) as well as help to get deeper understanding of events related to traffic (for instance traffic accidents) or even the traffic flow nature in particular region. The modelled traffic volumes can show not only current, but mainly future bottlenecks of regional transportation infrastructure (see the Belgium pilot) and therefore it can be taken into account for future regional transportation infrastructures.

The article will be followed by the practical applications that will be validated through the pilot regions. Based on the achieved results it will be possible to do the real assessment of benefits using the traffic volumes in such computations.

The OTN project aims to increase the use of open and geographic data in the transport domain. Transport is essential for various specialisms including forestry and agriculture. The OTN pilot regions serve as test beds for the OTN solution that should be replicable and could be used in other regions and specialisms. For example engineering vehicles such as tractors in agriculture significantly influence the speed and flow of traffic. This usually results in congestions and higher carbon emissions. An application using prediction of traffic volumes could optimise the routes for such vehicles.

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References

[1] Charvat, K., Mildorf, T., Tuchyna, M., Vohnout, P., Krivanek, Z. SDI4Apps. 2014 IST-Africa Conference and Exhibition, IST-Africa 2014, Le Meridien Ile Maurice, Mauritius. 6 May 2014 through 9 May 2014. ISBN: 978-190582444-1.

[2] Goodchild, M. F. Citizens as sensors: The world of volunteered geography. In The Map Reader: Theories of Mapping Practice and Cartographic Representation, eds. Dodge, M., Kitchin, R., Perkins, C., Wiley, London, 2011, p. 370-378. ISBN. 978-0-470-74283-9.

[3] Janečka, K., Berzins, R., Charvát, K., Dzerve, A. On How to Build SDI Using Social Networking Principles in the Scope of Spatial Planning and Vocational Education. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 6783 LNCS (PART 2). 2011, p. 78-92. ISBN 978-3-642-21887-3.

[4] Janečka, K., Čerba, O., Jedlička, K., Ježek, J. Towards interoperability of spatial planning data: 5-steps harmonization Framework. International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM. June 16-22, 2013, Vol. 1, p. 1005 - 1016. ISBN 978-954-91818-9-0 / ISSN 1314-2704.

[5] Martolos, J., Bartoš, L. Možnosti stanovení návrhových intenzit dopravy na základě krátkodobého měření. Dopravní Inženýrství. Febr. 2, 2012. [On-line] Available: http://www.dopravniinzenyrstvi.cz/clanky/moznosti-stanoveni-navrhovych-intenzit-dopravy-na-zaklade-kratkodobeho-mereni/ [Accessed: 15 Oct. 2014]. ISSN 1801-8890.

[6] Martolos, J., Šindlerová, V. Nová metodika stanovení intenzity generované dopravy. Dopravní Inženýrství. Jan 1, 2013. [On-line] Available: http://www.dopravniinzenyrstvi.cz/clanky/nova-metodika-stanoveni-intenzity-generovane-dopravy/ [Accessed: 15 Oct. 2014]. ISSN 1801-8890.

[7] McShane, W. R., Roess, R. P. Traffic engineering. In Prentice Hall polytechnic series in traffic engineering, Englewood Cliffs, N.J, Prentice-Hall. 1990, p. 643-656. ISBN: 9780139261480.

[8] OECD. Impact of Transport Infrastructure Investment on Regional Development. 2002, p. 152. [On-line] Available: http://www.oecd-ilibrary.org/transport/impact-of-transport-infrastructure-investment-on-regional-development_9789264193529-en [Accessed: 3 Jun. 2015], ISBN: 9789264193529.

[9] Rietveld, P. Infrastructure and regional development. The Annals of Regional Science. 1989, Vol. 23, No. 4, p. 255-274. [On-line] Available: http://link.springer.com/article/10.1007/BF01579778 [Accessed: 3rd Jun. 2015]. ISSN: 1432-0592.

[10] Ruston, S., Mareels, G., Vaysse, L. Open Transport Network, Deliverable 1.1, Project Vision. 2014. [On-line] Available: http://www.opentransportnet.eu/otn/sites/default/files/OTN_D1.1_Project%20Vision_v2.3.pdf [Accessed: 15 Oct. 2014].

[11] Ruston, S., Cave, B., Vaysse, L., Smits, G., Radford, A., Kozuch, D., Charvat, K. (2014). D2.4 Co-design Workshops Reports. 2014, [On-line]: http://opentnet.eu/otn/sites/default/files/OTN%20D2.4%20Co-Design%20Workshop%20Reports_v1.0.pdf [Accessed: 15 Oct. 2014].

[12] Ruston, S., Lievens, B. Open Transport Network, Deliverable 2.3, Pilot Scenarios. 2014. [On-line] Available: http://www.opentransportnet.eu/otn/sites/default/files/OTN%20D2.3%20Pilot%20Scenarios%20v1_v3.1-4.pdf [Accessed: 15 Oct. 2014].

[13] Yusoff, N. M. R. N., Shafri, H. Z. M., Muniandy, R. An effective road management system using web-based GIS software. IOP Conference Series: Earth and Environmental Science. 2014, Vol. 20, No. 1. Article number 012025. 7th IGRSM International Conference and Exhibition on Remote Sensing and GIS, IGRSM 2014; Kuala Lumpur; Malaysia; 21 April 2014 through 22 April 2014. ISSN: 17551307.

[14] Zhang, H., Feng, Z., Gao, R. Research and development of intelligent decision system for highway maintenance based on GIS. In Proceedings of 2011 International Conference on Electronic and Mechanical Engineering and Information Technology, EMEIT. 2011, Vol. 4, Article number 6023483, p. 1945-1948. ISBN: 978-161284085-7.

Mobile Applications for Agricultural Online Portals – Cross-platform or Native Development

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Anotace

K vývoji aplikací pro mobilní zařízení existuje několik možných přístupů. Článek se zabývá možnostmi vývoje nativních aplikací pro mobilní zařízení. Analyzuje základní ekonomické aspekty pro dva přístupy - vývoj nativních aplikací pomocí nástrojů pro jednotlivé platformy (Windows Phone, Android, iOS) a vývoj nativních aplikací pomocí multiplatformních nástrojů, který představuje nástroj Xamarin. V článku jsou definovány základní proměnné a vzorec pro výpočet nákladů. Závěry ukazují, že použití multiplatformního nástroje Xamarin může přinést výraznou úsporu. Je však nutný další výzkum především v oblasti složitosti vývoje multiplatformními nástroji a splnění požadavků na UI a UX..

Klíčová slova

Mobilní zařízení, aplikace, Android, iOS, Windows Phone, Xamarin, náklady.

Abstract

There exist several possible approaches to the development of mobile applications. The paper treats the options of native applications for mobile devices. It analyzes economic aspects of two approaches - native applications development with the help of tools for individual platforms (Windows Phone, Android, iOS) and native applications developed by cross-platform tools represented by the tool Xamarin. In the paper basic variables and a formula for costs calculation are defined. The conclusions show that the utilization of the cross-platform tool Xamarin can lead to significant costs reduction. However, further research is needed mainly in the area of both the complexity development by cross-platform tools and meeting the requirements on UI and UX.

Key words

Mobile devices, applications, Android, iOS, Windows Phone, Xamarin, expense.

Introduction

Our contemporary society has been characterized not only by a permanently growing number of information sources but also by an access to these sources from various client devices and platforms. An enormous growth has been recorded especially in the area of single-purpose or multi-purpose mobile devices. There exists an inexhaustible number of mobile devices using several platforms from which users connect to the server sources of information. Sales of smart phones have been higher than those of classic notebooks even though a slight decline of growth in 2015 has been proposed (Gartner, 2014).

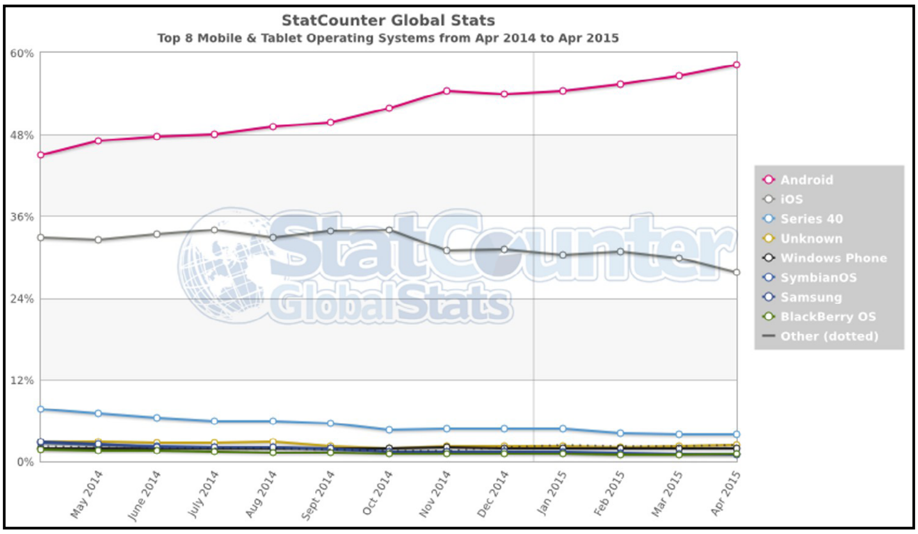
Owing to the development of mobile devices and mobile and wireless access to the Internet, the number of accesses not only to web portals with the use of mobile devices has been rising. The situation seems to be the same in the area of agriculture, forestry, water supply and distribution, countryside, food industry etc. There exist several approaches how to make this access simpler for users. The first approach is the optimization of web pages with the utilization of responsive design with the help of module media queries in CSS3 (Nebeling 2013). The second approach means the creation of own applications for these devices. In the market with the mobile operational systems there exist three most widespread platforms - Google Android, Apple iOS a Microsoft Windows Phone. The statistics of accesses to web pages can be seen in Figure 1. You can see here Series 40 item, too. That primarily belongs to older devices Nokia with the operational system Symbian S40. These devices have already been in decline and this operational system is no longer developed or supported.

There exist three types of approaches to the development of own applications for mobile devices - native applications development, hybrid applications development, native applications developed by cross-platform tools. In the case of a Native mobile application there is the need of development for each platform separately - using various tools and technologies including the creation of updates. The orientation of native applications to concrete platforms puts serious obstacles in the path of the utilization of different development environments, technologies and API which inevitably leads to waste of time and effort including higher expenditure on maintenance (Xanthopoulos and Xinogalos, 2013). The advantages of hybrid applications lie in the fast development, fast updates and relatively easy extension of application. The opposite could be a non-optimum result in terms of UI (User Interface) and UX (User eXperience). According to Amatya (2013) this approach is the best one for the development of cross-platform applications. Nevertheless, another approach has recently appeared - native applications developed by cross-platform tools. This approach combines advantages of the previous two approaches. The most powerful representative in this area is the tool Xamarin. Its disadvantage is the higher price of licenses for development tools. According to Seung-Ho (2015) there are two key factors in the development of mobile applications – one is a user interface design, and the other one is an efficient utilization of device capabilities such as various sensors, cameras, network interfaces. Both these factors are met by this tool in the same way as native applications.

One of the most frequently visited information sources of the agrarian sector in the Czech Republic is the agrarian WWW portal Agris. The main aim of the agrarian WWW portal Agris is to create a unified on-line information space on the Internet for the area of the agrarian sector (agriculture, food industry, forestry, water supply and distribution) and rural areas. The task group of users consists of enterprises' managers, managers from state and local administration, students, all consumers of food and inhabitants of rural areas.

The area of the agrarian sector and portal task groups brings a number of special characteristics and requirements for these applications.

- Possibility to store articles offline
    - In rural areas in the Czech Republic there occur problems with the cover by mobile networks, especially data services and their quality
- Simplicity and intuitiveness of the application
    - It should comply with well-tried standards for the respective platform
    - Hybrid applications don't meet this requirement



Source: http://statcounter.com

Figure 1: Mobile operating systems statistics.

- Adequate demands on the mobile device performance
- The use of similar applications is expected in the sector where wages and salaries are on a lower level. There we can expect the use of older and less efficient devices.
- The assumption of limited funds for the development of the application is closely connected with the previous point

Within the framework of research projects at the Department of Information Technologies (Faculty of Economics and Management, Czech University of Life Sciences Prague) several applications for the agrarian portal have been developed: a web mobile application, a native application with the help of cross-platform tool Xamarin and simultaneously an application for OS Android with the use of native development tool Android Studio.

The aim is the analysis of possibilities of native applications (for mobile devices) development. Basic economic aspects for two different approaches have been analyzed: a) the development by means of native development tools for an individual platform (Windows Phone, Android, iOS) and b) the cross-platform tool Xamarin. The analysis should provide an answer to the basic hypothesis whether it is economically favourable to develop applications with the help of this tool or not.

Materials and methods

In the case of native mobile applications there is the need of development for each platform separately - using various tools and technologies including the creation of updates. With the increasing number of platforms the length of needed time grows, too; and so do the costs of mobile applications' generation and maintenance. Nevertheless, there is the advantage of an optimum result in the form of stable and fast mobile applications with a possibility to work off-line. To utilize these advantages, tools for the development of native applications by means of cross-platform tools are being created (for all the platforms at the same time).

Android

The operational system Android is the most open platform. The native development proceeds in the JAVA language and development environment (IDE) Android Studio which is based on IntelliJ IDEA. Nevertheless, the resulting applications do not use JAVA Virtual Machine, but an own solution in the shape of Dalvik, or from Android 5.0 ART (Android Open Source Project, 2015).

From the point of view of costs, the developmet for this platform only requests the payment for the developer account amounting to $25 (Android Developers 2 2015). This is a lump sum and thereafter it is possible to publish an unrestricted number of applications.

iOS

For the development of applications for this platform the IDE Xcode is used. For the programming itself languages Objective C and Swift are utilized (Apple 2015). For a completely functional development, and for the application testing in particular, it is necessary to build applications on Apple devices (Macbook, iMac, etc.). The license for the developer account is subject to a fee amounting to $99 annually. Development tools are provided free of charge.

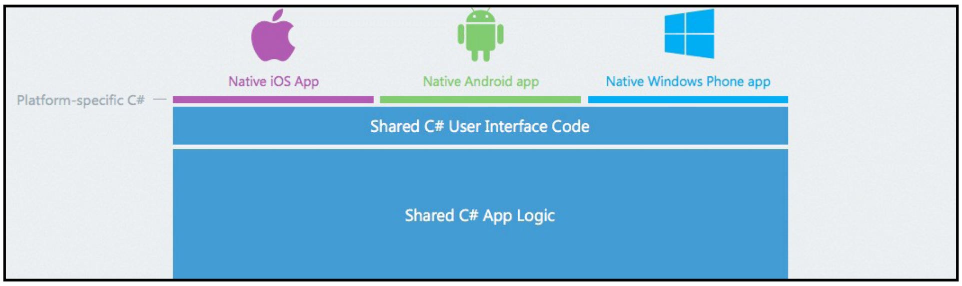
Windows Phone

For the development of applications for the operational system Windows Phone (Windows 10 in the future) development environment (IDE) Visual Studio is used. This environment exists in several variations. The development is possible in variations such as Community, too. And these variations are free of charge. The development itself proceeds under the platform of the framework .NET (it is possible to use languages C# or Visual Basic) (Microsoft 2015).

From the point of view of costs, it is again necessary to pay a lump sum for the developer account. Here Microsoft offers two rates. The Individual account variation (for individuals or small unincorporated groups) costs $19. The Company account variation (for businesses, mobile operators or OEM) the fee amounts to $99 (Windows dev center 2015). The latter provides authors and developers with more opportunities.

Xamarin

Xamarin is a set of tools for a cross-platform development. It facilitates the developing of native applications which share the same code across platforms (Xamarin 2015). The situation is shown in Figure 2. Applications thus do not have the disadvantages of hybrid applications in the form of nonstandard user interface. As a development tool it is possible to use special Xamarin Studio or Microsoft Visual Studio (for some licenses only). The development then proceeds with the help of programming language C#.



Source: http://xamarin.com/platform

Figure 2: The chart of the shared code for applications developed with the help of the Xamarin tool.

This tool also facilitates - in contrast to hybrid applications – an access to nearly all native API individual platforms. Xamarin (2015) writes bluntly: „Xamarin apps have access to the full spectrum of functionality exposed by the underlying platform and device, including platform-specific capabilities like iBeacons and Android Fragments." Thus it is possible to use all functions of mobile devices such as cameras, sensors, print readers etc.

From the point of view of costs, Xamarin already requests payments for licenses and offers four basic variations. In principle, all licenses are bound to one developer, platform and year. The payment is needed for iOS and Android, but Windows platform is free of charge. More detailed price list is shown in Figure 3.

Variations of licenses differ in opportunities which they provide to developers.

1. Starter Edition
    - 1.1. The development with the help of Xamarin Studio
    - 1.2. Free of charge, for small applications, development testing, deployed only to devices only
2. Indie
    - 2.1. The development with the help of Xamarin Studio
    - 2.2. Designed for individual developers or companies with up to 5 developers
3. Business, Enterprise
    - 3.1. The opportunity to use MS Visual Studio
    - 3.2. For companies with more than 5 developers
    - 3.3. Business features and other opportunities such as e-mail support, tuition, etc.

Costs of development

Costs spent on the development of applications for individual platforms belong to key criteria as to the determination which approach to the development to choose. Total costs include several items. Above all, it concerns the price of programmers' / developers' work. Furthermore, it is necessary to include the payment for the license of the development tool and price for publications. Native development tools for individual platforms are provided free of charge. With the cross-platform tool Xamarin there is the need to pay for the license. Prices are calculated per a developer and a platform for which it is possible to develop, with the exception of Windows Phone which is always free of charge. For individual developers the price is $538.2 for all the platforms. In the case of applications development it is necessary to calculate with a license for organizations which amounts to $1,798.20 for all the platforms. On top of that, there is the need to include the fees connected with publishing in respective application shops. Total costs are shown in Table 1.

For publishing in the Google Play shop a lump sum of $25 is paid. Such a lump sum must be paid in the case of Microsoft Store, too. Nevertheless, price policy here is divided into individual accounts and accounts for organizations. In the case of the iOS platform the payment for a developer account amounts to $99 annually.

Furthermore, there is the need to include personal costs for developers, e.g. their wages or salaries. In the case of the development for individual platforms it is necessary to allow for three developers, or for one developer only, but with triple time needed for the development. From the point of view of the costs calculation, it is the same. In the case of cross-platform development it is not possible to divide the time simply by three. It is necessary to take into consideration individual

Source: http://xamarin.com/platform

Figure 2: The chart of the shared code for applications developed with the help of the Xamarin tool.

	Xamarin Individual	Xamarin Organisation	Native Development	Native Dev. (Individual)
IDE	$538.2 per year	$1798.2 per year	0	0
Google Play	$25 once	$25 once	$25 once	$25 once
iOS Appstore	$99 per year	$99 per year	$99 per year	$99 per year
Microsoft Store	$19	$99	$19	$99
	once	once	once	once
Total $	**681.2**	**2021.2**	**138**	**223**

Source: own processing

Table 1: Expenses for application stores and IDE licenses.

adjustments for individual platforms.

Overall, it is possible to set several key variables for the calculation of total costs.

ide - Price for development tools (IDE). This variable can be taken into consideration only with the development tool Xamarin where there is the need to pay for the license.

google, apple, ms - Prices for publications of applications in respective application shops (Google Play, Apple Appstore, Microsoft Store). This price is paid for a development account which can publish an unrestricted number of applications.

gAppN, aAppN, mAppN - Numbers of applications published in individual shops among which it is necessary to divide the costs for a development account.

devE - Monthly costs for one developer.

devL - The length of application development in months.

devN - Key factors are the number of developers and the length of development.

Results and discussion

In previous chapters there have been indicated analyses of possible native applications development for mobile devices. Based on established cost items, key variables have been set. Thus it was possible to put together a formula for the general calculation of total costs for the development of an application.

$$Total\ costs = \left(ide \times devN + \frac{google}{gAppN} + \frac{apple}{aAppN} + \frac{ms}{mAppN}\right) \times \frac{devL}{12} + devE \times devN \times devL$$

For a model calculation a beginning company (Startup) was considered. The given application will be developed by one developer in the case of the tool Xamarin utilization. For native development environment three developers will be considered. The length of the development was set at 6 months for the utilization of the Xamarin tool, 4 months for a native development. Calculation values can be seen on Table 2.

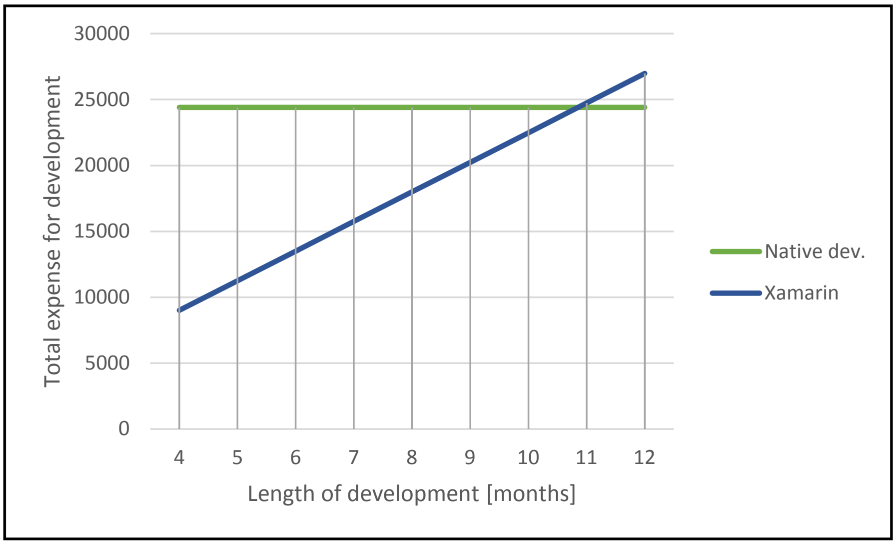
From the calculations it is clear that the key factors are the length of the development and the number of developers. For the development by means of native tools it is necessary to employ 3 developers, especially because of time demand. When choosing the approach to application development, the most important factor is the length of application development and thus the complexity of the development with the use of the cross-platform tool Xamarin.

Based on the above stated formula, it is possible to deduce the requirements of the development

	Xamarin Individual	Xamarin Organisation	Native Development	Native Dev. (Organisation)
IDE + Publication	340.6	1010.6	46	74.33333333
Developer per month	2000	2000	2000	2000
N° of developers	1	1	3	3
Length of dev.	6	6	4	4
Developers exp.	12000	12000	24000	24000
Total	**12340.6**	**13010.6**	**24046**	**24074.33333**

Source: own processing

Table 2: Total expenses for development.



Source: own processing

Graph 1: Native and Xamarin development comparison.

and the critical value when it is worthwhile to use cross-platform development environment Xamarin. First, the costs per one month of development with the use of formula XX were calculated. Variables set up in the previous chapter were used. To simplify the calculation, costs for development account Google Play and Microsoft Store were removed. These are lump sums and from the previous formula it follows that their influence is not that big.

$$Monthly\ costs = apple + devN \times ide + devN \times devE$$

After the substitution into the formula, monthly costs for native development amount to \$6,099. For the tool Xamarin they amount to \$2,248.85. From these data we can define the complexity coefficient of mobile applications development, which is in this case 2.71. If the native development lasts 4 months, the multiplatform development must not last longer than 10.84 months. This relation is presented in Graph 1.

Conclusion

The paper primarily treats the economic aspects of the choice of approach to the development of a native application for mobile devices. The given formula for the calculation of costs for development can be utilized in general. From the formula it is clear that the key factor is the time demand - the length of application development. Fixed costs for development environment and applications publication are - from the long-term point of view - less important. As assumed, the highest cost items are developers' salaries.

The performed analysis for the setting of exact economic indicators should be more detailed. However, it is sufficient for the purpose of our basic aim and research questions. It shows that the cross-platform development of native applications with the help of the tool Xamarin could significantly reduce costs and thus increase profit.

For the subsequent research it is possible to formulate some conclusions and solutions.

There is the need to set up the complexity coefficient of applications development with the use of the Xamarin tool. To maintain cost effectiveness, this coefficient should not be higher than 2.7. From the existing research it seems to be substantially lower. In the subsequent research it is necessary to set up this coefficient. Even though this requirement is unfeasible on general level, it seems to be feasible for the purpose of specific types of applications (for example for news portals such as Agris.cz).

It is also necessary to assess if the application created with the help of the Xamarin tool meets the requirements on user interface, especially in the area of applicability and User Experience (UX) of the respective platform. Possible adaptation could lead to a disproportionate increase of the complexity coefficient. This tool enables the creation of user interface natively for each platform separately. However, a question arises whether this approach is useful or not.

A more detailed analysis and the creation of relevant economic or econometric modules could help with setting the limits of cost effectiveness in key aspects (the length of development, complexity coefficient, number of developers, costs per a developer).

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References

[1] Account type. Windows Dev Center. 2015, [Online] Available: https://appdev.microsoft.com/StorePortals/en-US/Account/Signup/SelectAccountType [Accessed: 11 March 2015].

[2] Amatya, S., Kurti, A. Cross-Platform Mobile Development: Challenges and Opportunities. Advances in Intelligent Systems and Computing. 2013, Vol. 231, p. 219-229. ISSN 2194-5357. [Online] Available also: http://link.springer.com/10.1007/978-3-319-01466-1_21 [Accessed: 16 May 2015].

[3] Android Developers. Android Studio Overview. 2015, [Online] Available: http://developer.android.com/tools/studio/index.html [Accessed: 11 May 2015].

[4] Android Developers. Get Started with Publishing 2015, [Online] Available: http://developer.android.com/distribute/googleplay/start.html [Accessed: 10 May 2015].

[5] Android Open Source Project. ART and Dalvik 2015, [Online] Available: http://source.android.com/devices/tech/dalvik/index.html [Accessed: 10 May 2015].

[6] APPLE. Developer. 2015, [Online] Available: https://developer.apple.com/ [Accessed: 28 May 2015]

[7] Gartner Says Sales of Tablets Will Represent Less Than 10 Percent of All Devices in 2014. Gartner. 2014, [Online]. Available: http://www.gartner.com/newsroom/id/2875017 [Accessed: 25 May 2015].

[8] LIM, Seung-Ho. Experimental Comparison of Hybrid and Native Applications for Mobile Systems. International Journal of Multimedia and Ubiquitous Engineering. 2015, Vol. 10, No. 3, p: 1 - 12. DOI: 10.14257/ijmue.2015.10.3.01.

[9] MICROSOFT. Windows Dev Center. 2015, [Online] Available: https://dev.windows.com/en-us/home. [Accessed: 11 May 2015].

[10] Nebeling, M., Norrie, M. C. Responsive Design and Development: Methods, Technologies and Current Issues. p. 510. DOI: 10.1007/978-3-642-39200-9_47. [Online] Available also: http://link.springer.com/10.1007/978-3-642-39200-9_47. [Accessed: 15 May 2015].

[11] XAMARIN INC. Xamarin Platform: BUILD BETTER APPS. 2015, [Online]. Available: http://xamarin.com. [Accessed: 11 May 2015].

[12] Xanthopoulos, S., Xinogalos, S. A comparative analysis of cross-platform development approaches for mobile applications. Published in Proceedings of the 6th Balkan Conference in Informatics. 2013, p. 213 - 220. ISBN 978-145031851-8.

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Community Co-design of a Geospatial Linked Open Data Platform for Environmental Management

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Abstract

SDI4Apps is an EU project that is building a cloud-based Geospatial Linked Open Data platform for data integration, to bridge from the top-down managed world of Geospatial Information to the bottom-up user-driven mobile world of Linked Open Data voluntary initiatives and micro SMEs developing applications using the information. To ensure its success, SDI4Apps has ensured the active participation of user communities in its co-design and validation through the implementation of 6 varied pilots involved in environmental management across Europe. Successful implementation of the SDI4Apps user communities' participation and their social validation is described in this paper. The social validation methodology has included development of specific criteria for measuring the platform's success, methods for multi-stakeholder social participation, analysis for internal and external communities and a clear set of indicators, which are now being measured during the validation process based on structured pilot scenarios. This robust stakeholders' involvement methodology, which is central to SDI4Apps, is not only generating sustainable economic returns through the interface between the users, SMEs, policy makers and scientific communities, but guarantees a solid contribution to the knowledge-driven economy and environmental management across Europe.

Key words

Geospatial Information, Linked Open Data, Environmental Management, SDI4Apps, Social Validation, Community Co-design, European Project.

Introduction

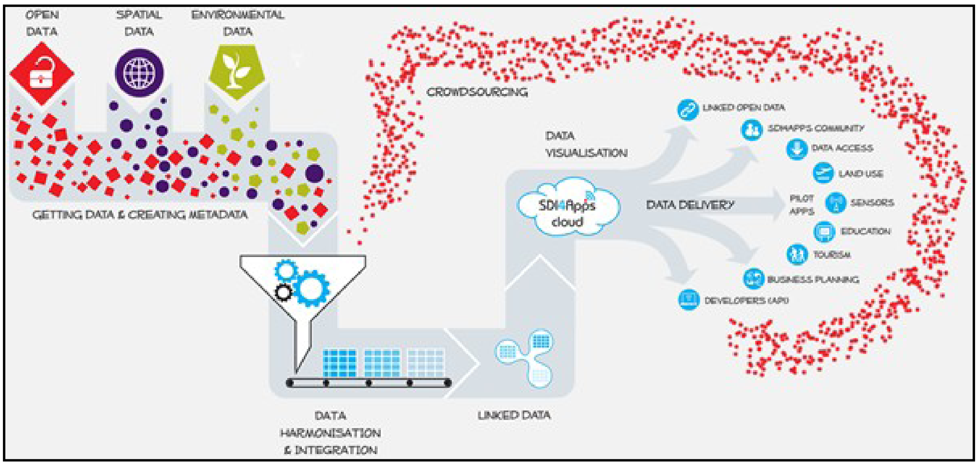
The potential of Geographic Information (GI) collected by various actors ranging from public administration to voluntary initiatives of citizens is not fully exploited. The advancements of Information and Communications Technologies (ICT) and the shift towards Linked Open Data (LOD) gives an excellent foundation for innovation based on the reuse of GI (Abbas and Ojo, 2013). The establishment of Spatial Data Infrastructures (SDI) has largely been driven by the "traditional" GI community and the national and European policies governing this sector. However now GI is no longer a separate information space but finds itself part of a larger European information space where the ultimate objective is the creation of value-added services based on use and reuse of public sector information as defined by the Public Sector Information (PSI) and Infrastructure for Spatial Information in the European Community (INSPIRE) Directives rather than exchange of "layers" between different GI software (Vilches-Blázquez, Saquicela and Corcho, 2012).

Material and methods

SDI4Apps (Uptake of open geographic information through innovative services based on linked data) is an EU Competitiveness and Innovation Programme (CIP) pilot action project that aims to bridge from the top-down managed world of INSPIRE, Copernicus and Global Earth Observation System of Systems (GEOSS) Geospatial Information (GI) to the bottom-up mobile world of LOD voluntary initiatives and micro SMEs developing applications based on GI and LOD. SDI4Apps is adapting and integrating experience from previous projects and initiatives to build a cloud based LOD framework with an open Applications Programme Interface (API) for data integration, easy access and provision for further reuse (Figure 1: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014).

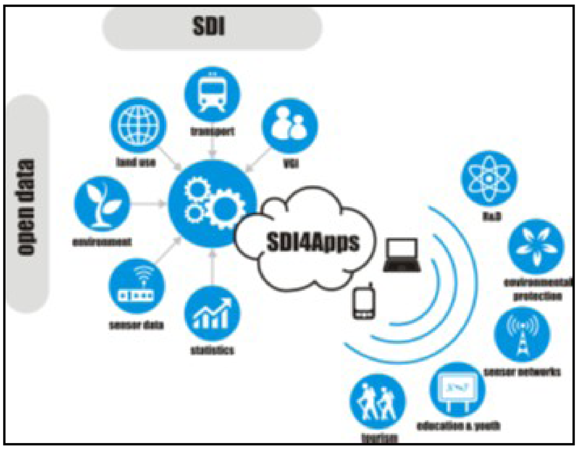
The SDI4Apps project is integrating a cloud-based platform for data reuse. On that platform, several user-driven applications (pilot apps) are being designed and implemented (Figure 2).

To ensure its success, SDI4Apps requires



Source: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014

Figure 1: SDI4Apps Platform.



Source: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014

Figure 2: SDI4Apps Pilot Applications.

the active participation of user communities in its co-design and validation through the implementation of 6 varied pilots involved in environmental management across Europe. These pilots include:

1. Easy Data Access - supporting easy access to existing services and integrate an API solution, to facilitate easy collection of information using smart phones and integrate this information into current SDIs.
2. Open Smart Tourist Data - supporting related business issues such as easy integration of the SDI4Apps system into proprietary solutions (thanks to the implementation of standards), reusing and sharing existing information resources, channels and tools. Open Smart Tourist Data is integrating users' data, free and open global data, SDI4Apps Team's data, crowd-sourced data and social media.(Vohnout, Cerba, Kafka, Fryml, Krivanek and Holy, 2014; Karam and Melchiori, 2013)
3. Open Sensors Network - to create an environment where different groups of volunteers (for example farmers) are able to integrate low cost sensors (meteorological, quality of air, etc.) into local and regional web sensor networks.
4. Open Land Use Map Through VGI - an initiative for voluntary Open Land Use Mapping.
5. Open INSPIRE4Youth - to generate local educational multilingual environmental and cultural heritage applications for students and youth.
6. Ecosystem Services Evaluation - focused on the sustainable support of tourism.

The SDI4Apps platform and tools are being community co-designed and socially validated through these 6 deployed community pilot demonstrators that will be technically evaluated for:

1. the effectiveness of the approach for the Cloud, LOD and semantic services (Kritikos, Rousakis, and Kotzinos, 2013);
2. how well the proposed architecture can be adapted to different scenarios (Metzger, Flanagin and Medders, 2010)
3. the limitations and benefits of the approach compared to existing technologies.

Community-based businesses foster trust, commitment, high-quality of products and services, accountability, social-environmental responsibility, business ethics, and "contagious commitment". Thus in each of the 6 SDI4Apps pilots, the project nurtures the Service Provider and User concept and makes them both integral to the community co-design and social validation participatory process so that it becomes accepted as a necessary interchange and form part of an emerging business environment. The robust stakeholder involvement central to SDI4Apps is not only generating sustainable economic returns through the interface between the business and the scientific community, but guarantees a solid contribution to a knowledge-driven economy and environmental management in Europe. The long-term sustainable implementation of the SDi4Apps platform depends on three main pillars:

1. A large user community with strong commitment (based on involvement, trust and the benefits they receive from using the services).
2. A reliable supply of global SDI data content, guaranteed large scale of services.
3. A thriving private sector of small enterprises (individuals, SMEs and NGOs) that provide value-added services of mutual benefit to all involved.

Stakeholders and user groups

SDI4Apps is building user communities that actively participate in the processes of design, integration, validation and uptake of the proposed SDI4Apps cloud platform. The specific operational objectives include (Elwood, Goodchild and Sui, 2012):

- community building and management with a focus on pilot regions and potential external users and developers:
- launch and maintain the SDI4Apps platform for the consolidation of its user communities and their structured participation in key project activities;
- engage stakeholders involved in SDI4Apps pilot services on the one hand, and participants in the extensive thematic, global and trans-European networks represented by project partners on the other hand, for active participation in the SDI4Apps communities (Norton and Krummenacher, 2010);
- working with the SDI4Apps communities to develop user scenarios exploiting the availability of harmonised and interoperable data sets and services to access INSPIRE-related data by a large and extended community;
- define a validation methodology for internal and external validation of the platform
- on the basis of the project results and especially the outcomes of the validation pilot services, assess the potential impact of scaled-up adoption of SDI4Apps metadata profiles, data models and SDI services on environment-related activities that they carry out in their daily work;
- support the social validation of the system by internal user groups and external communities, and provide feedback for the technical teams.

This building of a community around the SDI4Apps Cloud, is based on a core community represented by the project partners. This community is being extended by other related communities and through organising sprint code workshops and developers' contests, as follows (Figure 3):

Source: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014

Figure 3: Learning Community Space.

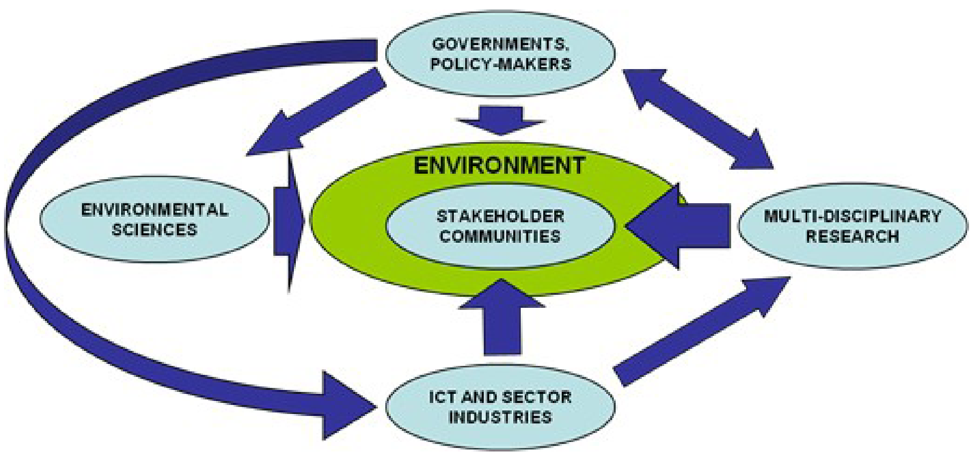
While the stakeholder mapping emphasizes the institutional/market relationships between the stakeholders driving their transactions, it is also necessary to model the technical level at which the pilot is operating and the different layers of services involved.

The stakeholder and layered service models adopted in SDI4Apps have been developed from the ICT-ENSURE project (ICT-ENSURE), which explored the broad dynamics of the contribution of ICT towards environmental sustainability, considering GI and LOD as important components Figure 4).

The SDI4Apps stakeholder mapping, based on ICT-ENSURE's analysis of the environmental management problem space, is based on institutional, operational, and economic standpoints related to the environment, and the key roles were identified as follows:

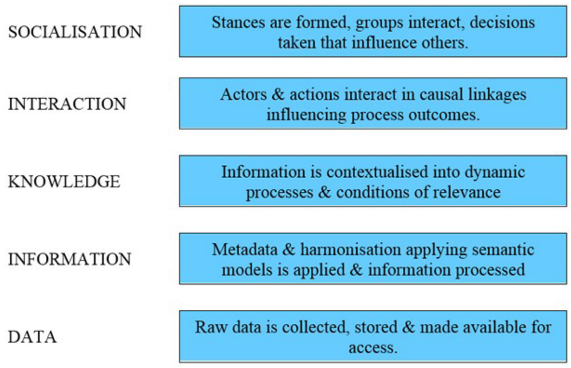
- Governments and policy-makers: mainly as funders of environmental research, the initiators of top-down actions such as SISE and SEIS, and generally institutionally mandated for the implementation of INSPIRE and open data standards. In SDI4Apps, different levels of government are represented in all of the pilot communities.
- - Environmental experts: experts in the field of the environment (generally universities or government bodies) applying GI and LOD to improve their capacity to monitor and predict; these actors generally assume an observational stance with respect to the environment, and are also present in several but not all of the SDI4Apps pilots
- ICT and sector industries: this includes in the broadest sense industrial activities with an effect on the environment, i.e. tourist organisations, agro-food multinationals, the construction industry, etc.; these stakeholders are present in several but not all of the SDI4Apps pilots. This category also includes the ICT industry and its potential interest in adopting and building its services on top of the SDI4Apps platform. Many SDI4Apps partners therefore fall into this category.
- Multi-disciplinary research: this groups socio-economic and ICT researchers into a multi-disciplinary perspective on the SDI4Apps problem space as a question of sustainable development including both the environment and human communities within it; this group drives some of the SDI4Apps pilots, particularly those with a stronger Living Lab approach.
- Stakeholder communities: these are the associations, local NGOs, etc. who represent those directly affected by environmental change; they are involved primarily in information management, dissemination and awareness activities; these actors can be said to be "inside" the environment rather than observing it and are often the "champions" within SDI4Apps pilot communities.

While the following figure illustrates the layered mapping of stakeholders for ICT services such as those that are enabled by the SDI4apps Platform (Figure 5).



Source: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014

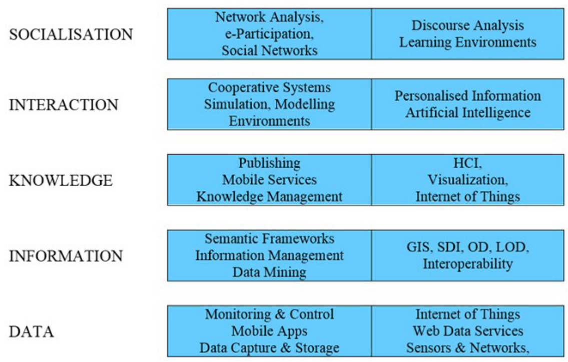
Figure 4: SDI4Apps stakeholder mapping.



Source: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014

Figure 5: Layered model of ICT relevance.

This dimension of stakeholder mapping refers to the technical level of ICT relevance, which in the ICT-ENSURE project (ICT-ENSURE), was developed as a layered model from the data level up to the social sphere where environmental information is used, as follows (Figure 6).

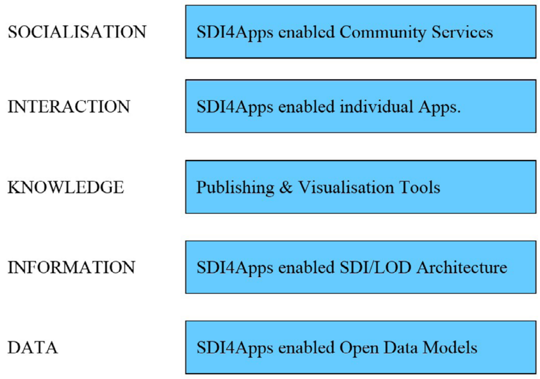


Source: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014

Figure 6: Layered ICT infrastructures and services.

This model can be directly related to the different levels of social validation with respect to data modelling at one extreme and end-user services at the other. It is useful to see how each layer associates with the relevant ICT infrastructures, services, and research fields that can make a contribution to environmental management. Many of the technologies listed here have in fact been adopted and/or explored by SDI4Apps pilots.

With specific relevance to the SDI4Apps project, the same layers can finally be developed as supporting different levels of the SDI4Apps platform-based community co-designed services, from the data access level to community and social networking services (Fig. 7).



Source: SDI4Apps Social Validation Methodology

Figure 7: SDI4Apps-based infrastructure and service layers.

Mapping of stakeholders and their interactions provides the basis for the analysis of the potential for market development of the different scenarios as thrown up by the pilots. Different pilots have their own dynamics in terms of the following elements:

- Their positioning with respect to the three impact scenarios of user engagement, user interaction and community co-design.
- The set of stakeholders involved in developing the pilot requirements and scenarios
- The role of the project partner responsible for the pilot within that stakeholder community

Social Validation

The SDI4Apps team combines partners covering the entire chain from data providers, technological developers and geospatial data experts to final end users. The consortium includes partners involved in Living Labs which is part of the overall methodology for the platform integration and social validation. The Living Labs approach, as an essential building block of SDI4Apps, is aimed to structure wide-spread end-user participation in new technologies' integration and adoption, and in research and new innovation activities. (Schade and Granell, 2014).

The SDI4Apps methodology is not using the following standard sequence of actions of pilot projects:

User requirements → Design → Development → Deployment → Testing

Instead SDI4Apps is following a different approach, as:

1. The majority of EU projects are collecting new requirements which in most cases overlap,

2. There already exists many implementations of state of the art technologies, and user requirements collection is not leading to any progress,
3. Users are interested in getting results as soon as possible, and standard project methodologies do not deliver satisfying results in time.

For these reasons SDI4Apps is using the following very different user-driven approach:

(1) Deployment of SDI4Apps Cloud platform (state of art technologies, Open Tools)

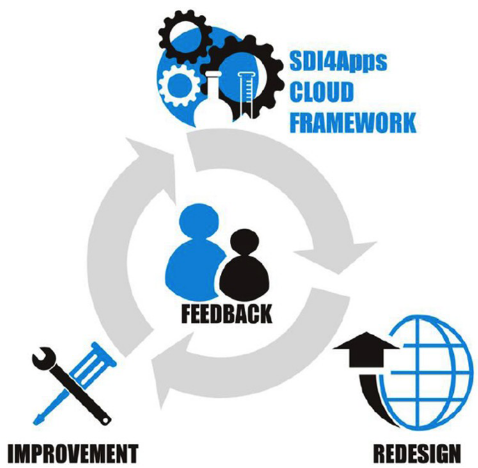
→ **(2) User experimentation and social validation in real-world scenarios**

→ **(3) Feedback from the SDI4Aps community**

→ **(4) Redesign**

→ **(5) Improvement of the SDI4Apps Cloud Framework**

→ **(6) User experimentation and social validation in real-world contexts → 2)** (Figure 8)



Source: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014

Figure 8: SDI4Apps Approach to User Validation.

SDi4Apps is bringing together the demand-driven power of the market-oriented solutions and the institutional legitimacy of INSPIRE/OD/LOD, which places the public interest before commercial needs. The approach is based on social validation, a process which engages "those who will adopt" within institutionally framed pilot experiments in the 6 diverse pilots. The social validation is being provided by defining Use Cases in the User Scenarios of each pilot, according to a defined methodology and common structured description, based on:

- Community Building and Engagement
- Emerging Business Models
- Added Value of the SDI4Apps platform
- Interoperability with other SDI4Apps Pilots

Thus central to validation of the SDI4Apps pilots are user and community actions that aim to both build individual and collective assets by better understanding and potentially improving the effectiveness and transparency of the interaction amongst different organizational and institutional contexts which govern the use of these assets.

In particular, SDI4Apps is extending to the cloud, an environment with an open API based on Open Source components. This platform, which is an extension of the current INSPIRE architecture, incorporates the basic principles of neogeography (Goodchild, 2009) and Volunteered Geographic Information (VGI) (Spinsanti,and Ostermann, 2013). These community-based techniques are being used as the main building blocks of the SDI4Apps social validation. It is allowing users and data providers to test existing technologies, customise solutions for their purposes and thereby generate further research tasks through user-driven processes.

The methodology and methods for multi-stakeholder analysis adopted for implementation in the SDI4Apps social validation builds on the tradition of community-based participatory research (Francisco and Butterfoss, 2007), asking a number of evaluative questions to assess how involved end-users and more generally the overall population are affected by a given intervention, project or programme. A key methodological reference point is the Living Labs/SSRI (Social Spaces for Research and Innovation) (SSRI) approach to deal with the social, organisational and institutional dimensions of innovation in parallel with the technical aspects, and to engage in validation activities with all user groups, stakeholders, and content providers in an open and inclusive way, supported by the SDI4Apps platform and tools.

In the early evaluative rounds that being carried out within the SDI4Apps project, social validation is related to the benefits associated with the deeper involvement of actual end-users in data access and service co-creation, according to the Living Labs user-centred open-innovation approach. In a conceptual definition of the social validation "space", the focus of application for behavioural analysis to ensure its credibility (Flanagin and Metzger, 2008) is threefold, namely:

1. **The social significance of stated goals.**
   - Do the specific development objectives correspond to what users really want?
   - Are they fulfilling a need that is shared by the prospective end users?
   - Does the broader community in which the SDI4Apps infrastructure is located value the new services as important to them?
2. **The social appropriateness of followed procedures.**
   - Do the ends justify the means?
   - Do users feel that they have a voice in SDI4Apps infrastructure improvement?
   - How do they feel they are included in the development, implementation and assessment process?
   - Do users and/or local stakeholders consider the procedures for their involvement acceptable?
   - Do they recommend them in other situations?
3. **The social importance of obtained effects.**
   - Are end users satisfied with all of the results, including any unpredicted ones?
   - Do domain experts value the effects and believe that they were indeed caused (or facilitated) by services developed using the SDI4Apps platform?
   - Does the broader community appreciate the outcomes?
   - Does it value them as something that should be extended to other domains?

Basically we look at what happened, and ask "**Did it matter** ?".

The objective of the SDI4Apps Social Validation methodology was first of all to identify specific criteria and indicators of success according to the different standpoints of the actors represented in each usage scenario, as a framework for evaluating the added value of the services that conform to the standards proposed by SDI4Apps. This activity did not start from scratch, but took into account the taxonomy of social validation approaches elaborated in the HABITATS project (Navarro and Saez, 2013), i.e.

- Validation driven by the prospect of **user engagement**

  In this case end-users are not yet directly involved in social validation, but the prospect of user engagement is already influencing institutional behaviour.
- Validation through direct **user interaction** with the **open data access** process

  With the direct participation of (expert/ non expert) users in data access.
- Validation driven by the **co-design** of innovative "demand pull" **services.**

  This is the most user-driven approach, as it actually involves final end-users in the co-design of services that use the SDI4Apps platform.

The indicator sets that have been defined so far are matched with a composite list of evaluative questions used for the pragmatic assessment of impact generated by the Apps and services enabled by the SDI4Apps platform on each of the six pilot scenarios – and more broadly, on the environmental related activities in which users are involved.

Using this method, the following table shows a broad initial estimate of the mapping of the 6 SDI4Apps Pilots from the structured descriptions of the User Scenarios (Table 1).

Pilot & Validation Approaches.	**Validation driven by the prospect of user engagement**	**Validation through direct user interaction with the open data access process**	**Validation driven by the co-design of innovative "demand pull" services**
P1. Easy Data Access	X	X	X
P2. Open Smart Tourist Data	X	X	X
P3. Open Sensor Network		X	
P4. Open Land Use Map through VGI.	X		
P5. Open INSPIRE4Youth/ education	X		X
P6. Ecosystem Services Evaluation.		X	

Source: SDI4Apps Social Validation Methodology

Table 1: SDI4Apps Pilots & Validation Approaches.

Success criteria

The social validation includes criteria for measuring the SDI4Apps platform's success, methods for multi-stakeholder social participation, analysis for internal and external communities and also a set of indicators, which is measured during the validation process based on structured pilot scenarios.

The methodology involves evolving these structured descriptions as the project and social validation develops with the communities involved. Using these structured descriptions of the 6 pilots (identified as P1 to P6 in Tables 1 and 2), the validation approach and initial mapping of each pilot's metrics and criteria of success have been identified, and the following mapping of each pilot's own success criteria for the communities involved have been identified (Table 2).

These Success Criteria for the SDI4Apps platform in each of the 6 User Scenarios has a number of issues:

1. In some cases it may be difficult to evaluate each scenario. There may be licensing issues of software components specific to certain scenarios.
2. There may be limited access to certain data - either not permitted or restricted – and the source data may need to be modified
3. One option is to use training materials prepared to assess the usability and functionality scenarios.
4. For the initial external evaluation scenarios it is necessary to prepare a set of criteria/ questions that can be targeted at specific problems and scenarios.
5. Are the scenarios understandable for developers ?

Following through on the methodology, the initial set of required SDI4Apps platform's Enabler functions that the pilots require have been grouped by its Basic and Extended Functionalities (Table 3).

These user required 9 functionalities and 15 Enablers provide input to and are now being implemented in the SDI4App platform (SDI4Apps Architecture).

Results and discussion

Implementation of the SDI4Apps Social Validation methodology is both light and effective. It has been developed from the work and experience of other projects such as HABITATS,

Pilot & Validation Approaches	Each Pilot Community's Criteria of Success	P1	P2	P3	P4	P5	P6
Validation driven by the prospect of user engagement	Usage level & Social Validation of Services that use SDI4Apps	X	X	X	X	X	X
	Easy collection of information using smart phones & LOD	X					
	More Young People using GI services					X	
	Sustainable support of tourism with ESS methodology & datasets.						X
	Local youth educational environmental & cultural heritage apps.					X	
Validation through direct user interaction with open data access processes	Integration of VGI into existing SDIs & LOD	X					
	Integrate VGI with low cost sensors in local web sensor networks			X			
	Increased access to harmonised & interoperable GI, L/OD& VGI data	X	X	X	X	X	X
	Integrate data from users', OD, crowd-sourced & social media.	X	X			X	
	VGI Open Land Use Mapping				X		
	Availability of Valuation map of ecosystems with UI & API						X
Validation driven by co-design of innovative "demand pull" services	Reuse & share tourist information resources, channels & tools	X	X				
	SMEs, Students & Researchers developing new Apps	X	X	X	X	X	
	New tourism activities, visitors & jobs, and SME developed services.	X	X		X		

Source: SDI4Apps Social Validation Methodology

Table 2: Validation approach & Initial mapping of each Pilot's Success Criteria.

SDI4Apps Functionality	SDI4Apps Enablers	P1- Easy Data Access	P2- Open Smart Tourist Data	P3 - Open Sensor Network	P4 - Open Land Use Map Through VGI	P5 - Open INSPIRE4Youth	P6 - Ecosystem Services Evaluation
Advanced visualisations	1. Advanced Visualisation framework & API (of GI & non-GI components)	X	X	X	X	X	X
Data harmonisation	2. Scalable GI to LOD transformation and harmonisation service, from many heterogeneous database sources, including HALE [HALE] support.	X	X	X			X
	3. Validation and integration tools				X	X	X
	4. Scalable publishing of harmonised data sets.				X	X	X
Integration of mobile apps	5. Scalable crowdsourced/VGI real-time data collection with Open API.	X	X		X	X	
Interoperability between local and global geospatial models.	6. Scalable Geo-focused Crawler for automatic collection of OGC services endpoints representing spatial content available via the deep web.	X			X		X
	7. Scalable intelligent deep-Web GI/LD Search & discovery with Open API		X	X		X	
	8. Scalable Smart Sensor Networks and SensorML support, to extend the PPP FI ENVIROFY Specific Enablers [ENVIROFI]			X			
	9. Interoperable scalable access to sensors			X			
	10. Analytical and modelling toolset						X
Linked Open Data	11. Scalable INSPIRE GI schema to LOD transformation and harmonisation service, with persistent URIs.	X			X		X
	12. Scalable RDF Triple Storage service for LD (such as Virtuoso)	X	X	X	X	X	X
	13. Semantic indexing infrastructure to transform GI to LOD	X	X		X	X	
Scalable execution of spatial models	14. Scalable fast PostGIS and concurrent PostgreSQL support, providing clustered real-time updates on all master databases.		X		X		X
	15. Scalable GeoServer implementation				X		X

Source: SDI4Apps Social Validation Methodology

Table 3: SDI4Apps Functionality Enablers required by the Pilots.

Plan4All, Plan4Bussiness and SmartOpenData. The methodology basically consists of iteratively presenting in a structured way the best practice SDI4Apps platform to the various stakeholder communities and asking them what they want of it and how well it meets their needs, and then improving it. The methodology involves the SDI4Apps partners, users' and developers' communities, meetings, observations, surveys and other evaluation techniques to track progress against agreed indicators, as discussed above. The process and methods consists of:

1. Identifying the stakeholder communities of:
    1. Users – represented by the 6 Pilots and operation of their user scenarios
    2. Developers –
        1. represented initially by the consortium's internal partners, and
        2. later by the external developer communities that will be addressed through the activities to support External Developers
2. Asking the communities what they want in the context of what the SDI4Apps platform and tools can deliver, by:
    1. Providing the SDI4Apps infrastructure based on "best practice" architecture and tools from previous work
    2. Developing a coherent Social Validation Methodology, Plan and Indicators (SDI4Apps

Social Validation Methodology).

3. Checking if the communities are satisfied, by:
    1. Internal validation of the pilots and their users.
    2. External validation of user and developer communities using the SDI4Apps Platform to enable services beyond the pilots.

The SDI4Apps Social Validation Methodology involves communities of stakeholders that the partners define who and where they are:

1. End Users – particularly in the pilots
2. Developers
    1. Internal – to define the SDI4Apps Architecture and basic cloud functionality
    2. External – to take-up the open source SDI4Apps APIs and modules for new services.
3. Pilots – leveraging previous and existing work in defining Scenarios in terms of:
    1. Use Cases
    2. Datasets
    3. Applications and Services.

Evaluation of the SDI4Apps tools is based on community co-defined Use Cases in the User Scenarios of each pilot, in a structured format that describes the stories and context behind why a specific user or user group comes to a service or App. They note the goals and questions to be achieved and sometimes define the possibilities of how the user(s) can achieve them on the site. Scenarios are a critical method for both designing an interface and usability testing.

The methodology involves the scenarios being carried out even before they are implemented. This is based on tabulated documentation of advance knowledge of the criteria and target evaluation scenarios, and as understood by developers. This results in better implementation of the SDi4Apps platform's tools.

Good scenarios are concise but answer the following key questions (Scenarios):

- **Who is the user?** Using the personas that have been developed to reflect the real, major user groups coming to the service.
- **Why does the user come to the service?** Noting what motivates the user to come to the service and their expectations upon arrival, if any.
- **What goals does he/she have?** Through task analysis, we can better understand what the user wants of the service and therefore what it must have for them to leave satisfied.
- **How can the user achieve their goals using the service?** Defining how the user can achieve his/ her goal on the service, identifying the various possibilities and any potential barriers.

Each evaluation criterion is not being evaluated by all evaluators but is being targeted at specific groups of evaluators. The potential user groups that are being addressed include:

- **SDI4Apps Integrators:** people who have to use heterogeneous GI to meet the requirements of their daily work (e.g. integration of LOD for complex analysis). They need the actual data and access this from different facilities potentially in different formats. They have to combine various data sources and harmonise them to make use of them for their own purposes. This group should understand the SDI4Apps platform as an efficient toolset to support the required data processing. They are mainly service providers.
- **SDI4Apps Users:** consist of a large group of people who want to solve a problem and decides to use LOD for their applications / purposes – they are not interested in the harmonization of data resources itself but only in its results. Two subgroups are distinguished within this user role:
- **SDI4Apps Development of LOD:** users who are directly working with or create LOD. They transform heterogeneous GI sources and create either LOD in an already harmonised form, or LOD that doesn't need harmonisation or integration at all. They make further application modules using LOD for end users.
- SDI4Apps End-Users of Applications: people who do not use LOD directly, they only use information arising from it (indirect use of LOD) or directly use applications. Most commonly they are users at a layman level, e.g. people using navigation systems, online routing services, etc.

Implementation of Social Validation in SDI4Apps involves the 3 dimensions of Social, Technical and Validation activities as illustrated in the following table over the 3 yearly periods of the project (Table 4).

In year 1 the project has undertaken the following twin track parallel work:

1. Technical: Provide the SDI4Apps Architecture and Basic Functionality
2. Social: Build the Communities for Social Validation

Then in years 2 and 3 the project is focusing on validation in the parallel tracks of:

1. Social: Undertake the Internal Community Validation and Pilots.
2. Social: Build external Communities & Validation.
3. Technical: Add extended functionality.

These SDI4Apps activities aim to achieve the following major Social Validation Indicators (SVI) of the project (table 5).

To monitor progress of this plan the SVIs indicate how well the SDI4Apps Platform is meeting the needs of its stakeholder communities. The SVIs' focus is very much on WHAT, not HOW the various users' needs are being addressed, particularly in the pilots.

Conclusions

Any SDI/LOD platform should be seen as an evolving concept that sustains (or mediates) various perspectives or stakeholders' views. Depending on the user's interest and role within the broader community, its design and implementation (as well as the corresponding assessment process) gets reshaped by a continuous negotiation and re-negotiation with all involved actors. In addition, 'space' – or the ultimate object of any SDI/LOD Platform – is socially produced as well, which makes the validating role of socio-technical platforms such as that of the SDI4Apps social validation even more important.

It is envisaged that the robust stakeholder involvement central to SDI4Apps will not only generate sustainable economic returns through the interface between the users, SMEs and scientific communities, but guarantees a solid contribution to the knowledge-driven economy and environmental management across Europe.

SDI4Apps Dimension	Activity	Y1	Y2	Y3
Social	Social Validation Methodology	X		
	Community Building & Support	X	X	X
Technical	Basic Cloud Functionality	X		
	Extended Functions & Data transformation		X	X
Validation	Internal Validation & Pilots		X	X
	External Validation & OSS Communities			X

Source: SDI4Apps Social Validation Methodology

Table 4: SDI4Apps Social, Technical & Validation Activities.

SDI4Apps Dimension	Year 1	Year 2	Year 3
Technical	Architecture & Basic Functionality	Extended Functions.	Wider SDI4Apps Services.
Social	Build Communities	Internal Pilots, Internal Developers	Wider Communities, External Developers
Validation	Define methodologies.	Apps & APIs	New service possibilities.

Source: Charvat, Mildorf, Tuchyna, Vohnout and Krivanek, 2014

Table 4: SDI4Apps Social, Technical & Validation Activities.

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References

[1] Abbas, S., Ojo, A. Towards a linked geospatial data infrastructure, 2nd Joint International Conference on Electronic Government and the Information Systems Perspective, and Electronic Democracy, EGOVIS/EDEM 2013; Prague; Czech Republic; 26 August 2013 through 28 August 2013; Code 100240, Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), Vol. 8061 LNCS, 2013, p. 196-210. ISSN 03029743, ISBN 978-364240159-6.

[2] Elwood, S., Goodchild, M. F., Sui, D. Z. Researching Volunteered Geographic Information: Spatial Data, Geographic Research, and New Social Practice, Annals of the Association of American Geographers. 2012, Vol. 102, No. 3, p. 571-590. ISSN: 00045608.

[3] ENVIROFI. Specific Enablers for the environmental Usage Area within the Future Internet Public Private Partnership programme (FI-PPP). [Online] Available: http://catalogue.envirofi.eu/ [Accessed: 26 Aug.2014].

[4] Flanagin, A. J., Metzger, M. J. The credibility of volunteered geographic information, GeoJournal, 2008, Vol. 72, No. 3-4, p. 137-148. ISSN 03432521.

[5] Francisco, V. T., Butterfoss, F. D. Social Validation of Goals, Procedures, and Effects in Public Health, Health Promotion Practice. 2007, Vol. 8, No. 2, p. 128-133. [Online] Available: www.ncbi.nlm.nih.gov/pubmed/17384403 [Accessed: 26 Aug.2014].

[6] Goodchild, M. NeoGeography and the nature of geographic expertise, Journal of Location Based Services. June 2009, Vol. 3, No. 2, p. 82-96. ISSN 17489725.

[7] HALE. HUMBOLDT Alignment Editor. [Online] Available: https://joinup.ec.europa.eu/software/hale/description [Accessed: 26 Aug.2014].

[8] Charvat, K., Mildorf, T., Tuchyna, M., Vohnout, P., Krivanek, Z. SDI4Apps, 2014 IST-Africa Conference and Exhibition Conference Proceedings. ISBN: 978-190582444-1.

[9] ICT-ENSURE. European Union Framework Seven project ICT for Environmental Sustainability Research, Grant Agreement number 224017. [Online] Available: www.ict-ensure.eu [Accessed: 26 Aug. 2014].

[10] Karam, R., Melchiori, M. A crowdsourcing-based framework for improving geo-spatial open data, 2013 IEEE International Conference on Systems, Man, and Cybernetics, SMC 2013; Manchester; United Kingdom; 13 October 2013 through 16 October 2013; Category number E5154; Code 102429. ISBN: 978-076955154-8.

[11] Kritikos, K., Rousakis, Y., Kotzinos, D. Linked open GeoData management in the cloud, 2nd International Workshop on Open Data, WOD 2013; Paris; France; 2 June 2013 through 2 June 2013; Code 102309, ACM International Conference Proceeding Series, 2013. ISBN: 978-145032020-7.

[12] Metzger, M. J., Flanagin, A. J., Medders, R. B. Social and heuristic approaches to credibility evaluation online, Journal of Communication,Sept. 2010, Vol. 60, No. 3, p. 413-439. ISSN 00219916.

[13] Navarro, M., Saez, A. INSPIRE and Social Empowerment for Environmental Sustainability - Results from the HABITATS project. [Online] Available: www.inspiredhabitats.eu/index.php?option=com_content&view=article&id=86&Itemid=119 [Accessed: 26 Aug. 2014)]. ISBN-13; 978-84-616-3646-4.

[14] Norton, B., Krummenacher, R. Geospatial linked open services, Workshop Towards Digital Earth: Search, Discover and Share Geospatial Data 2010, DE 2010 - Future Internet Symposium; Berlin, Germany; 20 Sept. 2010 through 20 Sept. 2010; Code 101301, CEUR Workshop Proceedings, 2010, Vol. 640, p. 4. ISSN: 16130073.

[15] Scenarios. [Online] Available: www.usability.gov/how-to-and-tools/methods/scenarios.html, [Accessed: 26 Aug.2014].

[16] SDI4Apps Architecture. SDI4Apps Architecture Concept, SDI4Apps deliverable D3.1, July 2014.

[17] SDI4Apps Social Validation Methodology. Social Validation Methodology, SDi4Apps deliverable D2.2, September 2014.

[18] Schade, S., Granell, C. Shaping digital earth applications through open innovation - setting the scene for a digital earth living lab, International Journal of Digital Earth, Aug. 2014, Vol. 7, No. 7, p. 594-612. ISSN 17538947.

[19] Spinsanti, L., Ostermann, F. Automated geographic context analysis for volunteered information, Applied Geography. 2013, Vol. 43, p. 36-44. ISSN 0143-6228.

[20] SSRI. Social Spaces for Research & Innovation. [Online] Available: www.c-rural.eu/index.php?option=com_content&task=view&id=74&Itemid=2 [Accessed: 26 Aug.2014].

[21] Vilches-Blázquez, L. M., Saquicela, V., Corcho, O. Interlinking geospatial information in the web of data, 15th International Conference on Association of Geographic Information Laboratories for Europe, AGILE 2012; Avignon; France; 24 April 2012 through 27 April 2012; Code 100775, Lecture Notes in Geoinformation and Cartography. 2012, p. 119-139. ISSN 18632351, ISBN 978-364229062-6.

[22] Vohnout, P., Cerba, O., Kafka, S., Fryml, J., Krivanek, Z., Holy, S. SmartTouristData approach for connecting local and global tourist information systems, 2014 IST-Africa Conference and Exhibition, 6 May 2014 through 9 May 2014. ISBN: 978-190582444-1.

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Software Tools for Movement Visualization in Agrarian Sector

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Anotace

Rozvoj informačních a komunikačních technologií přispěl k rozvoji metod vizualizace dat. Existuje mnoho nástrojů, které umožňují monitorování pohyblivých objektů v agrárním sektoru a řada způsobů využití polohových dat a přístupu k nim. Jejich použití závisí především na uživatelských požadavcích. Každá skupina uživatelů má jiné nároky a jiné kompetence k ovládání softwarových nástrojů. Hlavním cílem tohoto článku je analýza cílových skupin uživatelů a určení vhodnosti jednotlivých GIS (geographic information system) pro různé uživatelské skupiny.

Experimentálně byly ověřeny tři způsoby užití a to: desktop, server a developer. Byly zhodnoceny jejich možnosti s ohledem na cílovou skupinu a požadovanou funkcionalitu. Testování využívalo standartní úlohy vizualizace pohybu, například zobrazení bodů, tras pohybu, polygonů a heat map výskytu. Použitá datová základna byla získána v rámci dlouhodobé spolupráce Katedry informačních technologií a Katedry myslivosti a lesnické zoologie.

Klíčová slova

GIS, Google Maps ,vizualizace pohybu, geolokace, mapové služby, uživatelské skupiny.

Abstract

Development of information and communication technology also led to development in data visualization methods. There are many tools for monitoring of moving objects in agrarian sector, and also many different approaches on how to access and utilize location data. The suitability of given solution depends mostly on user requirements. Every user group has different demands and rights when operating software tools. The main objective of this article is to analyze different user groups and suitability of various GIS (geographic information system) for them.

Three different approaches were experimentally evaluated: desktop, server and developer. Possibilities of these GIS solutions were ascertained with the target user group and required functionality in mind. Software was tested using standard movement visualization tasks, such as point location, movement paths, occurrence boundaries, and occurrence heat maps. Data used for the evaluation was procured from a long-term cooperation between Department of Information Technology and Department of Game Management and Wildlife Biology.

Key words

GIS, Google Maps, movement visualization, geolocation, map services, user groups.

Introduction

GIS originated in 1960s and its development is closely linked to the evolution of computer hardware and aeronautics (Rhind and Coppock, 1991). Computers were necessary for automated processing of large amount of information and satellite imagery provided previously unavailable data. Development of GIS started in academic environment in USA and Canada, and penetrated to government and private sector during the 70s and 80s. The two most commonly used GIS today by ESRI and Intergraph have its origins in those decades. With the wider spread of the internet, GIS development focused mainly on standardization during the 90s. In the new millennium, thanks to the boom of personal computer technology, GIS transformed from being a tool used by a handful of specialists to a ubiquitous system that is commonly used by many users, whether they need to find a closest bus stop on their mobile phone or plan a family vacation using interactive map on their desktop computer.

GIS are specialized systems for geographic data management, storage and processing (Heywood et al., 2011). They are capable of solving wide array of tasks and spatial calculations regarding the position, relationships and trends of spatial data using maps, globes, reports and charts to visualize the results (Klimešová and Brožová, 2010). One subset of these tasks comprises of movement monitoring, which models the dynamics of real world objects by capturing data about their movement and running further spatial calculations upon the data. Movement monitoring includes scenarios such as animal movement in open air, cars inside traffic, packages or containers within storage halls or during transit (Dimitrova et al., 2013), or people in city environments such as shopping malls. Using buoy with GPS locator, it is also possible to measure river stream speed, depth or water temperature in sections of the river without the need of multiple costly measurements (Hooge et al, 2001). Processing movement data helps to better understand the behavior of objects within the observed system and aids analysis and categorization of the given space, which in turn provides crucial information for tasks such as construction planning or public space organization (Koshak and Fouda, 2008).

In agrarian sector it is often required to monitor moving objects, such as animals or agricultural machinery. Positional data need to be stored and accessed in an optimized form. Various types of GIS can achieve these tasks. The specific requirements depend mostly on type of users, which access the data. Each user group has different needs and competence to handle the software tools.

Main objective of this article is to analyze different user groups and the suitability of various GIS software types for these user groups. Analysis is specifically focused on visualization of object movement. Several GIS solutions were experimentally tested with the target group and its needs in mind.

Materials and methods

According to Bonham-Carter (1994) working with GIS can be divided into three fundamental phases. Firstly, the used data has to be gathered. Then the actual GIS software is used to process the data and perform tasks and calculations. In the last phase, results are analyzed, visualized and conclusions are reached. In the area of movement monitoring, the data acquisition is usually done using GPS or other location tool, which is attached to moving objects. In case of small and closed environments such as storage halls or shopping malls, CCTV (closed circuit television) can be used instead. Movement monitoring is highly specific in the data processing phase, since it uses calculations that are tailored for visualization of movement and can be hardly used for stationary objects. The most common tasks in agrarian sector are calculation of movement paths, their occupancy, traffic density in individual nodes or routes, or the expected occurrence of an object in given area. GIS also allows additional object properties to be attached, so that multidimensional queries using various object attributes are also possible. Lastly, the output of these tasks usually comes in form of graphical representation, such as point and line for paths, polygons for significant areas or heat maps to categorize observed space. Processed data can be also used for further non-GIS calculations, such as statistical analysis.

Majority of GIS software is capable to handle these task with relative ease, but every type of GIS solution has certain specifics which can lead to different levels of performance and usability. Every individual case can therefore have different GIS solution that is most suitable. Sometimes, the basic personal version of GIS using a desktop computer is enough, other times it might be necessary to employ a more robust solution using server GIS alongside smaller hand-held clients. Some problems may require a more tailored solution developed specifically for them. This article classifies GIS and ascertains suitability of different types of GIS with respect to the user group and its needs.

GIS software categories

GIS encompasses all software that deals with geographical data in any manner or form. It is possible to separate GIS software into categories based many different criteria. Longey et al (2005) divided GIS software into five categories based on its main purpose and type of deployment:

- **Desktop GIS software** is targeted for personal computers. Software in this category can be divided by the type of operating system, or it can be separated into sub-categories based on its functionality and overall scope. There are software ranging from basic map viewers, to more complex mapping and editing systems, and very high-end systems for professional users with high demands.

- **Server GIS** processes requests from clients in the network. Those can be lightweight versions of desktop application or field devices such as mobile phones. Server GIS can usually also accommodate service using web browser interface. Its deployment is best suited for problems that involve a network of multiple users and allows every user to access full functionality capabilities of the server GIS using only a "thin" client.
- **Developer GIS** are toolkits for programmers to create highly customized and optimized applications. These can be either stand-alone applications or embedded inside another piece of software. Web applications with integrated GIS capabilities can also fall into this category.
- **Hand-held GIS** operates on a smaller machine, like mobile phone or tablet. This type of GIS generally does not provide the same capabilities as desktop version due to the limited hardware capacity. Some most common and easy to process functions are usually included, but for the more complex calculations, hand-held devices often need to access GIS server.
- **Other GIS types** besides the main four also exist. They usually provide some very specific functionality. Most of software in this category does not feature the full GIS core but rather focuses on a certain aspect of geographical related problems and offers a precise solution. Usual specializations include geographical data management, image processing, visualization and modelling tools.

Each software type comes with a specific set of possible uses and applications. Some problems can be addressed with multiple types of GIS software, while others require the usage of certain software category.

Software requirements

According to Eldrandaly (2007) there are five major criteria when selecting the appropriate GIS software: cost, functionality, reliability, usability and vendor support. However in this article we will focus mainly on the first two. The main priority is to choose a solution that is functionally capable of solving the problem. After eliminating software that is missing the required functionality, the overall cost of solution has to be determined in order to select the most suitable software.

Total cost of a GIS solution is comprised of multiple expenditures which can be divided into three main groups. Firstly, the cost of hardware which depends on the technical requirements. Desktop GIS can be generally run on any personal computer, while server GIS may require a designated engine with nonstop runtime and sometimes also requires additional hand-held client devices. Second part are software costs. This includes the price of the actual GIS software as well as any other required licenses / permits. Lastly, there are costs embedded in human resources. These can involve the training needed for users to operate the GIS software, or the cost of hiring new employees to create, use and maintain the software solution.

The above mentioned costs can further be separated into two groups based on time. One is the initial price and other is long term upkeep and maintenance (Idrizi et al, 2014). The initial hardware cost includes the purchase of any equipment while the upkeep cost encompasses the price of keeping the machines running. Software costs can be separated into those two groups as well, since GIS software licenses can have a yearly based character. Any costs for support from the software vendor can be also considered as a long term software cost. Costs in human labor can be divided like this too. There can be a higher initial cost, for instance when deploying a developer type based solution. But once created the costs in human resources will drop significantly. No matter the type of solution, someone will be always required to operate it. Salary of administrators or other involved personnel constitutes the long term human resources costs.

Moving object visualization

According to Jarolímek et al (2014) the following graphic representations are most crucial in visualization of moving objects in agrarian sector, specifically animals:

- **Point** holds the information where the object was at a given time. Every point can contain additional information such as conditions at the time, object status or activity being performed.
- **Path** connects points based their succession in time. Path allows for the movement of object to be captured and easily displayed. The shorter the interval

between measurements, the more accurate the path will be.

- **Occurrence boundaries** is a polygon shaped space which determines where the object is commonly located. Overall or time specific boundaries can be calculated. When dealing with animal movement this area is usually called “home range”.
- **Occurrence heat map** uses colors to distinguish areas based on how often the object was present there. This allows to model the probability of occurrence at each possible location. Illustration of this type of visualization is illustrated on figures 2 and 3 in the Results and discussion section of this article.

GIS software user groups

GIS application users can be divided based on various criteria. Two important categorizations are based on the type of user access and user environment.

Type of user access determines the authorization that the user will be given, limiting the extent of control over the application and data. The four main types of user access are:

- **Main administrator/s** is a group of users that has the most control over the software. This group has the absolute authority and generally includes only people with good knowledge of the actual GIS environment. Users in this group manage the system, determine rights for other users, manage the data sources and also create outputs.
- **Regular user** is usually someone from the wider range of people who work on a given project. These can also be associates or business partners that are allowed to access the core GIS functionality. Users in this group perform common tasks and operate the software. They generally have lower rights than the main administrators.
- **Professional public** comprises of academic, business or government administration users who are not directly involved in the project, but may require access to it for various reasons. Users in this group are expected to have at least basic knowledge of GIS. They usually do not have access to the source data, but may be given access to outputs generated by the application or limited rights to operate the software.
- **General public** has the same rights as professional public, but users in this group do not possess any special training or knowledge about the project. They usually access the application by chance or by using a mediator. These users generally do not operate GIS much and only require to view the most basic and plain outputs. Projects that focus on this user group specifically are generally trying to popularize the issue in question.

Second categorization is based on the environment where GIS is initially being used and therefore determines the general purpose of its application. The four main categories are:

- **Science** where GIS is used to analyze research data and create outputs for research results publishing.
- **Business** environment where GIS is used to optimize business processes and achieve better profit or other company goals.
- **Government administration** which uses GIS application to effectively govern and share important data with citizens.
- **Personal** usage can for instance include individuals that use GIS for their hobby or various clubs and non-profit organizations that need GIS because of the focus of their activity.

Results and discussion

Based on the analyses of different GIS types and user groups in the previous chapter, the following three main types of GIS deployment were selected to be included in the experimental evaluation:

Desktop GIS

Solution based on desktop GIS is suitable mostly for smaller teams, regardless of the user environment. One or few users can be selected to serve as the main administrators who also operate the GIS while the rest of the team does not use it often or at all. This can make the overall management much easier. This solution can also be the cheapest. Software licenses are generally expensive but when it necessary to purchase only one or few copies for couple of personal computers, the overall cost is not that high. The costs of hardware are usually negligible, since in general, no new machines have to be purchased. Desktop GIS is robust enough to contain the required functionality for movement visualization. The main disadvantage of this approach is that the outputs have to be manually created. Desktop GIS does not have high level of automation and the outputs are not interactive. After each data update, processing and creation of outputs has to be done over again.

Server GIS

Server GIS solution is best used in business environment, government administration or larger research groups. It allows for centralized data management and presentation of results using report modules that can directly feed the output to web interface. This type of solution is however too robust for movement monitoring which is only small sub-section of server GIS capabilities. Therefore the costs (both software and hardware) may be unnecessarily too high. If the software can be used for other purpose within the company or research team, the investment might be worth it, but it can also lead to the server being overloaded. Processing calculations in batches can decrease the server traffic but introduces a delay and reduce the solution interactivity. The basic schema of server GIS solution is illustrated on figure 1.

Developer GIS

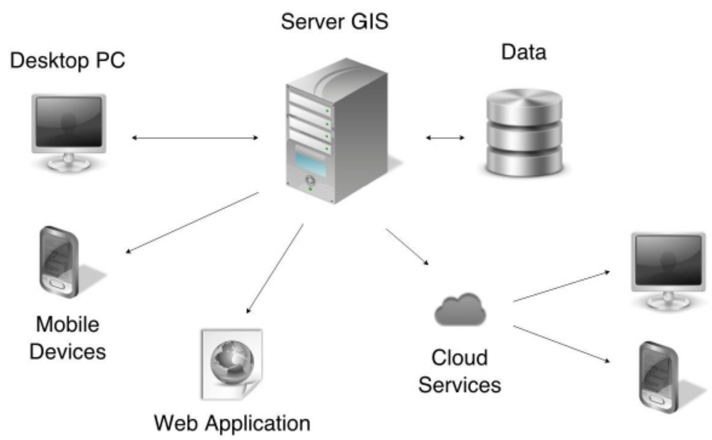
Using GIS developer tools it is possible to create own solution for the project. It does not have to be very costly since open-source software can be used. The main issue of this solution is its time consumption, because the entire application has to be written first. It requires a significant time investment and an experienced programmer or team. After its development the application can be usually maintained easily by an administrator with proper training. Another major disadvantage is the application low flexibility. When new functionality, updates or upgrades to the application are needed an extensive overhaul has to take place, which produces more time delays and additional costs. GIS application can be developed to be integrated inside a web application which makes the outputs more accessible and interactive. This type of solution is therefore most suitable for situations where the entirety of required functionality is known beforehand or if results have to be published online.

Table 1 summarizes the aspects of different GIS solutions with regards to the extent of their functionality, output publishing, costs and user groups.

Experimental verification

To verify defined requirements and limitations, each of the three types of deployment was tested. Used data depict animal movement and was obtained from a long-term conjoint research of Department of Information Technology, faculty of Economics and Management and Department of Game Management and Wildlife Biology, faculty of Forestry and Wood Sciences. The results of the three experimental solutions follow:

- **Desktop GIS:** ArcGIS software, version 10.2.1 was used. Data about animal movement were transferred from Microsoft SQL database server to Microsoft Excel format and uploaded into the ArcMap application. Thus the base data layer was created upon which the visualization tasks were computed (see figure 2). This solution provided high level of control over the calculation processes, but had little to no automation and provided only static outputs.



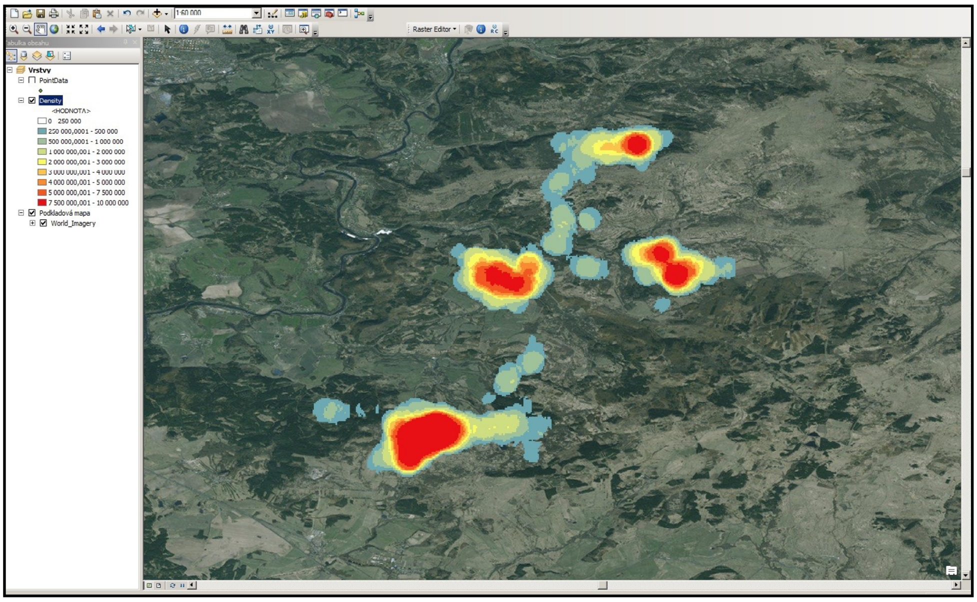
Source: Author; general structure of the schema is taken from ARCDATA, 2015

Figure 1: Server GIS schema.

	Functionality extent	Output publishing	Costs	User groups
Desktop	can handle common tasks, additional modules can be purchased if needed	manual output creation, static outputs	low hardware costs, medium software costs	small teams, business, science, personal use, usually has only one main administrator
Server	very robust, can handle almost everything	easy outputs using report modules, utilizes web interface	hardware and software both very costly	government, business and research, larger teams, many regular users
Developer	functionality has to be determined beforehand, difficult to change	can be highly automated, interactive outputs via web application	costly to develop (programmer salary), time consuming	any environment and user access, tailored to fit the actual needs

Source: Author

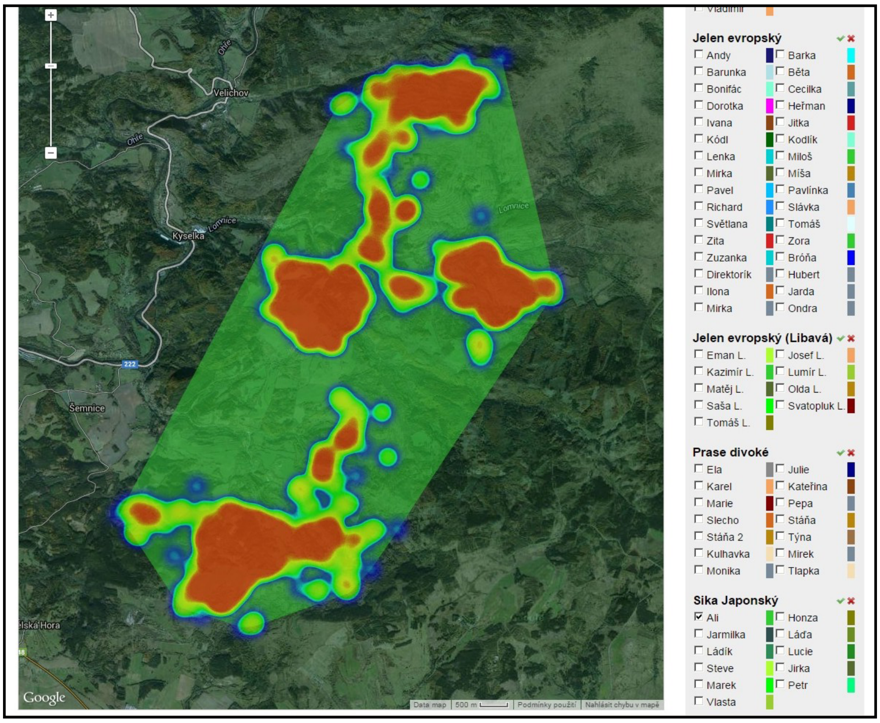
Table 1: Comparison of different GIS types.



Source: Author

Figure 2: Animal movement heat map – solution in desktop ArcGIS.

- **Server GIS:** This solution was created using open source platform GeoServer. This software uses XML (Extensible Markup Language), more specifically SLD (Styled Layer Descriptor) documents to control the calculations and resulting visualizations. Commercial server software generally uses the usual point-and-click interface similar to desktop GIS. This solution was highly complex and because of the small team of authors working on this article, it was actually very demanding to deploy. But it provided better functionality than desktop solution and more importantly it allowed for automation and somewhat interactive outputs.
- **Developer GIS:** This solution was already created from previous research projects (Masner and Stočes, 2013) in web application Game Online (zver.agris.cz). Google Maps Javascript API v3 (application programming interface) was used to integrate maps and calculations into the web application. Animal movement data is continuously updated within Microsoft SQL database using Ground Station Harvester 1.0. The application accesses the data directly and no conversion is therefore needed. Developer GIS solution had the highest demands to implement, since it required knowledge of all used languages (HTML, SQL, javascript). But significant time investment lead to a solution that is highly tailored to the required task, does not contain any excess functionality and allows for high level of output interactivity, which can be seen on figure 3. Easy to control web interface makes this solution very suitable for general public.



Source: Author

Figure 3: Animal movement heat map and home range polygon – solution in GoogleMaps.

Conclusion

Based on analysis and synthesis of available source material, essential properties of movement visualization solutions were compared. Three main GIS deployment types (desktop, server, developer) were experimentally tested. Theoretical knowledge was verified, using sample animal movement visualization project. Desktop GIS proved to be very scalable and inexpensive, but with shortages in output and automation. Therefore desktop GIS should be used mainly in scientific, small business and personal environments. Server GIS solution is very robust and in turn expensive and is too strong of a tool for movement visualization which is only a small subset of possible performed tasks. Its use is recommended in government and large business environments, or in the field of science, provided it can be used for multiple different projects. Developer GIS solution turned out to be highly effective thanks to being crafted accurately according to the project needs. Time consumption and demand for programming prowess of developers can be compensated by higher level of automation and interactivity when integrated inside web application. This solution is therefore most suitable for project that require bigger involvement of public user groups.

Summary of apt conclusions for different GIS types with regards to defined user group access type and environment is depicted in tables 2 and 3 respectively.

Experimental verification was conducted within the area of agriculture using animal movement data. Similar approach can be used for other agrarian tasks such as movement of agricultural machinery. In many cases, reached conclusions can be in effect in other areas of human activity as well.

	Desktop	Server	Developer
Main administrator	+ high level of control - no automation	- difficult to manage if administrator team is small	- time demanding to change or add functionality
Regular user	- expensive if there are many users	+ multiplatform access + easy data sharing	+ easy to operate - single platform access
Professional public	- static outputs	+ access through web interface	+ easy data sharing if required
General public	- no web integration	- traffic can cause server overload	+ possibility of web integration

Source: Author

Table 2: GIS comparison for defined user group access type.

	Desktop	Server	Developer
Science	+ scalability - no extensive publication	- only for large projects	- need to specify functionality beforehand
Business	- no data sharing outside of company	+ suitable for big companies with many users	+ cheaper for IT companies who already employ programmers
Government Administration	- no automation	+ can handle many simultaneous agendas	- difficult to keep up to date with changing legislature
Personal	+ some vendors provide major discounts for personal use	- too costly	+ can be tailored to accommodate unusual requirements

Source: Author

Table 3: GIS comparison for defined user group environment.

Acknowledgements

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References

[1] ARCDATA PRAHA. ArcGIS for Server, ARCDATA PRAHA, 2015. [Online] Available: http://www.arcdata.cz/produkty-a-sluzby/software/arcgis/serverova-reseni-esri/arcgis-for-server/ [Accessed: 18 March 2015].

[2] Bonham-Carter, G. F. Geographic Information Systems for Geoscientists – Modelling with GIS. Pergamon, Computer Methods in the Geosciences, 1994, Vol. 13. ISBN: 978-0-08-042420-0.

[3] Dimitrova, T. V., Tsois, A., Camossi, E. Visualization of Container Movements through a Web-Based Geographical Information System. Intelligence and Security Informatics Conference (EISIC). 2013, p. 182-185. DOI: 10.1109/EISIC.2013.40.

[4] Eldrandaly, K. GIS software selection: a multi-criteria decision making approach. Applied GIS. 2007, Vol. 3, No. 5, p. 1-17. ISSN 1832-5505.

[5] Heywood, I., Cornelius, S., Carver, S. Introduction to Geographical Information Systems. Prentice Hall. 2011. ISBN 978-0273722595.

[6] Hooge, P. N., Eichenlaub W. M., Solomon E. K. Using GIS to analyze animal movements in the marine environment. Spatial Processes and Management of Marine Populations. Lowell Wakefield Fisheries Symposia Series. 2001, Vol. 17, p. 37-51. ISBN: 1-56612-068-3.

[7] Idrizi, B., Zhaku, S., Izeiroski, S., Kabashi, I., Nikolli, P. Defining methodology for selecting most appropriate GIS software. Survey Review. 2014, Vol. 46, No. 338, p. 383-389. ISSN 0039-6265.

[8] Jarolímek, J., Vaněk, J., Ježek, M., Masner, J., Stočes, M. The telemetric tracking of wild boar as a tool for field crops damage limitation. Plant, Soil and Environment. 2014, Vol. 60, No. 9, p. 418-425. ISSN: 1214-1178.

[9] Klimešová, D., Brožová, H. Knowledge maps in decision making using GIS support. 19th International Scientific Conference on Agrarian Perspectives. 2010, p. 343-356. ISBN 978-80-213-2123-6.

[10] Koshak, N., Fouda, A. Analyzing pedestrian movement in Mataf using GPS and GIS to support space redesign. In The 9th international conference on design and decision support systems in architecture and urban planning. 2008. ISBN 978-90-6814-173-3.

[11] Longley, P., Goodchild, M., Marguire, D., Rhind, D. Geographic Information Systems and Science. New York, Wiley. 2005. ISBN 978-0470870013.

[12] Masner, J., Stočes, M. Web application for collection and visualization of positional data - Wild boars and deer monitoring in Czech Republic. 22nd International Scientific Conference on Agrarian Perspectives. 2013, p. 141-147. ISBN 978-80-213-2419-0.

[13] Rhind D. W., Coppock, T. J. The history of GIS. Geographical information systems: Principles and applications. Harlow, U. K.: Longman Group, 1991, Vol. 1, p. 21-43.

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Competitiveness of the EU Beef Sector – a Case Study

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Anotace

V tomto příspěvku je analyzována konkurenceschopnost sektoru hověziho masa v EU za použiti hodnotového řetězce. Následovně je diskutován dopad vnějších faktorů jako je Společná zemědělská politika EU a zahraniční obchodní politika za účelem vytvoření doporučení. Ukazuje se, že investice do spolupracujících nabídkových řetězců může zlepšit znevýhodněnou pozici výrobců hovězího masa, kteří mají nejmenší sílu v nabidkovém řetězci. Dále, oblast vědy a výzkumu poskytuje řadu příležitostí, které by měly být více využity, jako jsou zlepšeni v logistice a vytvoření lépe zaměřeného systému kvality masa. Hlavní ohrožení vyplývají z potenciálních dohod volného obchodu, klimatické změny a konkurence výroby hovězího masa s jinými zemědělskými komoditami. Lepši zaměření SZP a environmentální aspekty jsou navrženy pro udržení konkurenceschopnosti evropských producentů hovězího masa.

Klíčová slova

Hovězí a telecí maso, exporty, konkurenceschopnost, Evropská unie, hodnotový řetězec, Společná zemědělská politika, liberalizace obchodu.

Abstract

In this study, the elements of competitiveness of the EU beef sector are assessed using the value chain approach. Consequently, the impact of the external factors represented by domestic policy and foreign trade policy is discussed, with the aim of deriving recommendations for policy makers. It is shown that investing in collaborative supply chains can improve the disadvantaged position of beef producers, which have the least power in the supply chain. Furthermore, the domains of science and innovation provide several opportunities that could be further explored, namely improving the logistics of the supply chain and developing more tailored quality systems. The main threats stem from potential free trade agreements, climate change and the internal competition between other agricultural crops. Better targeting of the CAP and environmental aspects are suggested to maintain the competitiveness of European beef producers.

Key words

Beef and veal, exports, competitiveness, European Union, value chain, Common Agricultural Policy, trade liberalization.

Introduction

Livestock farming systems offer numerous benefits. Besides producing foods rich in protein and with high nutritional value, they also provide environmental and social benefits to society, since they preserve ecosystem services and provide employment in marginal areas. On the other hand, there are also negative aspects resulting from livestock farming. It is well established that among the major food items, beef carries the highest environmental burden (Nguyen et al., 2010) and has a significant contribution to climate change.

The conditions for beef production in the European Union are highly variable due to the variety of climates and landscapes. However, the prospects of beef production in the EU are not driven only by biophysical factors, but increasingly by the effects of globalization. On one hand, increased demand for beef in developing countries could stimulate production of beef; on the other hand, climate change concerns could act against it. European producers of beef are also facing increasing market competition due to continuous liberalization efforts on the part of WTO, as well as new free trade agreements that will further open European markets to important players such as the United States, Canada and the Mercosur countries. To turn these potential threats into opportunities, strategies for increasing competitiveness are necessary.

In relation to this, the paper deals with the following objectives: i) to analyse the position of EU beef sector within the increasingly globalized world and ii) to identify major factors of competitiveness of the EU beef sector taking into account both internal and external pressures.

In this study, the elements of competitiveness of the EU beef sector are assessed using the value chain approach[1]. Consequently, the impact of the external factors represented by domestic policy and foreign trade policy is discussed, with the aim of deriving recommendations for policy makers. The paper is structured as follows: at first, a descriptive analysis of the beef sector is provided. Chapter 3 contains results of the value chain analysis and discussion and chapter four concludes.

Characteristics of the global and EU beef markets

1. Global trends in trade, production and consumption of beef

Total global production and consumption of beef nearly doubled between the decades of the 1960s (29.3 million tons) and 2010s (58 million tons), and worldwide exports grew in volume by 300%. Nowadays, about 15% of world production is exported, which is double the rate in the 1960s and underlines the rising importance of foreign trade on beef markets.

The United States is the largest producer of beef in the world, with levels of production exceeding 10 million tons a year (Table 1). However, the share of US production is declining slightly as other countries become more involved in producing beef. This refers mainly to Brazil, which nowadays produces almost 8 million tons of beef and has replaced the EU in the second position. The European Union has recently moved into the third position with a production of 7.7 million tons, which represents a decline from the year 2000 in the share of global production from 16% to 12%. China and India are also noteworthy global producers of beef. Although China produces 10% of the world's production, this is not sufficient to cover domestic consumption, making China a net importer of beef. India, on the other hand, due to the constraints on beef consumption in the domestic diet, is able to produce a surplus, which makes India an increasingly important worldwide net exporter.

The evolution of production trends from a dynamic perspective, including projections until 2020, is depicted in Figure 1. Since 2000, EU and US production has been stable at the levels of 12 and 8 million tons, respectively, with some periods of decline caused by BSE outbreaks. In Brazil, the production of beef has been sharply increasing since 1980. From 2 million tons of beef in 1980, Brazil has expanded its production to almost 10 million tons in 2013. According to FAPRI estimates, it is expected that by 2020 Brazil will be the largest producer of beef in the world, displacing the US to the second rank due to its gradual decline in production to below 12 million tons. Continuous growth in production has occurred in India and China, and it is expected to continue until 2020.

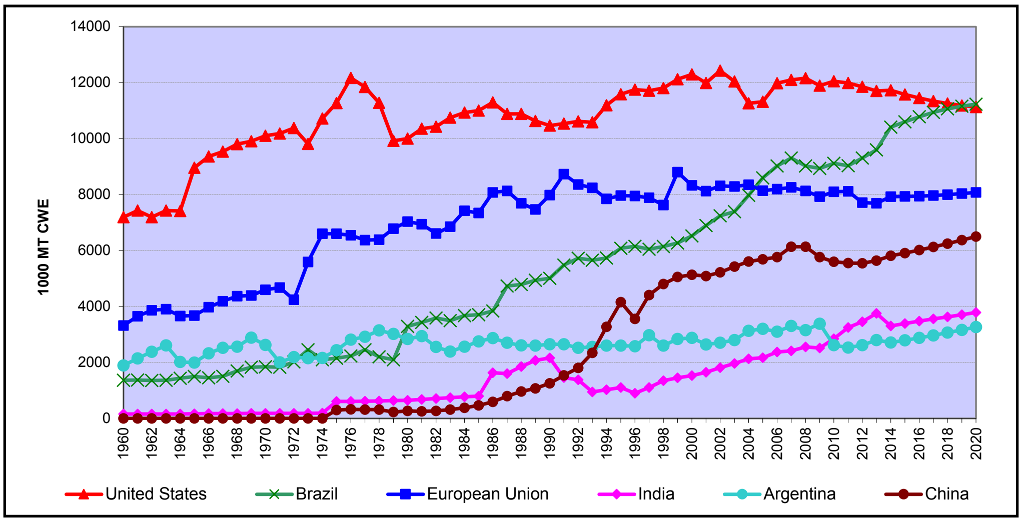
Changes in production and consumption levels are reflected in the volumes of net exports. Table 2 shows the top ten exporters in the world from 1960 until today. Argentina, Australia and New Zealand have traditionally ranked at the top as the largest net exporters of beef in the world. Whereas Australia

[1] The results of this paper served for the elaboration of the study prepared for the European Parliament (2014): EU-Member States in Agri-Food World Markets: Current Competitive Positions and Perspectives.

Country	Top producers of beef and veal				Top consumers of beef and veal			
	2000	% share	2013	% share	2000	% share	2013	% share
United States	12 298	23%	11 702	20%	12 502	24%	11 638	20%
Brazil	6 520	12%	9 600	16%	6 105	12%	7 860	14%
European Union	8 325	16%	7 690	13%	8 157	15%	7 780	14%
China	5 131	10%	5 637	10%	5 100	10%	6 007	11%
India	1 525	3%	3 750	6%	2 545	5%	2 620	5%

Source: USDA FAS-PSD Online 2013, author's elaboration

Table 1: Top worldwide producers and consumers of beef and veal (1,000 MT CWE).



Note: Data for the EU for 1960-1993 represents production in countries included in the European Community, data for 1993-1999 represents the EU-15, and for 2000-2013 the EU-27.

Source: USDA FAS-PSD Online 2013 (1960-2012), FAPRI-ISU 2012 (2013-2020)

Figure 1: Selected worldwide producers of beef.

Ranking	Country	av 1960	Country	av 1980	Country	av 2000	Country	av 2010
1	Argentina	577	Australia	809	Brazil	1 391	Brazil	1 506
2	Australia	377	New Zealand	369	Australia	1 356	Australia	1 418
3	New Zealand	160	Argentina	361	India	530	India	1 312
4	Ireland	100	Ireland	324	New Zealand	511	New Zealand	513
5	Uruguay	93	Brazil	285	Argentina	461	Uruguay	352
6	Denmark	92	Netherlands	209	Uruguay	322	Paraguay	256
7	France	70	Denmark	158	Canada	292	Argentina	207
8	Yugoslavia	70	Germany	157	Paraguay	141	Belarus	172
9	Brazil	43	Uruguay	152	Ukraine	82	United States	132
10	Mexico	35	France	121	Belarus	66	Nicaragua	132

Note: mean 2010 is computed for 2010 – 2013

Source: USDA FAS-PSD Online 2013, author's elaboration

Table 2: Top net exporters of beef and veal (1,000 MT CWE).

has managed to keep the highest rank over time, with net exports expanding from 377 thousand to 1.4 million tons of beef, Argentina has seen a decline in net exports from its premium ranking in the 1960s to the tenth position, with traded volume falling to 132 thousand tons. This negative development was caused by an adverse governmental policy that applied protectionist measures on exports of beef to prevent domestic prices from rising. As a result, Argentinean farmers reduced stocks of herds and converted to soybean production. Compared to Argentina, Australia's strong competitive position is also enhanced by its disease-free status, which secures preferential access to the high-priced markets of Japan and the United States, the largest export markets for Australia (Spencer, 2014).

Since 2000, the traditional exporters of beef have faced increasing competition from Brazil and India. Currently, Brazil is the largest net exporter of beef in the world, with net exports reaching 1.5 million tons. This is supported by very favourable conditions for grass-fed beef production, given that the amount of pasture land available for cattle production reaches 171 million ha (UZEI, 2013). Furthermore, the increase in the supply of beef was also driven by significant improvements in technical efficiency that resulted in an 86% increase in the volume of beef processed in Brazil. The most important Brazilian export markets are Russia, which imports 40% of its beef from Brazil, followed by Hong Kong and Egypt.

India has also seen a boom in beef exports, fuelled by increasing cattle herds resulting from rising consumption of dairy products, private investments in agriculture and the ability to offer lower-quality halal meat, which makes India attractive in the Southeast Asia and Middle East markets (USDA, 2014).

Table 3 presents a list of the largest net importers of beef and veal in the world. In the 1960s and 1970s, the United States was the largest net importer of beef. Since 2000, this position has been occupied by Russia, which currently imports over 1 million tons of beef. The second most significant importer of beef is Japan, which is mainly dependent on Australian exports and recently also on the United States, which is becoming an important competitor for Australia due to offerings from the food-service sector and ready-to-eat businesses (USDA, 2014).

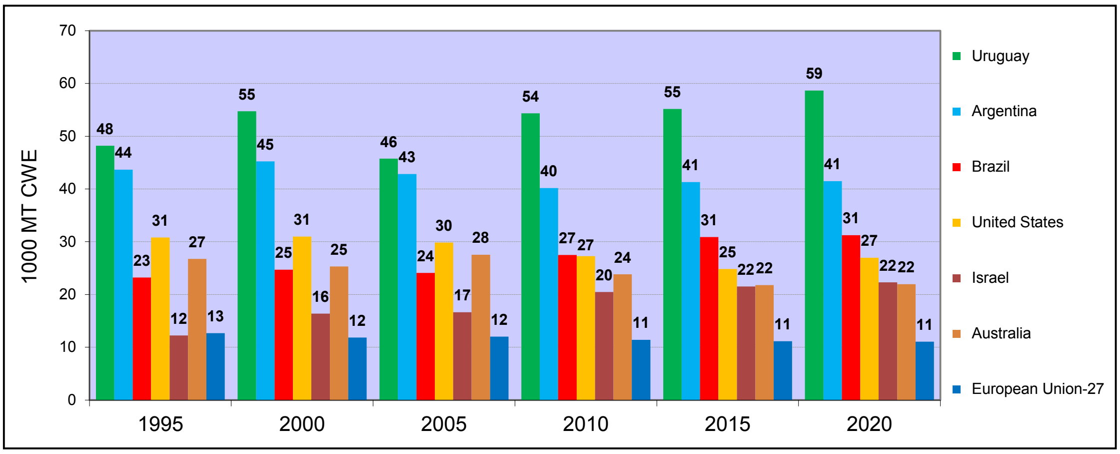
An important factor that influences the foreign trading of beef is the evolution of per capita beef consumption. There is a large gap between the OECD countries, where consumers eat around 15 kg of beef per year, and developing countries which consume less than 5 kg on average (according to OECD-FAO, 2014). Lower consumption of beef in developing countries might be a result of the generally higher price level of beef compared to other sources of protein nutrition, such as pork and poultry, which makes beef a more luxurious type of good. In many countries, consumption of beef is also driven by religion and local eating habits. In developed countries, consumption of beef per capita has been declining, which may be associated with vegetarian trends in diets, concerns about environmental sustainability, mistrust in beef consumption due to health crises and limited options for ready-to-eat alternatives (Hocquette and Chatellier, 2011).

The largest per capita consumption of beef is found in Uruguay (Figure 2), where the level exceeds 50 kg per year and, according to the projections,

Ranking	Country	av 1960	Country	av 1980	Country	av 2000	Country	av 2010
1	United States	513	United States	738	Russia	880	Russia	1 011
2	UK	422	Italy	357	Japan	760	Japan	742
3	Italy	220	Soviet Union	283	United States	618	Korea, South	382
4	Germany	110	Japan	259	Mexico	363	Hong Kong	249
5	Spain	66	Russia	252	Korea, South	317	Egypt	236
6	German DR	59	UK	192	EU	202	Iran	215
7	Greece	30	Egypt	144	Egypt	201	Venezuela	196
8	Switzerland	29	Greece	131	Malaysia	144	Chile	184
9	Czechoslovakia	27	Hong Kong	74	Chile	142	Malaysia	168
10	Chile	24	Saudi Arabia	45	Philippines	135	Saudi Arabia	131

Source: USDA FAS-PSD Online 2013, author's elaboration

Table 3: 10 largest net importers of beef and veal (1,000 MT CWE).



Source: OECD-FAO Agricultural Outlook

Figure 2: Projections of beef consumption per capita for the largest consumers of beef per capita.

could further increase to 59 kg. Even with such high per capita consumption, Uruguay is able to produce a surplus of beef, which gives it good prospects for maintaining its position among the top ten exporters in the world. The second largest per capita consumption of beef (40 kg per capita) is found in Argentina, where production recently declined due to the mentioned policy interventions. In Brazil, the third largest consumer of beef per capita, the increasing trend in consumption will limit further expansion of beef exports in the future. The United States, Israel and Australia occupy the next ranks, with consumption levels exceeding 20 kg. The consumption of beef per capita in the European Union is considerably lower – the average European citizen consumes only 11 kg of beef per capita per year, which is well below the OECD average and the average for all developed economies. This is explained by the fact that other types of meat, for instance pork, are traditionally preferred in many EU countries. Being a more luxurious commodity, beef has also suffered more from the impacts of the economic crisis in the EU, resulting in the replacement of beef with less-expensive chicken meat.

2. Characteristics of the beef sector in the European Union

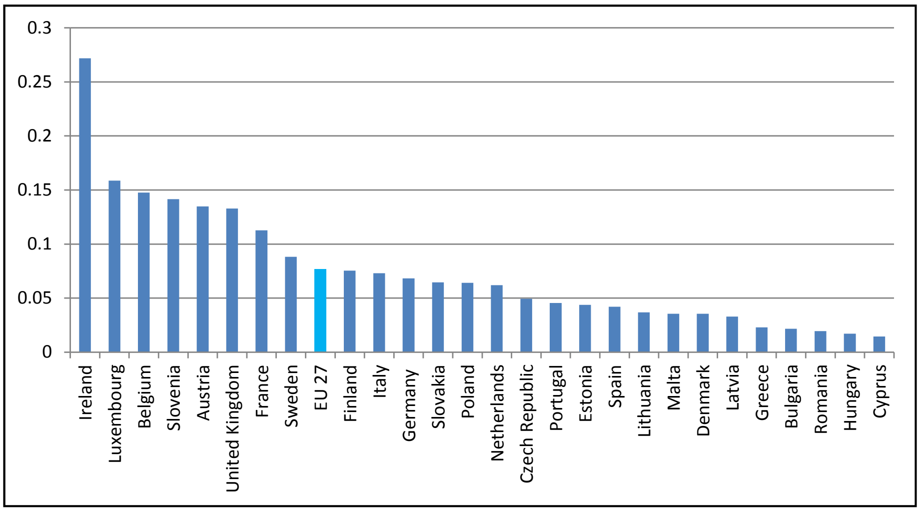
The average share of beef production in total agricultural production reaches 8.4% in the European Union, which is slightly less than the share of pork (9.5%), but more than for cereals (5.9%), for instance. There is considerable variance across the EU member states regarding the importance of cattle. In Ireland, beef contributes to total production by 28%, whereas in Hungary, Cyprus and Romania it reaches only 2% (Figure 3). This is related to the conditions of beef farming in the EU. In Ireland, the UK and central France, extensive cow-calf farms can be found, whereas in Southern Europe, intensive beef fattening systems prevail.

With respect to cattle herds, 50% of all head are concentrated in France, Germany and the United Kingdom. Regarding beef production, next to France and Germany an important producer of beef is Italy, which occupies the third rank, followed by the United Kingdom and Ireland.

The structure of exports shows that most trade in beef is carried out as in the intra-European regime (87%), and most trade is carried out in the form of fresh meat (83%); only 17% of beef is traded in the form of live animals.

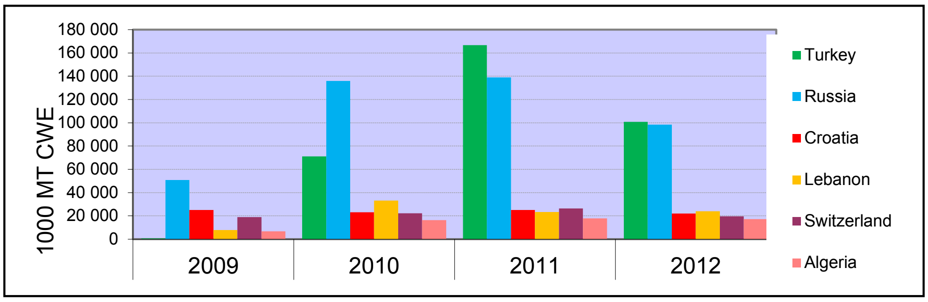
Concerning the extra-EU trade, the most important export territories for beef and veal are Russia and Turkey (Figure 4). In 2011, exports to these two territories reached almost 70% of all trade. Turkey became a significant export market for EU beef in 2010, and in 2011, exports to Turkey exceeded 160 thousand tons. However, exports to Turkey fell noticeably in 2012 due to restrictions on imports of live cattle, beef and derivative products on the part of the Turkish government. A declining trend is also seen in the case of Russia, which has reacted to the higher prices of beef in the EU as well as the depreciating currency of Latin American economies.

With respect to EU imports (Figure 5), the largest importer of beef to the European market is Brazil,



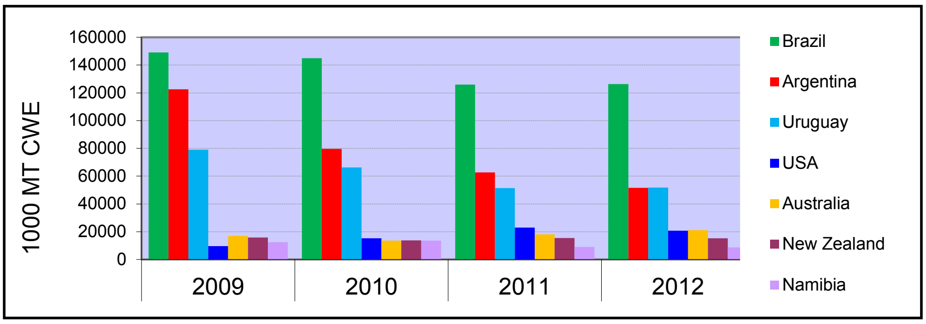
Source: Eurostat Economic Accounts for Agriculture (2013), values at constant 2005 prices

Figure 3: Share of cattle production in agricultural output in 2013.



Source: European Commission (2012), cit. in UZEI Report (2013)

Figure 4: Main exporting territories for the EU¬-27 trade in beef and veal.



Source: European Commission (2012), cit. in UZEI Report (2013)

Figure 5: Main importing territories for the EU¬-27 trade in beef and veal

which accounts for about 40% of total imports. Beef is also imported from Argentina and Uruguay, and to a lesser extent from the US and Australia. Although their beef exports to the EU have increased, Brazil has a limited ability to supply the EU, as few cattle farms are eligible to export to the European market due to the restrictions imposed on Brazil in 2007 (Only 2,000 farms in Brazil are currently authorized to export beef to the EU, down from 26,000 before the restrictions).

Materials and methods

The objective of the study is to assess the competitive position of the EU beef sector in the global market by examining the influence and scope of policies affecting competitiveness. The study contains two axes:

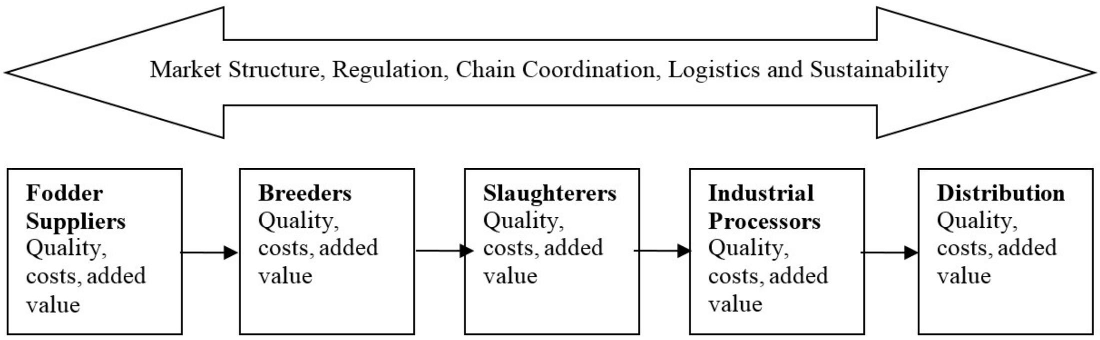
- From a positive point of view, the study considers the strengths and weaknesses of the sector, with reference to the beef value chain, including a thorough analysis of import-export performance.
- From a normative point of view, the study adopts the method of policy evaluation, with a view to assessing policy developments, the new EU tools for the period 2014–2020, and possible new tools in order to promote competitiveness and innovation for the beef sector.

The first part of the study assesses the competitiveness of the EU beef sector using the value chain approach based on Hofwegen et al. (2005). The following drivers of the supply chain were determined: market structure, regulation, chain coordination, logistics, quality, value added, and the costs and sustainability of the value chain. A graphical representation of the drivers in the beef supply chain is provided in Diagram 1.

Given that the study encompasses the whole EU region, a micro-level case study would not be appropriate. Therefore, the value chain approach is elaborated using secondary data and is based on a wide range of literature sources. More specifically, various elements of the value chain are assessed, compiling evidence from individual case studies, policy-oriented reports and academic journals. Finally, a synthesis of the key aspects of competitiveness and prospects for the future is provided.

The second part of the study discusses the external drivers that affect the competitiveness of the EU beef sector. Three specific policy areas are identified as the key external drivers of competitiveness.

Finally, the EU beef sector's future prospects,



Source: author's own elaboration based on Hofwegen et al. (2005)

Scheme 1: Schematic representation of the beef supply chain and its main drivers.

classified into key opportunities and threats, are discussed.

Results and discussion

1. Drivers of competitiveness in the beef and veal value chain

1.1. Market structure of the beef supply chain

Market structure is an important external driver of competitiveness. The type of market structure consequently determines the quality of chain coordination, the distribution of value added in the chain, and the costs that are passed on to consumers.

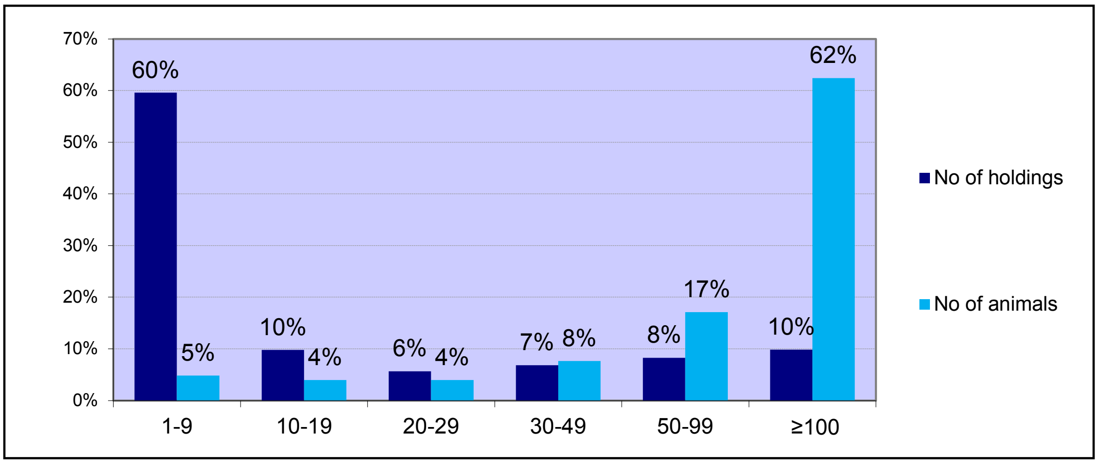
In the European Union, there are about 2,500 farms engaged in cattle production. Figure 6 demonstrates the inequality in cattle farms in percentage terms. It can be observed that 60% of farms possess only 5% of herds, whereas 10% of farms operate with 62% of all animals.

These figures support the general observation that the producer base for beef in the EU is fragmented. Concrete examples can be given for various EU countries. In Britain, for instance, there are 63,000 individual producers, which leads to inconsistency in the composition of finished animals and creates unnecessary costs that are passed on to consumers. These factors lead to a greater price differential in beef compared to chicken (Value Chain Management Centre, 2014). Another example can be seen in Ireland, where the average herd is 18 cows per farm and the average farm size is 27.5 ha (Irish Department of Agriculture, 2014), a situation which increases costs and reduces the adoption of modern management practices. Evidence also comes from Italy, where there were 80 thousand stock farms for 2,200 slaughterhouses in 2010 (Golini and Kalchschmidt, 2011).

On the other side of the supply chain, conditions are quite the opposite. There is strong evidence that the retail environment in most EU countries is highly concentrated and heavily dominates the beef sector (Hofwegen et al., 2005). For instance, Great Britain has five major retailers (Value Chain Management Centre, 2014) and they account for 80% of beef sales (Hofwegen et al., 2005). According to Francis et al. (2003), the concentration of market power in the hands of food retailers has contributed to an unprecedented structural change in the beef sector.

Problems with imbalance in the value chain are found in non-EU countries as well. For instance, a study on supply chain performance in the Australian beef industry (Uddin, 2011) reported that producers have a much lower ability to negotiate prices in the supply chain than processors and retailers, which leads to power imbalance in the chain. The authors also found that the power of a farm significantly increases with its size.

Evidence of the weak market power of suppliers in the beef market has also been confirmed in the academic literature. For instance, in a study by Rezitis and Stavropoulos (2010), the authors examined the supply responses of the Greek beef market and found a negative asymmetric price volatility, which implies that producers have a weak market position. Rumánková (2012) analysed the price transmission mechanism in Czech meat markets. Employing the VECM model, she found imperfect competition in the form of oligopsony or oligopoly, confirming that wholesalers have a stronger position than farmers. Furthermore, she also concluded that agri-food chains can be considered demand-driven.



Source: European Commission (2012)

Figure 6: Structure of cattle production by herd size.

1.2. Regulations concerning production of beef and veal

Regulations set the boundary condition for doing business within the supply chain (Hofwegen et al., 2005). On one hand, regulation generally increases the burden on producers as well as the production costs; on the other hand, it positively promotes sustainable practices that otherwise would not be pursued, as follows from a study by Golini, Kalchschmidt (2011).

The beef sector is one of the most regulated sectors. One of the most important regulations concerning beef production is the ***EU Directive on Traceability*** (EU Commission Regulation (EC) No. 178/2002), formulated and adopted as a consequence of the BSE scare, which highlighted deficiencies in traceability systems and in European law (Safe Food, 2008).

The Traceability Directive requires the identification and registration of bovine animals (EU Directive 1760/2000) and their movements from birth to slaughter, including a compulsory individual cattle passport that must accompany all intra-Community movements of the animals.

In addition to traceability, the European Commission also requires proper ***labelling standards***. In 2000, the EU introduced Beef Labelling Regulation 1760/2000, which gives detailed instructions on labelling meat originating both within the EU and from third countries, as well as sold over the counter or in restaurants.

Concerning ***animal welfare***, EU farmers must follow the general requirements of Directive 98/58/EC, which governs the welfare of farm animals and also the legislation and codes of practice in the countries in which they are based.

In addition to the regulations obligatory for all members of the beef supply chain, farmers are also required to comply with ***cross-compliance rules***, which can generate additional costs of production. In (Roest et al. 2008), the authors examine the impact of the Nitrate Directive and the identification and registration of bovines on the competitiveness of the EU beef sector. The calculations show that 100% compliance with both standards would increase production costs and cause a 3.7% decline in EU exports, which would mostly favour Brazil.

1.3. Issues concerning chain coordination

There are various arguments in favour of increasing coordination in the value chain of beef. First, as follows from market structure analysis, there is a strong imbalance between producers and the other parts of the supply chain. One way to increase the bargaining power of farmers is by creating horizontal cooperatives or vertical coordination. In this way "*producers can gain power as marketers rather than sellers*" (Uddin, 2011).

A study by the Canadian Value Chain Management Centre (2011) on the British beef industry revealed that, "*producer-driven initiatives often have the greatest chance of succeeding over processors and retailer-led initiatives as they often focus on price ahead of other factors*". One British example of a successful value chain initiative in beef is the Blade Farming model, which ensures that beef is produced according to consumer requirements, thereby benefiting all members of the entire chain. The following are important features of these initiatives:

* Consistency in the quality of beef is ensured by controlling the genetic content of semen (cross of Angus and Holstein), which ensures the proper carcass composition of the calf.
* Quality control ensures stable, pre-agreed prices for calf, weaner and finisher producers.
* Stability increases the efficiency of finishing, as the calves are delivered and collected in entire lots, and reduces mortality.

Second, the need for a coordinated supply chain is driven by the increased risk exposure of farmers due to the decoupling of direct payments, which are intended to increase the market orientation of farmers. According to Revoredi-Giha et al. (2008), collaborative supply chains for finished livestock may contribute to higher income stability due to stable demand and market access and less variability in carcass prices. "T*he outcomes of the case study showed that farmers selling through producer clubs are more satisfied than farmers selling through auctions*".

Third, supply chain coordination by forming a strategic alliance through contracting or vertical integration is an efficient way to cope with high transaction costs, in which the use of a spot or open market system is inefficient. Transaction costs arise from contacting buyers and sellers and negotiation, and are stimulated by opportunistic behaviour and the asymmetry of information between buyer and seller in the supply chain. Vertical coordination can have different forms, described in Uddin, 2011. Auction and spot markets represent the lowest level of coordination, and are characterised by short-term relationships, opportunism and limited information sharing. With increasing vertical coordination, the coordination becomes managed internally and the members of the supply chain openly share information; the coordination is characterized by long-term relationships and mutual interest. The example of the Irish sector shows that coordination of the beef supply chain could be improved, as there is a perception of poor communication within the entire value chain resulting in poor market signals to producers. For Australia, it is estimated that the transaction costs of the supply chain from producer to processor to distributor, as well as retail costs, could increase by 80% in the absence of a highly coordinated supply chain.

1.4. Role of logistics

Within the EU-15, transport intensification, involving about 45 million transported cattle per year, contributes significantly to the stress and harm to the well-being of the animals and the accompanying environmental degradation. Therefore, there is great concern that agri-food logistics systems be designed properly in order to strengthen the economic competitiveness of stakeholders in the food supply chain, maintain the quality of food and animal welfare and mitigate the environmental impact (Gebresenbet and Bosona, 2012).

With regard to animal transport, the logistics components involve loading, transporting and unloading animals, as well as the slaughter chain. One of the largest logistical concerns is the impact of transport operations on animal welfare. Long-distance transport and poor handling increase the stress level of the animals. Loading and unloading during transport for slaughter are also indentified as very stressful activities for animals – a study carried out by Bulitta et al. (2011) showed that the heart rate of the animal increases from 80 bpm to 136 bpm during loading. Moreover, the increased stress exposure negatively affects meat quality, and long transport distances increase emissions.

According to Gebresenbet and Bosona (2012), there are two strategies for improving animal welfare during transport. The first strategy focuses on minimising stress-inducing factors by improving transport logistics and handling methods. The second strategy is to support small-scale or mobile abattoirs. A study performed in Sweden showed that when compared with a large-scale abattoir, a small-scale abattoir can reduce transport time and emissions by about 40%. A comparable time and cost reduction can be achieved by increased coordination in the food distribution system, such as through combined loading or the optimization of vehicle fleets.

1.5. Issues concerning beef quality

The quality of beef is assured by a regulatory system which imposes traceability and labelling standards. On top of that, there are various optional instruments used to guarantee quality, such as the EU quality schemes PDO, PGI and TSG. However, as pointed out in Hockettet and Chatellier (2011), consumers may become overwhelmed in the presence of so many official quality signs. As many European consumers are also price sensitive, the high price of a product associated with a quality label may reduce the demand. What is more, the trust of consumers may not be sufficiently secured by the quality labels. Particularly in the case of beef, food safety concerns have been important. As a result of the BSE crisis in 2000, consumption decreased substantially, for instance by 40% in France, 60% in Germany and 42% in Italy (Angulo and Gil, 2007). In order to restore the damaged trust of consumers, traceability and labelling was introduced, and a larger emphasis was placed on Protected Designation of Origin. The results of a Spanish study on the perception of risk associated with the safety of beef revealed that only one in four respondents is willing to pay a premium for the indication of traceability, because they perceive beef safety as a given.

From the consumer's point of view, the strongest quality attributes for beef are taste, tenderness, juiciness, leanness and healthiness (Verbeke et al., 2010). There is a general consensus that the most advanced system for guaranteeing the quality of beef is the Meat Standards Australia system, which predicts the palatability of individual muscles and of specific cooking methods and is therefore consumer oriented. By contrast, reliable eating-quality-guarantee systems are still lacking in Europe (in spite of individual efforts). As the authors further point out, European consumers seem to be more interested in a direct indication of the healthfulness and quality of beef than in traceability and origin information. Thus, *guaranteeing consistent eating quality can have multiple benefits, from more satisfied consumers to the increased profitability of the beef industry and improved competitiveness*. In the research of Verbeke et al. (2010), eight focus groups were selected in the capitals of Germany, Spain, France and the UK, and their potential acceptance of a beef eating-quality-guarantee system was studied, with a generally positive outcome. The development of such a system could enable the differentiation of exclusive cuts, offered for a higher price, according to marketing strategies for different target segments.

An interesting finding regarding the acceptance of safety-improving interventions in the beef chain was made by Wezemael et al. (2011). The safety interventions included cattle feed adjustment, hide decontamination, and other safety-improving processing techniques. The study showed that consumers were less inclined to receive such detailed information. Thus, the findings suggest that *providing too much detail about safety-improving interventions can actually raise suspicion.*

1.6. Production costs in the beef supply chain

The recent Agribenchmark study on the cost of production and competitiveness of beef compared the production costs of cow-calf production and beef finishing across the EU, US and Canada (Deblitz and Dhuyvetter, 2013). Whereas the typical American farm practices feedlot farming, EU farms are usually based on silage. It was found that production costs in the EU are higher than in the US (up to twice as high in the EU). As regards beef finishing, production costs for representative US farms are 340 EUR per 100 kg CW, which is about 20% – 70% lower than for representative European farms. In addition, the structure of production costs differs. For US feedlot farms, animal purchases and costs of feedstuffs are very important. For farms based on silage, a large share of the costs is in producing their own feed. Furthermore, American farms have a cost advantage in labour productivity, which is associated with economies of scale and cheaper labour from immigrant workers. On the other hand, the costs of producing grass-fed cattle in US are higher, which is related to higher pasture land costs.

The evolution of producer prices in the EU shows that they remain below estimated production costs. This suggests that the margins from beef production are negative and the existence of direct payments plays an important role in achieving profitability. This is confirmed by the Irish example, which reveals that only 20% of beef farms are economically viable and 50% of gross farm output is formed by decoupled farm payments. However, it should be noted that for the farm as a whole, profitability may be still achieved by profits from other farming activities such as dairy, which can cover the losses from beef production.

1.7. Sustainability aspects of the beef supply chain

The interconnection between the different aspects of sustainability and their joint effect on all parts of the supply chain suggests that in order to improve the sustainability of beef production, it is necessary to study the whole supply chain.

Three dimensions of sustainability in the beef supply chain are identified in Golini and Kalchschmidt (2011):

* *Environmental sustainability* concerns waste disposal, which affects almost all stages of the supply chain, but is also strongly regulated for each part of the chain. Next

to that, an important element of environmental sustainability is the intensity of agricultural production, which can create pollution and degrade natural resources. Nguyen et al. (2010) classifies up to five types of environmental degradation caused by beef production: global warming, acidification, eutrophication, land use changes and non-renewable energy use.

* *Social sustainability* mainly refers to food safety and animal well-being, but is also related to worker satisfaction and the social reputation of companies operating in the meat industry. The role of beef supply chains in mountain grassland areas is also part of the social dimension.
* *Economic sustainability*, in which the major concern is fragmentation in the upper part of the chain and concentration in the bottom part of the chain.

The environmental, economic and social aspects often overlap. One example is animal welfare, which positively affects worker satisfaction from a social point of view and prevents meat deterioration, thereby contributing to economic sustainability. An example of the joint effect of environmental and economic sustainability is the joint management of fodder and breeding activities. It can be noted that players operating in a chain driven by large retailers do not have strong incentives towards higher sustainability, except for social reputation. Furthermore, *the research shows that the upstream stages (i.e. the producers) have the largest potential to affect the whole chain* because with better fodder quality and animal well-being, costs related to slaughter processes are reduced and it is easier to process meat of high quality. Finally, higher quality meat translates into higher selling prices. Despite this evidence, the upstream players are usually in the least advantageous position for taking action.

2. External factors influencing the competitiveness of beef

2.1. Impact of the Common Agricultural Policy

The development of the beef sector is to a large extent affected by the Common Agricultural Policy. In line with the intention to move towards a greater market orientation, the Fischler reforms introduced decoupling of direct payments in 2003. The evidence shows that the detachment of direct payments from the quantity of animals slaughtered negatively impacted production profitability. Forewarning of this was already given in the projections of Fabiosa et al. (2006), which argued that the CAP reforms would have their greatest production impact on the beef sector, with a 5% decline in beef production. In recent literature, these worries were confirmed. For instance, Rezitis and Stavropoulos (2010) proved there were negative effects on production in the case of Greece; a decline in profitability has also been reported in Ireland (Irish Department of Agriculture, 2014). A study by Ihle et al. (2012) found that the 2003 EU agricultural policy reforms significantly impacted price relationships in the EU countries and led to a decrease in the price of calves. The authors further argued that the EU markets are highly integrated, which provides a strong argument against member-state-specific policy actions.

Decoupling has also had an indirect negative effect on beef production through a decline in dairy cow numbers. As regards the relationship with dairy production, the Irish report highlights the problem of cross subsidization of beef to dairy herds – "*the price differential between beef from suckler and dairy herds is regarded as too small and does not sufficiently reward farmers for producing quality leaner carcases*".

The fear of a drastic decline in suckler cow herds under the decoupling has led to the exemption of decoupling for the specific type of production that EU members will be able to opt for in the new reform, from 2013 onwards. With respect to the future development of the CAP, the abolition of milk quotas in 2015 might stimulate milk production in areas that are competitive for beef production, such as Ireland (Hocquette and Chatellier, 2011).

2.2. WTO Doha Round Agreement

Due to the existence of an import tariff on beef (12.8% of value), internal prices of beef in the EU are higher than international prices. Further liberalization of trade in the Doha Round agreement will thus reduce the domestic price level of beef. It is expected that the tariffs applied on beef imports will be reduced by 70%. According to FAPRI, this could result in a decline in beef prices in Ireland by 27% and a significant drop in beef production. If beef is designated as a sensitive product, there would be a 9% decline in Irish cattle prices.

Besides the WTO negotiations, there are two regional trade agreement initiatives that could significantly affect the competitiveness of beef in the EU – the Transatlantic Trade and Investment Partnership (TTIP) and the Mercosur free trade area.

2.3. Trade agreement with the US – Transatlantic Trade and Investment Partnership (TTIP)

According to an independent study by the Centre for Economic Policy Research (Francois et al., 2013), the Transatlantic Trade and Investment Partnership could provide the EU with economic gains of €119 billion a year once the agreement is fully implemented, and boost the GDP of the EU by 0.5%.

EU-US trade is also important for agriculture. When comparing domestic support and market access levels, it can be concluded that the European market is more protected than the American. According to Grueff and Tangermann (2013), the single commodity transfer for beef is 19.3% in the EU, whereas in the US it is close to 0%. This is mainly due to high import protection in the EU. The average tariff applied by the US on animal products is 2.4%, whereas in the EU it is 24.3%. For a successful conclusion of the TTIP agreement, import tariffs are going to be significantly reduced, which could represent an opportunity for both the EU and US to increase the volume of trade.

However, the major issues in the TTIP negotiations in beef are the sanitary and phytosanitary (SPS) measures, which have been a source of conflict in the past and have significantly impacted trade between the EU and US. Regarding exports from the US to the EU, a major concern relates to the EU ban on imports of beef produced with hormones (and beta-agonists), which was the subject of a dispute resolved by the WTO in 1999, ruling in favour of the US. It is estimated that the SPS measures may represent up to 70% of protection when converted to the equivalent tariff rate (Engelbert, 2013). Therefore, there are great expectations from the North American side to tackle the issue of hormone and beta-agonist use in the TTIP negotiations.

If the negotiations are completed successfully, it is expected that they will have a positive effect on European agriculture as a whole; however, for certain meat-producing sectors, the temporal effect could be negative (COM, 2013). This opinion contrasts with the findings of the Agribenchmark study (Deblitz and Dhuyvetter, 2013). The authors estimate that under the SPS conditions of exporting "*hormone/beta-agonist–free beef*", the prices of US beef would reach the same level as EU domestic prices (since the absence of hormones raises production costs in the US). However, an exact prediction of the cost increase for complying with the SPS rule is unknown. Therefore, it is still possible that imports from the US would increase. In that case, the production systems in Europe that would be most affected are grain-fed beef systems such as the Spanish feedlot system. Lower-quality beef originating from a dairy cow herd which is mostly used for minced meat would not be competitive with US exports.

2.4. Trade agreement with Mercosur

Negotiations of the EU-Mercosur Association Agreement were resumed in 2010 after a suspension in 2004 due to substantial differences in the trade part of the agreement. Preparations for concluding the agreement are ongoing. Agriculture plays an important role in the Association Agreement with Mercosur because the EU, being a net importer of agricultural products from Mercosur, accounts for more than 50% of Mercosur exports of agricultural products.

According to an impact assessment study prepared for the European Commission (Kirkpatrick and Gerge, 2009), under the scenario of full trade liberalization between the EU and Mercosur, meat production would increase significantly in Latin American countries, with the largest impacts in Brazil (+50%) and Paraguay (+70%). It is predicted that increased imports of beef and chicken would raise pressure on EU producers. According to the Copa-Cogeca Report (2011), the direct losses due to increased imports would reach €16 billion, and indirect losses from lower beef prices would be around €9 billion in the EU beef sector alone. Although these estimates could be exaggerated, according to DG Trade, there could be a negative social impact related to a decline in rural employment, particularly in marginal areas. Furthermore, there are also strong environmental concerns, since a significant increase in meat production in Latin American countries would result in adverse land use changes connected to a loss in global biodiversity, increased deforestation and a visible rise in emissions levels.

3.3. Future prospects, opportunities and threats to the EU beef sector

Based on the supply chain analysis and the external factors that affect the beef sector, some opportunities and threats were identified.

Opportunities for improving the competitiveness of beef in the EU:

- *Focus on science and innovation*

There are various opportunities that can be explored in the domain of science and innovation, of which the most important areas are animal genetics and nutrition efficiency. For instance, there are potential solutions in the form of technological innovations that monitor animal health and reproductive status using biosensors. Research potential also exists in the optimization of digestive and metabolic functions in order to improve nutrition efficiency and thereby reduce production costs. It was found that genetics (improving feed conversion, reducing veterinary and medical costs) enables producers to reduce their production costs by 223 pounds per cow.

More efforts should be made to understand the interaction of nutrition, climatic constraint and genotype. Finally, another area of attention should be the development of precision livestock farming in Europe.

- *Better coordination and involvement of producers in the beef supply chain*

Scientific contributions are insufficient if they are not implemented in a coordinated way. According to the experience of the British value chain initiative, the use of similar genetics and feeding practices that appeal to target consumer segments are the critical factors in the success of the value chain.

It has also been shown that vertical coordination can reduce transaction costs and thereby improve the share of added value that accrues to producers. Furthermore, collaborative supply chains help to reduce price risks. It is therefore important to support collaborative efforts at the policy level.

- *Improvement of logistics systems*

There are still possibilities for improving logistics systems. First, more careful handling of animals can significantly reduce their stress. Second, using route optimization methods can reduce transport time and emissions. Developing smaller-scale slaughterhouses would be another recommendation based on the empirical evidence.

- *Developing more advanced quality-guarantee systems*

From the consumer's point of view, there is great interest in information about health content and meat quality; however, eating-quality systems comparable to MSAS are still lacking. For producers, this could mean better pricing of the exclusive parts of beef and would allow them to apply different marketing strategies. Higher price differentials between suckler and dairy beef would also motivate farmers to produce quality leaner carcases.

Research evidence also shows that there could be too many quality signs currently in use, which causes great confusion and mistrust among consumers. Therefore, unification of the quality signs should be discussed.

Factors threatening the competitiveness of beef in the EU

- *Trade liberalization*

Given that the EU beef market is highly protected by both tariff and non-tariff measures, further liberalization will lead to open competition with external countries, which could seriously threaten the competitiveness of domestic beef. This mainly refers to the Mercosur Association Agreement, because the production costs for beef are higher in the EU than in Latin American countries. As for the US, the threat is lower due to the increased costs for beef produced without the use of hormones and beta-agonists.

- *Climate change*

According to McAlpine et al. (2009), beef consumption is a major driver of regional and global change. With increasing globalization, tropical forests are being replaced by grazing land in Brazil and other parts of Latin America, which substantially contributes to greenhouse gas (GHG) emissions and loss of biodiversity. These findings call for abandoning subsidies for beef production and supporting the reduction of beef in consumer diets. Therefore, in order to achieve sustainability in beef production, more research should be done to reduce GHGs, for instance by minimizing waste and through carbon sequestration.

- *Competition with other agricultural commodities*

Beef is a competitor of milk and grains. Regarding the abolishment of milk quotas, it is expected that producers will be motivated to orient towards milk production at the expense of beef. The recently higher prices for grain in turn raise competition for pasture production, which is replaced by cultivating crops instead of pastures. These trends can be observed mostly in Latin America, where feedlot production has been increasingly replacing traditional grasslands.

The above-mentioned threats suggest that it is important to better target direct payments to beef producers, given the low profitability of production in the EU. In light of the sustainability concerns, it is important to maintain and support a focus on environmental and territorial services.

Conclusion

The European Union is the third largest producer of beef in the world. The future prospects of beef production in the EU will be driven by the effects of globalization and trade liberalization. On one hand, increasing demand for beef in developing countries could act in favour of the further expansion of beef production; on the other hand, climate change concerns could act against it.

European producers of beef are facing tougher market competition due to CAP reforms and further trade liberalization, which will open European markets to important players such as the United States, Canada and the Mercosur countries. To turn these potential threats into opportunities, strategies for increasing competitiveness are necessary. In this study, it is shown that investing in collaborative supply chains can improve the disadvantaged position of beef producers with the least power in the supply chain. In addition, several opportunities that could be further explored come from the domain of science and innovation. Examples include animal genetics, nutritional science and greater exploration of possibilities for improving the well-being of animals and optimizing logistical routes.

Nevertheless, in view of the increasing liberalization efforts and high threat of major beef competitors such as Brazil or USA, the realistic vision is that EU beef sector be maintained at a self-sufficient level with a special accent on environmental sustainability and high consumer quality. In this respect, the direct payments can play an important role in stimulating beef production conditional to complying with strict environmental standards.

All these ideas lead to improved animal welfare, which is a central issue and is at the intersection of all sustainability dimensions of livestock farming systems.

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References

[1] Angulo, A., Gil, J. Risk perception and consumer willingness to pay for certified beef in Spain. Food Quality and Preference. 2007, Vol. 18, p. 1106-1117. ISSN: 0950-3293.

[2] Beef Magazine.com. Argentina provides a lesson in how to ruin a beef industry. [Online] Available: http://beefmagazine.com/beef-exports/argentina-provides-lesson-how-ruin-beef-industry [Accessed: Sept 26, 2013].

[3] Bulitta, F. S., Bosona, T., Gebresenbet G. Modelling the dynamic response of cattle heart rate during loading for transport. Australian journal of agricultural sciences. 2011, Vol. 2, No. 3, p. 66-73. ISSN 0004-9409.

[4] Copa Cogeca. The agricultural impact of an EU-Mercosur agreement. Report prepared by Copa-Cogeca, 2011. [Online] Available online: www.copa-cogeca.be/Download.ashx?ID=941661 [Accessed: Dec 10, 2013].

[5] Deblitz, C., Dhuyvetter, K. Costs of production and competitiveness of beef production in Canada, the US and the EU. Agribenchmark Working Paper 2013/5, 2013. [Online] Available: http://www.agribenchmark.org/fileadmin/Dateiablage/B-Beef-and-Sheep/Working-Paper/bs-05-USEU-neu.pdf [Accessed: Jan 4, 2014].

[6] Directorate-General for Agriculture and Rural Development. Agriculture in the European Union Statistical and Economic Information Report 2012, December 2012. [Online] Available: http://ec.europa.eu/agriculture/statistics/agricultural/index_en.htm [Accessed: January 15, 2014].

[7] Engelbert, T., Brockmeier, M., Francois, J. The role of agriculture in the EU-US free trade agreement – Empirical evidence based on a joint econometric-CGE modelling approach. Paper presented at the ETSG 2013 Birmingham Fifteenth Annual Conference, 12-14 September 2013, University of Birmingham.

[8] European Commission {COM(2013) 136 final}. Impact Assessment Report on the future of EU-US trade relations. [Online] Available: http://trade.ec.europa.eu/doclib/docs/2013/march/tradoc_150759.pdf [Accessed: Sep 15, 2014].

[9] European Parliament. EU-Member States in Agri-Food World Markets: Current Competitive Positions and Perspectives, 2014. [Online] Available: http://www.europarl.europa.eu/RegData/etudes/STUD/2014/514006/IPOL_STU%282014%29514006_EN.pdf [Accessed: Nov 20, 2014].

[10] Eurostat Economic Accounts for Agriculture. Values at constant 2005 prices. 2013. [Online] Available: http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data [Accessed: Feb 25, 2014].

[11] Fabiosa, J., Beghin, J., Dong, F., El Obeid, A., Fuller, F., Matthey, H., Tokgöz, S., Wailes, E. The impact of the European enlargement and CAP reforms on agricultural markets: Much ado about nothing? Poster paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006.

[12] Francis, M., Simmons, D., Bourlakis, M. Fearne, A. Identifying the determinants of value in the U.K. red meat industry: A value chain analysis approach. Journal on Chain and Network Science. 2003, Vol. 3, No. 2, p. 109-121. ISSN 1569-1829.

[13] Francois, J., Manchin, M., Norberg, H., Pindyuk, O., Tomberger, P. Reducing transatlantic barriers to trade and investment: An economic assessment. Centre for Economic Policy Research, Final Project Report, March 2013. [Online] Available: http://trade.ec.europa.eu/doclib/docs/2013/march/tradoc_150737.pdf [Accessed: Jan 21, 2014].

[14] Gebresenbet, G., Bosona, T. Logistics and supply chains in agriculture and food. Chapter in Groznik, A. and Xiong Yu: Pathways to supply chain excellence, InTech. March 2012, p. 208. ISBN 978-953-51-0367-7.

[15] Golini, R., Kalchschmidt, M. Sustainability in the food supply chain: Evidence from the Italian beef industry. In Correa, Henrique; Nelis, Mir (Eds.), Proceedings of the 22nd POMS Annual Conference, 2011. [Online] Available: http://hdl.handle.net/10446/25454 [Accessed: March, 2015].

[16] Grueff, J., Tangermann, S. Achieving a successful outcome for agriculture in the EU–U.S. Transatlantic Trade and Investment Partnership agreement. International Food & Agricultural Trade Policy Council. Discussion paper, February 2013. [Online] Available: http://www.agritrade.org/Publications/documents/FINAL_US_EU_FTA_fordistribution.pdf [Accessed: April 24, 2014].

[17] Hocquette, J. F., Chatellier, V. Prospects for the European beef sector over the next 30 years. Animal Frontiers. October 2011, Vol. 1, No. 2, pp. 20-28. ISSN 2160-6056.

[18] Hofwegen, G., Becx, G., Broek, J. Drivers for competitiveness in agri-food chains: A comparative analysis of 10 EU food product chains. A report for the EUMercoPol project – WP4, 2005.

[19] Ihle, R., Brummer, B., Thomson, S. Structural change in European calf markets: Decoupling and bluetongue disease. European Review of Agricultural Economics. 2012, Vol. 39, p. 157-179. ISSN 1464-3618.

[20] Institute of Agricultural Economics and Information (UZEI). Impact of global and European markets for milk, beef, pork, poultry and lamb on the Czech commodity market in 2013 (in Czech: „Vliv světového a evropského trhu mléka, hovězího, vepřového, drůbežího a skopového masa na trh komodit v ČR v roce 2013“). Report 2 (4222), September 2013.

[21] Irish Ministry of Agriculture. Meat Industry Ireland: 2020 Strategy – Beef Sector, submission from Meat Industry Ireland. April 2010, [Online] Available: http://www.agriculture.gov.ie [Accessed: Jan. 15, 2014].

[22] Kirkpatrick, C., George, C. Trade sustainability impact assessment of the association agreement under negotiation between the European Community and Mercosur. University of Manchester, Report prepared for the European Commission, 2009. [Online] Available: http://trade.ec.europa.eu/doclib/docs/2009/april/tradoc_142921.pdf [Accessed:March 5,2013].

[23] McAlpine, C. A., Etter, A., Fearnside, P. M., Seabrook, C. L., Laurance, W. F. Increasing world consumption of beef as a driver of regional and global change: A call for policy action based on evidence from Queensland (Australia), Colombia and Brazil. Global Environmental Change. 2009, Vol. 19, p. 21–33. ISSN 09593780.

[24] Nguyen, T. L. T., Hermansen, J. E., Mogensen, L. Environmental consequences of different beef production systems in the EU. Journal of Cleaner Production. 2010, Vol. 18, p. 756–766. ISSN: 0959-6526

[25] OECD-FAO. Agricultural Outlook Database, 2014. [Online] Available: http://stats.oecd.org/Index.aspx?DataSetCode=HIGH_AGLINK_2012 [Accessed: April 20, 2014].

[26] Revoredi-Giha, C., Leat, P. Collaborative supply chain initiatives as devices to cope with income variability in the Scottish red meat sector. Paper prepared for a presentation at EAAE Seminar, Warsaw, 2008.

[27] Rezitis, A., Stavroopoulos, K. Modelling beef supply response and price volatility under CAP reforms: The case of Greece. Food Policy. 2010, Vol. 35, p. 163-174. ISSN: 0306-9192.

[28] Roest, K., Jongeneel, R., Dillen, K., Winsten, J. Cross-compliance and competitiveness in the European beef and pork sectors. Paper presented for the 109th EAAE Seminar, November 20-21, Italy, 2008.

[29] Rumánková, L. Examination of market structure in selected livestock agri-food chains in the Czech Republic. Acta univ. agric. et silvic. Mendel. Brun. 2012, Vol. LX, No. 7, p. 243–258. ISSN 1211-8516

[30] Safefood. A review of the beef food chain, February 2008. [Online] Available: http://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Publications/Research%20Reports/Safefood_8202_A5_Beef_Summary-20(2).pdf [Accessed: Jan. 5, 2014].

[31] Spencer, S. Price determination in the Australian food industry: A report, Australian government, Department of Agriculture, Fisheries and Forestry, Canberra, 2004. [Online] Available: http://www.daff.gov.au/__data/assets/pdf_file/0003/182442/food_pricing_report.pdf [Accessed: Jan. 12, 2014].

[32] The Beef Site: What are the prospects for imports from Brazil? [Online] Available: http://www.thebeefsite.com/articles/3119/what-are-the-prospects-for-imports-from-brazil [Accessed: March 12, 2012].

[33] Uddin, M. N., Islam, N., Quaddus, M. Supply chain performance in the Australian beef industry. Department of Agriculture and Food, 2011. ISBN 978-0-9807334-2-6.

[34] United States Department of Agriculture, Foreign Agricultural Service – Production, Supply and Distribution Online Database (USDA FAS-PSD). [Online] Available: http://apps.fas.usda.gov/psdonline/psdQuery.aspx [Accessed: Jan 10, 2014].

[35] USDA. Livestock and poultry: Global markets and trade, November 2013. [Online] Available: http://apps.fas.usda.gov/psdonline/circulars/livestock_poultry.pdf [Accessed: Jan 5, 2014].

[36] Value Chain Management Centre. Learning from the British beef industry – research findings, 2011. [Online] Available: http://vcm-international.com/wp-content/uploads/2013/04/Learning-From-The-UK-Beef-Industry.pdf [Accessed: Jan 3, 2014].

[37] Verbeke, W., Wezemael, L., Barcellos, M., Kugler, H., Hocquette, J., Ueland, Ø., Grunert, K. G. European beef consumer interest in a beef eating-quality guarantee. Insights from a qualitative study in four EU countries. Appetite, 2010, Vol. 54, p. 289-296. ISSN: 0195-6663.

[38] Wezemael, L., VeRbeke, W., Kugler, J., Shcolderer, J. European consumer acceptance of safety-improving interventions in the beef chain. Food control. 2011, Vol. 22, p. 1776-1784. ISSN: 0956-7135.

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Anotace

Cílem článku je vyhodnotit vývoj podpory řízení rizik v zemědělství v České republice v období 2001 – 2013. Článek rovněž naznačuje možný budoucí vývoj podpory řízení rizik v ČR. Data poskytnutá Podpůrným garančním rolnickým a lesnickým fondem (PGRLF) a Českou asociací pojišťoven (ČAP) byla vyhodnocena metodami popisné statistiky (aritmetický průměr, směrodatná odchylka, variační koeficient). Zdrojem dat pro mezinárodní srovnání byly sekundární informace získané z výzkumných center Evropské komise. Autoři konstatují, že podpora řízení rizik v ČR po roce 2014 nebude využívat evropské fondy z Programu rozvoje venkova. Podpora bude založena na národních finančních zdrojích, buď ve formě přímé podpory (subvence pojistného, ad hoc podpory) nebo nepřímé podpory preventivního charakteru (nákazový fond, obnova genetického potenciálu). Za účelem eliminace neočekávané potřeby ad hoc pomoci je nanejvýš žádoucí založit a průběžně doplňovat fond pro krytí katastrofických rizik, která nemohou být zvládnuta zemědělci ani pojišťovnami. Fond by měl být přístupný pouze zemědělcům, kteří průběžně proaktivně přistupují k řízení rizik.

Klíčová slova

Zemědělské pojištění, veřejná podpora, vzájemné fondy, stabilizace příjmů.

Abstract

The aim of the article is to evaluate the development of risk management support in agriculture in the Czech Republic in the period 2001 – 2013. The article also tries to outline some possibilities for the future risk management scheme in the Czech Republic. Data provided by the Support and Guarantee Agricultural and Forestry Fund (PGRLF) and the Czech Insurance Association (ČAP) was described using descriptive statistical methods (mean, standard deviation, coefficient of variation). The data sources for international comparison come from secondary sources made by the research centres for European Commission. Authors identify that risk management support in the Czech Republic after 2014 will not use EU funds from the Rural Development Programme. It will depend on national financial sources, either in the form of direct support (premium subsidies, ad hoc aids) or indirect support of prevention (disease fund, recovery fund). In order to eliminate unexpected need for ad hoc aid, it is highly desirable to establish and continuously contribute a fund for covering catastrophic risks which cannot be managed by farmers or insurance companies. Such fund should be eligible only for those applicants who continuously take risk management measures.

JEL classification: Q10, Q14, G22

Key words

Agricultural insurance, public support, mutual funds, income stabilization.

Introduction

Agricultural insurance is one of the most important risk management tools worldwide. Crop insurance with a 90 % share of agricultural insurance premiums, plays a significantly more important role than the livestock insurance (with 4% share) worldwide (Iturrioz, 2009). This is because a compensation for the ordered destruction of animals in the case of an outbreak of dangerous diseases is usually legally mandatory[1] from public sources.

It is more widespread in developed countries which have good access to insurance and reinsurance markets. Agricultural insurance in developed countries originates in named peril products that were originally offered by private companies approximately two hundred years ago, first in Europe and then in the United States. Today, many complex agricultural insurance products are offered, most of them heavily subsidized by governments (Smith, Glauber, 2012).

The complexity of agricultural insurance and the rate of its public support depend on the risk exposure of regions. In the Europe, the Euro-Mediterranean countries are the major risk contributors. These countries not only have the highest expected loss but also high volatility of indemnity payments. On the contrary, the Nordic countries have the lowest indemnity payments and risk exposure (Yildirak, Gulseven, 2012).

The public support of agricultural insurance should encourage farmers to increase the use of agricultural insurance, to provide financial stability to farmers and other actors in the agri-value chain and to promote agricultural investment and access to credit in vulnerable regions. Farmers can exploit public support in many forms. Whilst premium subsidy is the most common intervention, other enabling measures are important, such as the legal and regulatory framework, reinsurance, technical and administrative assistance, and linkages to government extension services in agriculture, animal health or meteorology (Dick, Wang, 2010). The public support of agricultural risk management in less developed countries with high weather sensitivity and high importance of agriculture for households are especially provided World Bank and FAO incentives (Larson, Anderson, Varangis, 2004). In less developed countries, World Bank together with micro-financing institutions test new insurance products based on weather indices (Miranda, Gonzalez-Vega, 2011; Sarris, 2013; Bobojonov, Aw-Hassan, Sommer, 2014; Norton et al., 2014). However, the index insurance in agriculture suffers from relatively low ability to reduce volatility of crop yields because of wide spectrum of non-weather factors affecting farm yields (Elabed et al., 2013).

The agricultural insurance and its public support should gain holistic visibility. It means that insurance is not separate risk management tool. There are many other risk management tools for normal, marketable and catastrophic risks (OECD, 2009). The support of agriculture is included in Common Agricultural Policy of the EU after 2014 together with other risk management tools, e. g. mutual funds (Meuwissen, Assefa, van Asseldonk, 2013) and income stabilization tool (Finger, El Benni, 2014). Nevertheless, the alternative risk management tools are not accepted in all EU countries. Moreover, farmers can use direct payments or other subsidies are income risk management tools (Keeney, 2000, Špička, Boudný, Janotová, 2009, Řezbová, Tomšík, 2012).

In the field of agricultural risk management, cooperation between the private and public sector is generally recommended. The cooperation between public and private sector takes either a form of public-private partnership (Nussbaum, 2007) or a form of indirect cooperation through premium subsidies. In general, governments try to reduce the ad-hoc assistances for the agricultural sector. On the other hand, farms face some systematic risks which are commercially uninsurable. So, there should be public assistance for farmers facing systematic risks, such as drought.

In the Czech Republic, agricultural insurance is an important risk management tool. It is offered by several commercial insurance companies and it is supported from public sources, especially through the program "Support of insurance" provided by the Support and Guarantee Agricultural and Forestry Fund (PGRLF, Vávrová 2010).

The aim of the article is to evaluate the development of risk management support in agriculture in the Czech Republic in the period 2001 – 2013. This article describes the current approaches to risk management in agriculture and analyzes the situation of agricultural insurance in the Czech Republic compared with the OECD recommendations and with the situation in other countries. Moreover, the article also tries to outline some possibilities for the future risk management scheme in the Czech Republic.

The article follows the common structure. After description of data and methodology, the forms of insurance in the Czech Republic, USA and European Unions are provided. Special part of results is devoted to the agricultural insurance scheme in the Czech Republic. The discussion about support of risk management tools in the new Rural Development Programme is provided at the end of results. Conclusions summarize

[1] In the Czech Republic it is the Act No. 166/1999 Coll., Veterinary Act, § 67, 68.

the results and present suggestions for improvement of the Czech risk management system in agriculture.

Materials and methods

The method for identifying possible positive and negative impacts of agricultural risk management tools respects the holistic approach. The holistic approach examines relationships between sources of risk factors and risk management tools in agricultural businesses. The risks are divided into normal, marketable and catastrophic in the holistic approach. Marketable risks are designated as those risks whose effects can be eliminated or effectively reduce by the purchase of private insurance or futures contracts. Catastrophic risks generally affect a large number of farms throughout the region. It is usually not possible to reduce catastrophic risks through some private insurance, and thus government intervention is required. State aid can also help developing the private market of risk management tools effectively. Thus, support for insurance should be only temporary and after market stabilization should be reduced gradually. It is generally recommended not to use state intervention in the cases of normal risks, which should be managed at the farm level. The negative effects of such measures lies in displacing other proactive measures at farm level, such as the suppression of differentiated appropriate activities and sources of income. In this respect, the exceptions are the measures used in the assessment of income tax, mainly consisting of the possibility of averaging income over a period of several years (OECD, 2009).

Data provided by the PGRLF and the Czech Insurance Association (ČAP) was described using descriptive statistical methods (mean, standard deviation, coefficient of variation). The data sources for international comparison come from secondary sources made by the research centers for European Commission (Meuwissen, van Asseldonk, Huirne, 2008; Bielza Diaz-Caneja, 2009).

Results and discussion

Forms of insurance for crop production

The oldest type of crop insurance is the hail insurance. It covers the losses caused by single risk. Hail represents the potential risk of losing a substantial part of the crop production, especially for small farms. There is a relatively low incidence of occurrence and usually over the limited area which results relatively low premium rates for most of the field crops. Hail insurance can be extended to include other natural hazards (especially fire, flood, storm, landslide, damage through the winter or spring frost). The principle of calculation of damage remains the same - i.e. finding the actual damage caused by the insured risk. The premium for such insurance is proportionately higher. Generally, such insurance can be termed as crop loss insurance.

Another principle of insurance is the crop yield insurance. The object of crop yield insurance is to achieve the insured production volume, either at the farm level or at the level of an insured crop or group of crops. The compensation setting is based on the actual yield if the insured yield is not achieved. Such insurance was applied in the former Czechoslovakia in the years 1986 - 1990 as "The comprehensive crop yield insurance", which was part of the mandatory insurance for agricultural holdings. Crop yield insurance is also broadly applied in the USA.

A different approach to crop insurance represents insurance based on weather indexes (weather insurance) or weather derivatives. In this type of insurance a desired weather characteristic is selected (e.g. rainfall over a defined period) and if the agreed threshold is not achieved, there is a graduated payment according to how much the actual result drops below the agreed threshold. This system appears as promising in areas with homogenous natural conditions where fluctuations in income are caused almost exclusively as a result of drought. The low transaction costs are an advantage because it is not necessary to identify any actual damage or yields. The indemnity is entirely based on the exact data measured at the meteorological station mentioned in the weather contract. The basis risk is connected with the incomplete correlation of actually yields obtained with the values of selected meteorological parameters measured at the meteorological station. Recent research results show that the spatial and production basis risks reduce the efficiency of the weather derivatives. The potential for expansion of weather derivatives remains in the low income countries of Africa and Asia with systemic weather risk (Špička, Hnilica, 2013). The results of efficiency of weather derivatives in Czech crop production shows similar efficiency like in the Germany (Mußhoff, Odening, Xu, 2006; Weber et al., 2008). Kimura and Antón (2011) recommend index insurance and weather derivatives as effective tools for risk-management of drought in Australian agriculture. Conversely, for heterogeneous landscape conditions that are characteristic in Czech agriculture, such an approach does not seem to have a big potential.

United States of America

The current system of crop insurance in the United States was established in 1938. The most often insured crops are corn, soybeans, and wheat, about 80% of the total area is insured (2008). The total value of premiums in 2008/09 was almost $ 10 billion. The insurance coverage is 50% of the average yield and 55% of the expected crop prices in the basic CAT (Catastrophic) program. This basic coverage is fully subsidized by the state. Farmers can buy a higher level of insurance coverage with the Buy Up program, where it is possible to arrange insurance from 50% to 85% of the average yield and from 55% to 100% of the expected price. The premium depends on the actual production history (APH) on the farm. In the case of price insurance the Risk Management Agency provides price forecasts. The government pays the administrative costs of agricultural insurance and secures the reinsurance.

In the U.S., many stakeholders rated the system very positively (Latham, 2010). They are some critical assessments from the point of view of moral hazard (Horowitz, Lichtenberg, 1993) or adverse selection (Just et al., 1999).

Agricultural Insurance Systems in European Union

In the European Union, individual states use very different systems of agricultural insurance. The diversity of approaches and institutional arrangements to agricultural risk management is given by the heterogeneity of risks which threaten Europe's farmers. In general, the higher risk of crop damage occurs in southern European countries, with particularly high risks of drought and other significant effects of extreme weather events. Hail plays an important role in the Central European countries and with regard to climate change more frequent occurrences of drought and local torrential rains are predicted. In contrast, countries in North Europe are less threatened by drought or hail. Therefore a consistent willingness to have a common risk management approach is improbable in the European Union.

There are of state established institutions which provided compulsory agricultural insurance in Greece and Cyprus (Vilhelm, 2006).

In most countries private agricultural insurance is supported by the public sector. Such a system is used in the Czech Republic, the Slovak Republic, Poland and Austria for example. In Austria, 50% of the premium for crop insurance is subsidized from public sources (half from the state disaster fund, the second half from individual federal states). Unlike the situation in the Czech Republic the insurance subsidy is directly paid to the Austrian hail insurance company. Insurance covers more than 80% of agricultural land, of which more than 60% is insurance against more risks - freeze, hail, storm, flood, drought and other risks (Weinberger, 2009).

Spain has had a complex system of agricultural insurance based on the cooperation of the public and private sectors, with special institutions for its operation and development and state reinsurance, for more then thirty years. The system is financed by both the central Spanish government and from regional budgets. Total premiums for crop and livestock insurance under the system increased from about 3 billion € in 1991 to almost 11 billion € in 2008 and total support for increased insurance premiums over the same period ranged between 90 and 450 million € (Antón, Kimura, 2011). The share of the insured value of the total production was 72% for cereals, 76% for fruit and 79% for livestock (Toraño, 2010).

On the other hand, in some countries, the agricultural insurance system operates on a purely commercial basis without government interference (e. g. in Germany, Great Britain and the Scandinavian countries). In some countries, such as in France and in the Netherlands, the government plays a significant role in providing insurance funds, created in part by compulsory contributions from farmers. In the European Union is not available an insurance solution covering fluctuations in prices of agricultural commodities offered unlike the situation in the United States.

The European Union, under the Common Agricultural Policy (CAP) allows support of agricultural insurance from national sources. The CAP Health Check measures in 2008 (article 68) allow to retain up to 10 per cent of national ceilings for direct payments to provide support for agricultural insurance or mutual funds for animal and plant diseases. The support may be paid up to 65% of the insurance premium, while the share of EU CAP can be up to 75%.

The future public support of risk management in agriculture has been frequently discussed in recent years as a part of design of the new Rural Development Programme (RDP) for the period 2014-2020. Regulation (EU) No. 1305/2013 of the European Parliament and of the Council of 17th December 2013 on Support for Rural Development by the European Agricultural Fund for Rural Development (EAFRD) and Repealing Council Regulation (EC) No 1698/2005 list the risk management support in Article 36. Support under this measure shall cover:

1. financial contributions to premiums for crop, animal and plant insurance against economic losses to farmers caused by adverse climatic events, animal or plant diseases, pest infestation, or an environmental incident;
2. financial contributions to mutual funds to pay financial compensations to farmers, for economic losses caused by adverse climatic events or by the outbreak of an animal or plant disease or pest infestation or an environmental incident;
3. an income stabilisation tool, in the form of financial contributions to mutual funds, providing compensation to farmers for a severe drop in their income.

"Support under point (a) of Article 36(1) shall only be granted for insurance contracts which cover for loss caused by an adverse climatic event, or by an animal or plant disease, or a pest infestation, or an environmental incident or a measure adopted in accordance with Directive 2000/29/EC to eradicate or contain a plant disease, or pest which destroys more than 30 % of the average annual production of the farmer in the preceding three-year period or a three-year average based on the preceding five-year period, excluding the highest and lowest entry. Indexes may be used in order to calculate the annual production of the farmer. The calculation method used shall permit the determination of the actual loss of an individual farmer in a given year." Unfortunately, the 30% threshold of a loss from the average annual production of the farmer is not suitable for EU countries with high share of large agricultural companies (Czech Republic, Slovakia) since the probability of damage exceeding 30 % of the average annual production is low.

Mutual funds for adverse climatic events, animal and plant diseases, pest infestations and environmental incidents are eligible for support if a mutual fund:

- is accredited by the competent authority in accordance with national law;
- has a transparent policy towards payments into and withdrawals from the fund;
- has clear rules attributing responsibilities for any debts incurred.

The financial contributions of mutual funds may only relate to:

- he administrative costs of setting up the mutual fund, spread over a maximum of three years in a degressive manner;
- the amounts paid by the mutual fund as financial compensation to farmers. In addition, the financial contribution may relate to interest on commercial loans taken out by the mutual fund for the purpose of paying the financial compensation to farmers in case of crisis.

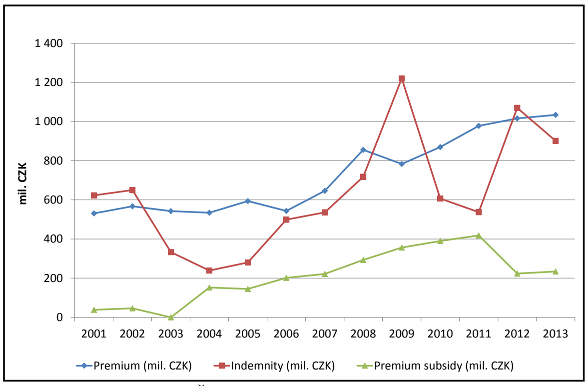
Moreover, the condition of support of risks which destroy more than 30 % of the average annual production is compulsory for all risk management tools in the RDP! The Dutch experience (Meuwissen, Assefa, van Asseldonk, 2013) shows that mutuals are well equipped to insure risks that are uninsurable in the commercial market. This is especially true for animal and crop disease risks. However, experience has demonstrated that mutuals are not always successful, even with substantial public support. Lack of members caused several mutuals to be discontinued only a few years after their foundation. In order to secure the benefits of mutuals, it is shown that there is a need to carefully balance size of risk, affordability of premiums, financial robustness and solidarity.

Finally, income stabilisation tools are closely connected to mutual funds. Supported income stabilisation tool shall only be granted where the drop of income exceeds 30 % of the average annual income of the individual farmer in the preceding three-year period or a three-year average based on the preceding five-year period excluding the highest and lowest entry. Finger and El Benni (2014) conclude that income stabilisation tolls significantly reduce income inequality, in particular by increasing lower quantiles of the income distribution. Nevertheless, the countries with low level of cooperation and integration in agriculture will not apply support of establishing mutual funds and income stabilisation tool (e. g. the Czech Republic).

Agricultural insurance in the Czech Republic

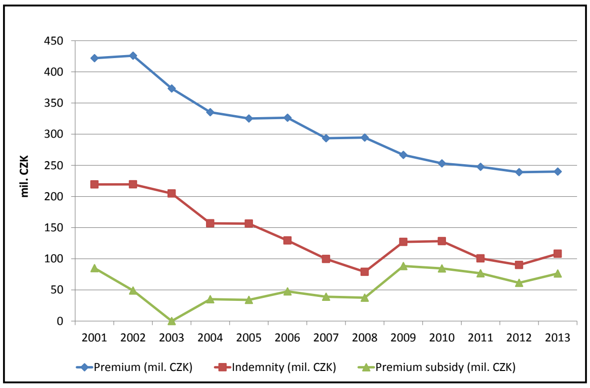
Agricultural insurance in the Czech Republic has operated on a voluntary basis in the Czech Republic since 1991. Formerly, the agricultural insurance had the form of mandatory insurance for all agricultural holdings (i.e., especially agricultural cooperatives and state farms) and was operated by the state insurance company until 1990. Seven commercial insurers offered agricultural insurance actively in 2013. According to the Insurance Act, agricultural insurance can be offered by any commercial insurance company licensed by the Czech National Bank and issued relevant insurance conditions. State reinsurance does not exist in the Czech Republic, unlike in Spain or United States. Creating a state reinsurance company for the reinsurance of agricultural risks was one of the proposals when deciding the optimal form of state involvement in agricultural insurance.

Agricultural insurance had no state support in the period 1991 – 1999. The Ministry of Agriculture began support through the No. 8 subsidy program - the animal contagious diseases fund and subsidies for agricultural insurance from 2000. The subsidy for agricultural insurance was conditioned by the non-spending of financial resources for superior subsidies. No subsidy for agricultural insurance was paid for this reason in 2003. The state-owned Support and Guarantee Agricultural and Forestry Fund (PGRLF) introduced instead a new program "Support of insurance" in 2004. This support of insurance was implemented as the retroactive reimbursement of premium costs paid by the insured farmer for crop insurance (insurance against hail, fire, storm, flood, landslides, spring frost or frost) and livestock insurance (insurance against death or being killed as a result of a natural disaster, or other dangerous diseases of an infectious or parasitic origin). The purpose of this support is to make insurance protection for farmers more accessible. The support from 2004 increased from 30% of the premium for crop insurance and 15% of the premium for livestock insurance to 50% for both types of insurance since 2009. Subsidy is available for small and medium holdings and it is provided only for insurance premium, that was really paid, which implies, that the real share of support on premium written is less than 50 %. Figure 1 shows the development of the crop insurance; figure 2 provide an overview on livestock insurance in the period 2001 – 2013.



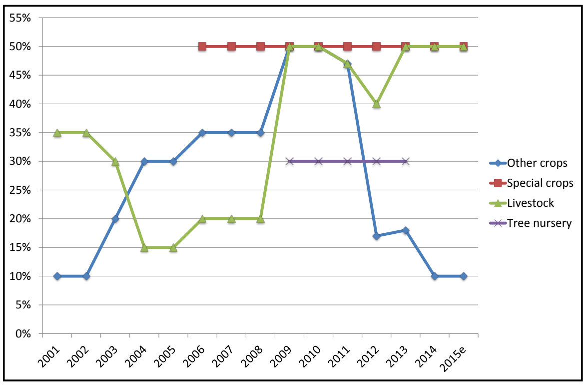
Source: ČAP, PGRLF, own calculations

Figure 1: Crop insurance in the Czech Republic between 2001 and 2013.



Source: ČAP, PGRLF, own calculations

Figure 2: Livestock insurance in the Czech Republic between 2001 - 2013.



Source: ČAP, PGRLF, own calculations

Figure 3: Rates of premium subsidies in the Czech Republic.

Figure 3 shows the development of rates of premium subsidies in agricultural insurance provided by the PGRLF in the period 2001 – 2013. The years 2014 and 2015 are estimates.

The crop insurance premium volumes have increased by 94.8 % from 2001 to 2013. The fluctuation of loss ratio was relatively high. The losses paid were higher then the premiums in four of thirteen years. Alternatively, livestock insurance showed a steady decline. The loss ratio in livestock insurance has been relatively low and stable. A higher loss ratio (at most 55% of total premiums in 2003) was seen in the years from 2001 to 2003, particularly in connection with cases of BSE. The overall downward trend in premiums corresponds to the decreasing numbers of farm animals in the Czech Republic.

Tab. 1 shows differences between crop and livestock insurance. The differences are described through sums, means, standard deviations and coefficients of variation of the parameters of agricultural insurance in the Czech Republic in last thirteen years, which illustrates the above mentioned characteristics.

The coefficient of variation of indemnity from the crop insurance is 0.462 whereas the coefficient of variation of indemnity from the crop insurance is 0.346. It is clearly shown that crop production is riskier than livestock production since the weather affects the crop yields rather than livestock production.

The share of insured livestock was estimated at 80%. Private insurance refers as well to cases of slaughter emergency of animals by the outbreaks of dangerous diseases which are compensated by the state according to the Veterinary Act. Compensation by the state together with the indemnity of the affected farmer's private insurance contract usually covers the damage not only of the lost animals but also the damage caused by the disruption of animal production. Unlike this solution the private business interruption insurance is offered for such cases in some other EU countries. The epizootic diseases are usually a standard exclusion in private livestock insurance in many countries.

The increasing rate of premium subsidies of crop insurance from 2001 to 2010 had a positive effect on the evolution of the total acreage of insured crops. The data refers to crops grown on arable land, vineyards, hop gardens and orchards. In 2010, the acreage of insured crops reached 1.5 million hectares. The share of the insured area was 48%, taking the total area of arable land, vineyards, hop fields and fruit orchards from the Czech Institute of Surveying, Mapping and Cadastre (ČÚZK). The share was 58% according to data from LPIS, which is related to the registered users of agricultural land and better represents the market potential for crop insurance. In recent years, the acreage of insured crops has slightly increased and reached 1.6 million hectares in 2013.

On the basis of the development of crop insurance penetration it can be noted that the premium subsidy has met its purpose and helped to develop the agricultural insurance market, especially crop insurance. This argument is valid only for actual insurable risks. Commercial insurance does not cover some important risks to crops in the Czech Republic; in addition to price risk, the risk of drought particularly but also the risk of rains at harvest time. The risk of draught, especially, has a much more systematic character than most of the present commercially insurable risks . This should lead to more government attention in this area.

There are various possibilities for further development of agricultural insurance. The relatively high support of commercial insurance could lead to the extension of the insurable risks in agricultural insurance products, as in Austria. Another possibility is the creation of a public fund as a financial instrument which would allow farmers to be compensated

Parameter		Sum (mil. CZK)	Mean (mil. CZK)	Standard deviation (mil. CZK)	Coefficent of variation
Crop insurance	premium	9 494.8	730.4	198.7	0.272
	indemnity	8 212.4	631.7	292.0	0.462
Livestock insurance	premium	4 042.7	311.0	64.9	0.209
	indemnity	1 818.7	139.9	48.5	0.346

Source: ČAP, PGRLF, own calculations

Table 1: Differences between development of premium and indemnity of crop and livestock insurance in the period 2001 – 2013.

for uninsurable risks (Prášilová, Hošková, 2010). The Agricultural Association of the Czech Republic suggests in this connection the creation of tools for risk and crisis management, with particular emphasis on coverage of uninsurable risks[2] from state budget after 2014.

The Czech Republic will not adapt support of risk management tools from the RDP due to specific size structure of Czech farms. The premium subsidies will be still provided from state budget by PGRLF. In the period 2014 – 2020, the ad hoc aids from the state budget are allowed by Framework program for dealing with risks and crises in agriculture - no. SA.37221 (2013/N). Estimated total budget for ad-hoc aids for the whole period 2014 - 2020 is 12 250 mil. CZK (= approximately 500 mil. €). The Framework enables to compensate losses caused by:

- natural disasters (earthquakes, landslides, floods, storm / hurricane and landslides),
- extraordinary events (major fires and industrial accidents),
- adverse weather events (heavy rain, flooding, drought, frost, ice, ground frost, hail).

Ad-hoc aid will be paid in the form of direct payments. Each applicant has to give confirmation on indemnity or risk uninsurability otherwise the aid will be reduced up to 50%.

Conclusion

The aim of the article is to evaluate the development of risk management support in agriculture in the Czech Republic in the period 2001 – 2013. This article describes the current approaches to risk management in agriculture and analyzes the situation of agricultural insurance in the Czech Republic compared with the OECD recommendations and with the situation in other countries.

The diversity of approaches to risk management in agriculture in the world and the countries of the European Union reflects various risks that farmers face in different countries. In the current period, the major sources of risk are the growing impacts of climate change and globalization of markets. The first case causes more frequent extreme weather events; the latter generates fluctuations in commodity prices and less dependence on the local production. Cooperation between the private and public sectors is generally considered as the optimal way to offer more effective tools of risk management. Normal risks, marketable risks and catastrophic risks specify the role of risk management at farm level, private market level and state intervention. The boundary between insurable and uninsurable risks is vague and different in various countries. For example, drought is often considered to be a systematic risk and therefore uninsurable, which is the case of the Czech agricultural insurance market. A similar conclusion applies to the risk of dangerous animal diseases. In this case the risk in the Czech Republic is generally insurable.

The Czech experience shows that support from public sources has helped to develop the agricultural insurance market. It would be desired to use the public sources for the heretofore uninsurable risks and to find the possibility for its insurability or to create a fond for such losses. In the case of livestock diseases the subsidized insurance covers also such cases which are indemnified by state according the Veterinary Act. A better solution would be to replace current livestock insurance by business interruption insurance for animal production.

The future of risk management support in the Czech Republic consists in ongoing premium subsidies from the state budget, state-financed ad hoc aids (or other equivalent tool for uninsurable risks), support of risk prevention from disease fund for livestock production and recovery fund for crop production. The direct payments will help farmers to increase the income level. The Czech Republic will not use any risk management support from the new Rural Development Programme in the period 2014 – 2020. Furthermore, it would be appropriate to focus attention on the creation of state co-financed instruments covering catastrophic losses. A possible solution is a creation of fund for uninsurable risks. The new instrument would replace the ad hoc state aid efficiently and effectively.

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[2] For losses caused by drought was paid 5 billion CZK in form of ad hoc state aid in 2000.

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References

[1] Antón, J., Kimura S. Risk Management in Agriculture in Spain. Paris: OECD Food, Agriculture and Fisheries Working Papers. 2011, No. 43, OECD Publishing. doi: 10.1787/5kgj0d57w0wd-en.

[2] Bobojonov, I., Aw-Hassan, A., Sommer, R. Index-based insurance for climate risk management and rural development in Syria. Climate and Development. 2014, Vol. 6, No. 2, p. 166-178. ISSN 1756-5529.

[3] Bielza Diaz-Caneja, M. , Conte, C. G., Gallego Pinilla, F. J., Stroblmair, J., Catenaro, R., Dittmann, C. Risk Management and Agricultural Insurance. Ispra: European Commission - Joint Research Centre - Institute for the Protection and Security of the Citizen, 2009. ISBN 978-92-79-12860-8.

[4] Dick, W. J., Wang, W. Government interventions in agricultural insurance. Agriculture and Agricultural Science Procedia.2010, Vol. 1, p. 4-12. ISSN 2210-7843.

[5] Elabed, G., Bellemare, M. F., Carter, M. R., Guirkinger, C. Managing basis risk with multiscale index insurance. Agricultural Economics (United Kingdom). 2013, Vol. 44, No. 4-5, p. 419-431. ISSN 0169-5150.

[6] Finger, R., El Benni, N. A note on the effects of the income stabilisation tool on income inequality in agriculture. Journal of Agricultural Economics, 2014, Vol. 65, No. 3, p. 739-745. ISSN 0021-857X.

[7] Horowitz, J., Lichtenberg, E. Insurance, Moral Hazard, and Chemical Use in Agriculture. American Journal of Agricultural Economics, 1993, Vol. 75, No. 4, p. 926 – 935. ISSN 0002-9092.

[8] Iturrioz, R. Agricultural Insurance. Primer series on insurance. 2009, No. 12. The World Bank, Washington DC 2009. Without ISSN/ISBN.

[9] Just, R. E., Calvin, L., Quiggin, J. Adverse Selection in Crop Insurance: Actuarial and Asymmetric Information Incentives. American Journal of Agricultural Economics. 1999, Vol., 81, No. 4, p. 834 – 849. ISSN 0002-9092.

[10] Keeney, M. The Distributional Impact of Direct Payments on Irish Farm Incomes. Journal of Agricultural Economics. 2000, Vol. 51, No. 2, p. 252-263. ISSN 0021-857X.

[11] Kimura, S., Antón J. Risk Management in Agriculture in Australia. Paris: OECD Food, Agriculture and Fisheries Working Papers, 2011, No. 39, OECD Publishing. doi: 10.1787/5kgj0d8bj3d1-en.

[12] Larson, D. F., Anderson, J. R., Varangis, P. Policies on managing risk in agricultural markets. World Bank Research Observer. 2004, Vol. 19, No. 2, 2004, p. 199-230. ISSN 0257-3032.

[13] Latham, B. Der Ernteversicherungsprogramm in den USA. Internationales Agrarversicherungssymposium „Risikomanagement durch Versicherungslösungen”, Wien, 21. 1. 2010. [Online]. Available: https://www.hagel.at/site/files/avs/DE_1_Latham.pdf [Accessed 10 Nov. 2014).

[14] Meuwissen, M. P. M., van Asseldonk, M. A. P. M., Huirne, R. B. M. Income Stabilisation in European Agriculture. Design and Economic Impact of Risk Management Tools. Wageningen: Wageningen Academic Publishers, 2008. 223 p. ISBN 978-90-8686-079-1.

[15] Meuwissen, M. P. M., Assefa, T. T., Van Asseldonk, M. A. P. M. Supporting Insurance in European Agriculture: Experience of Mutuals in the Netherlands. EuroChoices. 2013, Vol. 12, No. 3, p. 10-16. ISSN 1478-0917.

[16] Miranda, M. J., Gonzalez-Vega, C. Systemic risk, index insurance, and optimal management of agricultural loan portfolios in developing countries. American Journal of Agricultural Economics. 2011, Vol. 93, No. 2, p. 399-406. ISSN 0002-9092.

[17] Mußhoff, O., Odening, M., Xu, W. Zur Quantifizierung des Basisrisikos von Wetterderivaten, Tech. Rep. No. 14947, German Association of Agricultural Economists, Giessen, Germany, 2006. Without ISSN/ISBN.

[18] Norton, M., Osgood, D., Madajewicz, M., Holthaus, E., Peterson, N., Diro, R., Mullally, C., Teh, T.-L., Gebremichael, M. Evidence of Demand for Index Insurance: Experimental Games and Commercial Transactions in Ethiopia. Journal of Development Studies. 2014, Vol. 50, No. 5, p. 630-648. ISSN 0022-0388.

[19] Nussbaum, R. Public private partnership (PPP) for prevention and insurance of natural catastrophes in Europe. Houille Blanche. 2007, No. 2, p. 58-63. ISSN 0018-6368.

[20] OECD. Managing risk in agriculture: A holistic approach, OECD, Paris, 2009. ISBN 978-92-6407-530-6.

[21] Prášilová, M., Hošková, P. Development analysis and a system solution design for agricultural insurance in CR. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis. 2010, Vol. 58, No. 6, part 2, p. 379-388. ISSN 1211-8516.

[22] Sarris, A. Weather index insurance for agricultural development: Introduction and overview. Agricultural Economics (United Kingdom). 2013, Vol. 44, No. 4-5, p. 381-384. ISSN 0169-5150.

[23] Smith, V. H., Glauber, J. W. Agricultural insurance in developed countries: Where have we been and where are we going? Applied Economic Perspectives and Policy. 2012, Vol. 34, No. 3, p. 363-390. ISSN 2040-5790.

[24] Špička, J., Boudný, J., Janotová, B. The role of subsidies in managing the operating risk of agricultural enterprises. Agricultural Economics - Czech. 2009, Vol. 55, No. 4, p. 169 - 179. ISSN 0139-570X.

[25] Špička, J., Hnilica, J. A Methodical Approach to Design and Valuation of Weather Derivatives in Agriculture. Advances in Meteorology. 2013, Vol. 2013, 8 p. Article ID 146036. ISSN 1687-9309.

[26] Řezbová, H., Tomšík, K. Impact of complementary national direct payments on cattle breeding sector. Agris On-line Papers in Economics and Informatics. 2012, Vol. 4, No. suppl. spl. 4, p. 95-106. ISSN 1804-1930.

[27] Toraño, A. F. Das Ernteversicherungssystem in Spanien. Internationales Agrarversicherungssymposium „Risikomanagement durch Versicherungslösungen", Wien, 21. 1. 2010. Without ISSN/ISBN.

[28] Vávrová, E. Development of the agricultural Insurance market in the Czech Republic. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis. 2010, Vol. 58, No. 6, part 2, p. 613-624. ISSN 1211-8516.

[29] Vilhelm, V. Sympozium Světové asociace ovlivňování počasí. Pojistný obzor. 2006, Vol. 83, No. 5, p. 12 – 13. ISSN 0032-2393.

[30] Weber, R., Kraus, T., Mußhoff, O., Odening, M., Rust, I. Risikomanagement mit indexbasierten Wetterversicherungen – Bedarfsgerechte Ausgestaltung und Zahlungsbereitschaft. Risikomanagement in der Landwirtschaft. Schriftenreihe Band 23, Rentenbank, Frankfurt a. M., 2008. [Online] Available: http://www.rentenbank.de/cms/dokumente/10011465_262637/b4993161/Schriftenreihe_Band_23.pdf [Accessed 10 Nov. 2014].

[31] Weinberger, K. Management von Wetterrisiken in Anbetracht des Klimawandels und der GAP – Reform. „Ländlicher Raum" Online–Fachzeitschrift des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft. Jahrgang 2009. [Online] Available: http://www.bmlfuw.gv.at/land/laendl_entwicklung/Online-Fachzeitschrift-Laendlicher-Raum/archiv/2009/weinberger.html [Accessed 10 Nov. 2014].

[32] Yildirak, K., Gulseven, O. Indemnity payments in agricultural insurance: Risk exposure of EU states. Actual Problems of Economics. 2012, Vol. 127, No. 1, p. 381-388. ISSN 1993-6788.

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Potential of Open Data in the Agricultural eGovernment

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Anotace

Článek prezentuje přehled současného výzkumu potenciálu otevřených dat a jejich využití v zemědělství. Otevřená data jsou prezentována prostřednictvím konceptů informační potřeby a transformačních míst v zemědělských podnicích. Jako příklady možných příležitostí a stimulů pro otevřená data jsou uvedeny reálné příklady využití otevřených formátů (Open Office XML, CSV, ODS a RDF) a analýz dat s přidanou hodnotou na Portálu farmáře, který je vedoucím informačním zdrojem v českém zemědělství. Na základě rešerše literatury a analýzy sekundárních dat je v článku uvedena série dalších výzkumných otázek.

Klíčová slova

Open data, informační potřeba, informační systémy, ekonomie Open Dat, Open eGovernment, Zemědělský eGovernment.

Abstract

The paper presents overview of current research on open data potential and use in the agriculture. Open data are described through the concepts of information need and transformation places in the agricultural enterprise. Opportunities and stimuli of open data for agriculture are discussed such as real use cases of open formats (Open Office XML, CSV, ODS and RDF) and suggestions of value-added analysis of data available at eAGRI Portal that is leading information source in Czech agriculture. Based on the literature review and secondary data analysis a series of further research questions is provided in the conclusion.

Key words

Open data, information need, information systems, Open data economy, Open eGovernment, Agricultural eGovernment.

Introduction

The issue of the open data has recently been subject of intense research and discussions. This topic is relevant especially in relationship with the public sector in which following principles are implemented:

- *publishing:* ‚What is not secret can be published‘,
- *openness:* make available as much information about your own activities, decisions, rules, and financial flows as possible,
- *availability:* publish the information in available and understandable form,
- client-side control: transfer the relevance control of open data from publisher to recipient,
- *free access:* keep the open data available free of charge,
- *open standards:* comply with the open standards and data quality standards (Kučera and Chlapek, 2014; Open Government Standards, 2012).

In developing open data policies, governments aim to stimulate and guide the publication of government data and to gain advantages from its use. Currently there is a multiplicity of open data policies at various levels of government, whereas very little systematic and structured research has been done on the issues that are covered by open data policies, their intent and actual impact (Zuiderwijk, Janssen, 2014). By paper Luna-Reyes et al. (2014) this open data movement, although very recent, has begun to promote research to explore benefits and barriers (Janssen et al., 2012, Zuiderwijk et al., 2012), requirements and technical facilities to pro-mote value creation (Zuiderwijk et al., 2012, Arzberger et al., 2004), and policy issue and im-plications (Bertot, Choi, 2013).

	Drive Revenue through multiple areas	Cut Costs and Drive Efficiency	Generate Employment and develop future-proof skills
Benefit to Government	• Increased tax revenues though in-creased economic activity • Revenues through selling high value added information for a price	• Reduction in transactional costs • Increased service efficiency through linked data	• Create jobs in current challenging times • Encourage entre-preneurship
Benefit to Private Sector	• Drive new business opportunities	• Reduced cost by not having to invest in conversion of raw government data • Better decision making based on accurate information	• Gain skilled workforce

Source: (Tinholt, 2013)

Table 1: Economic benefits of open data to government and private sector.

Increasingly open data systems allowing individuals to trace and use information at all levels in companies require open and flexible employees, and transparency (Kjellberg, Werneman, 2000). An illustrative example of open data related business success has been the making of data from the military GPS satellite navigation project available for public use. The value of the business activities related to this technology has reached millions of dollars since. The open data currently finds its main use in traffic, logistics, health care, and insurance services (Chui et al., 2014).

The agriculture sector is a unique sector due to its strategic importance for both citizens (consumers) and economy (regional and global) that ideally should make the whole sector a network of interacting organizations. Rural areas are of particular importance with respect to the agrifood sector and should be specifically addressed within this scope (Charvat et al., 2014). Agriculture Secretary Tom Vilsack, along with Bill Gates, and U.S. Chief Technology Officer Todd Park, April 29, 2013 kicked off a two-day international open data conference, saying that data "is among the most important commodities in agriculture" and sharing it openly increases its value (G-8, 2013).

The goal of this article is to define the meaning and the benefits of open data in the agricultural sector, including the identification of possibilities and assumptions for their meaningful use, given the existing information needs and appropriate disposition.

Materials and methods

The required information set at the same time depends not only on the place of its use (the decision making point), but also on the experiences and knowledge of the management entity (Říhová, 1996). The nature of information, which is a subject of this need, possibly summariz-es the best the system approach definition specified as: “Information is the process of becom-ing informed; it is dependent on knowledge, which is processed data” (Zins, 2007). Based on this definition, a relationship of information to data, as well as knowledge can be defined as:

DATA → INFORMATION → KNOWLEDGE.

The level of the information need in the agricultural sector is relatively high, which is a logical consequence of the existing diversification of the pursued activities in a typical agricultural enterprise. This diversification is inherent to the very nature of agriculture, and the corresponding endeavour to target various production domains in order to mitigate the potential risks. This is among other solutions accomplished by parallel growing of several crop species in one year. In case the yields from one species are unsatisfactory, the yields from the others can partially cover for the loss making it less damaging for the agricultural enterprise. To the in-creasing information need in the agricultural sector thus also contributes that:

- many agricultural activities are affected by the significant lack of available experts or other information sources;
- many problems corresponding to these activities require timely and highly qualified solution;

- the nature of agricultural production requires cooperation of many subjects, such as farmers, phytosanitary specialist, fertilizer producers, scientists and managers that could use open data from their specialties, however open data are lacking or unknown or available in closed proprietary formats (Dengel, 2013).

The diversification of the activities pursued is the core determinant for the corresponding information resources and information systems of agricultural enterprises. The type scale of software components of such information systems describes the following Graph 1 (Vostrovský et al., 2013).

With the existing information need closely corresponds to so-called transformation place (TP). The information need is then defined as a specific set of information required for proper functioning of a TP. The diversification of agricultural activities, as described higher, is logically reflected in the amount of TP in the typical agricultural enterprise. The set of information needs of individual TP in fact determines the required information systems and information resources. Below is shown depicts how the set of TPs in a typical agricultural enterprise can be derived..

It is obvious that every TP does not necessarily need to be personally maintained by one specific manager. In smaller agricultural businesses, a single manager often operates several TPs at the same time because of the personal dispositions of such entities.

The information need of TP in agriculture relates to following types of information:

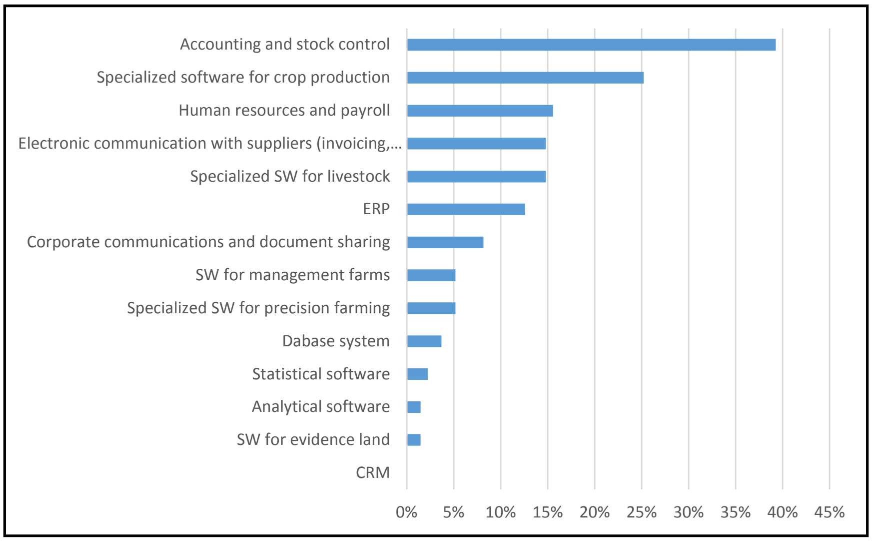
- *technological information* – in the agricultural enterprise relates mainly to matters of what to do, and how to do it,
- *value-assessing information* – express the financial burden of realised activities,
- *dynamic information* – relates to the time properties of these activities (when and up to when realize them).

Every individual TP thus shows specific information need, while the union of these sectional information needs represents the total information need of the individual enterprise, which should be covered by its information resources. If not, it is necessary to get the missing infor-mation from the external sources. This can determine the space of open data use in the agricul-tural sector.

When we analyse the type of the constitution of required information coverage of agricultural enterprises (see Graph 1), the relatively low share of software used for data analysis can be observed, which can be caused by the difficulty and complexity of such software solutions. On the other hand, the demand for data (information) evaluated by such a kind of software is high, as obvious from the Graph 2.

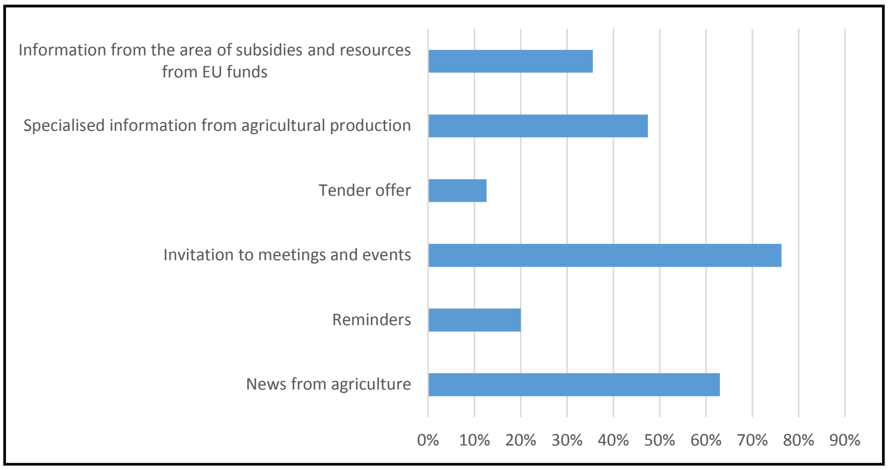
Chosen way of publication of open data must satisfy the following conditions:

- *transparency*, i.e. putting data sets in a catalogue in searchable format (.xls, .mdb),
- *legal openness*, i.e. publication of data under an open license,



Source: (Vostrovský et al., 2013)

Graph 1: Types of software used for satisfying information needs in Czech small farms.



Source: (Vostrovský et al., 2013)

Graph 2: Scale of required information in small Czech farms.

- *technical openness*, i.e. publication of data in a standard machine-readable format
- *comprehensibility expression*,
- *availability and originality*, ie. to publish individual data sets as a whole and unaltered,
- *possibility of the aggregation* of partial data.

To increase the potential of open data it will be appropriate to publish this data in a transparent form. The presentation in the form of interactive maps can be very suitable in this context.

Results and discussion

Open data as an economic stimulus in the agricultural sector

If open data should fulfill its purpose in the agriculture it must be published in an acceptable form. For this purpose, there are variety of suitable formats available:

- **Office Open XML:**

  MS Office 2007–2013 suit documents that use the new Office Open XML (OOXML) format, are the most widely used electronic documents by a large number of users in the world (Fu et al., 2014) (Figure 1).

- **Format CSV (Comma-Separated Values):**

  Format CSV is comma separated variable files. CSV files can also be read and pro-cessed by Microsoft ® Excel (Cremin, 2001) (Figure 2).

- **Format ODS (Open Document Spreadsheet):**

  OpenDocument format (ODF) is an XML-based open standard file format for office documents such as these. ODF is application-, platform- and vendor-neutral, and thereby facilitates broad interoperability of office documents (Weir, 2009) (Figure 3).

- **Format RDF (Resource Description Framework):**

  The Resource Description Framework (RDF) is a framework for representing infor-mation in the Web (Klyne, Carroll, 2006) (Figure 4).

The chosen format of open data significantly predetermines so-called degree of openness. In this context it should be noted that the chosen format must be available to the provider and recipient of open data. Tim Berners-Lee, the inventor of the Web and Linked Data initiator, suggested a 5 star deployment scheme for Open Data (Berners-Lee, 2012) (Figure 5).

Own potential of open data in potential of open data in the agricultural sector (PODAS) can be defined as

$$PODAS = f(C, DP, RD, WB, SA, HW)$$

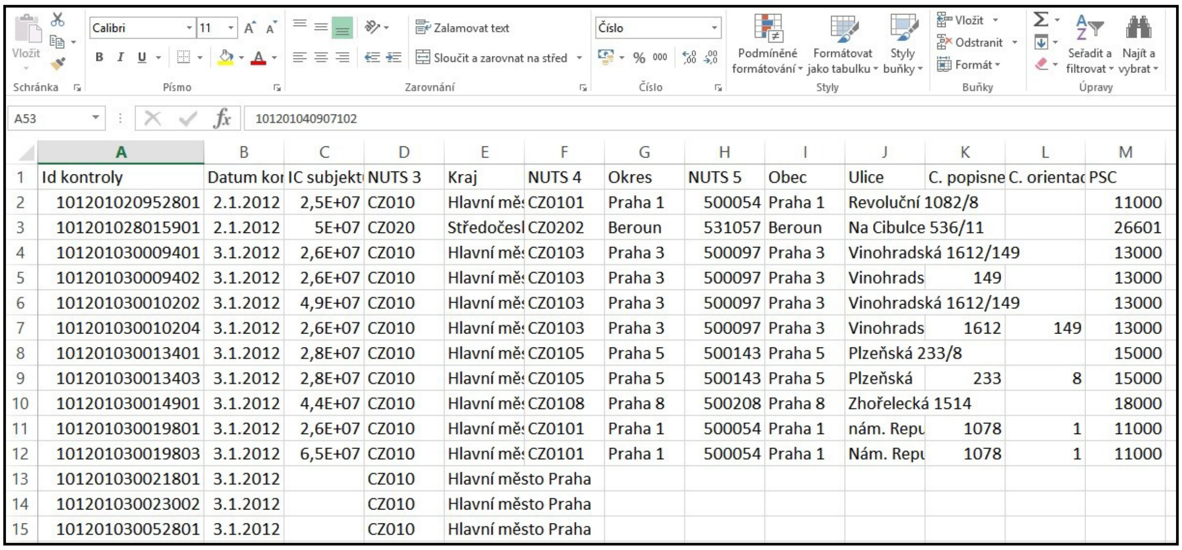
where *C* is *content* (ie. presented data set),

DP is *provider of open data*, (ie. his experience, skills, qualification, computer literacy),

RD is *recipient of open data* (ie. his experience, skills, qualification, computer literacy),

WB is *web browser* (ie. the its type, quality, version),

SA is *software amenities* of the provider and recipient open data (i.e. the its type, quality, version, development tools for web development, and Tools for Promoting accessibility, (XHTML validators, CSS validators),



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4	101201030009401	3.1.2012	2,6E+07	CZ010	Hlavní mě:	CZ0103	Praha 3	500097	Praha 3	Vinohradská 1612/149			13000
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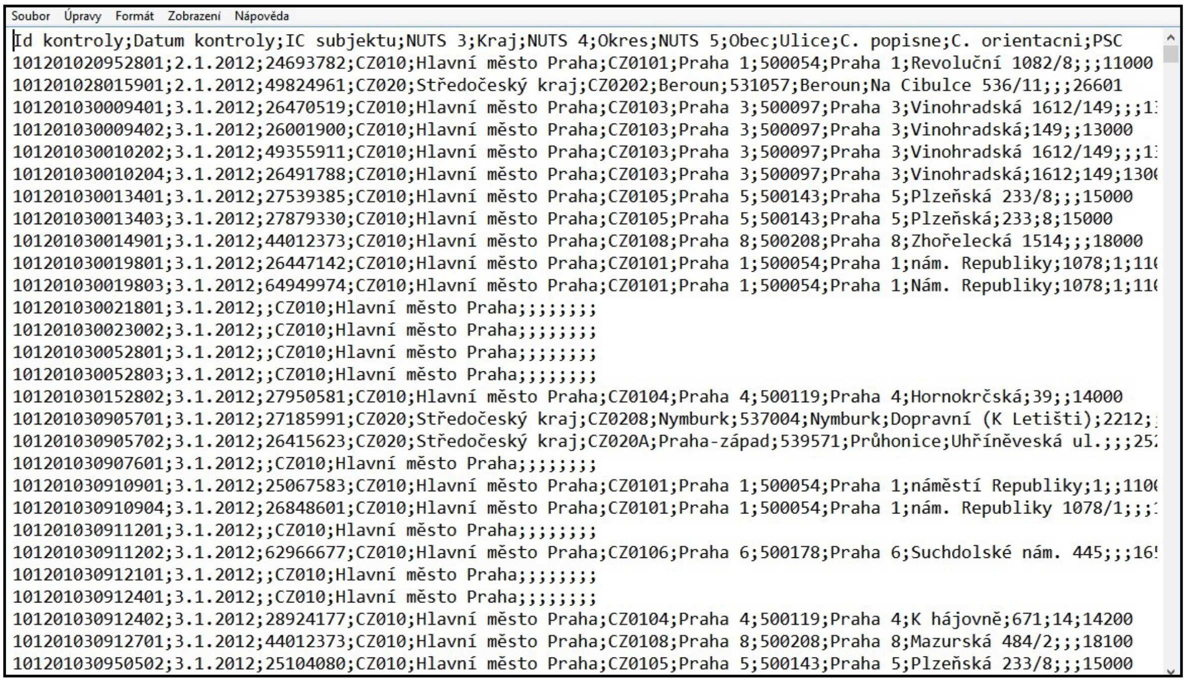
6	101201030010202	3.1.2012	4,9E+07	CZ010	Hlavní mě:	CZ0103	Praha 3	500097	Praha 3	Vinohradská 1612/149			13000
7	101201030010204	3.1.2012	2,6E+07	CZ010	Hlavní mě:	CZ0103	Praha 3	500097	Praha 3	Vinohrads	1612	149	13000
8	101201030013401	3.1.2012	2,8E+07	CZ010	Hlavní mě:	CZ0105	Praha 5	500143	Praha 5	Plzeňská 233/8			15000
9	101201030013403	3.1.2012	2,8E+07	CZ010	Hlavní mě:	CZ0105	Praha 5	500143	Praha 5	Plzeňská	233	8	15000
10	101201030014901	3.1.2012	4,4E+07	CZ010	Hlavní mě:	CZ0108	Praha 8	500208	Praha 8	Zhořelecká 1514			18000
11	101201030019801	3.1.2012	2,6E+07	CZ010	Hlavní mě:	CZ0101	Praha 1	500054	Praha 1	nám. Repu	1078	1	11000
12	101201030019803	3.1.2012	6,5E+07	CZ010	Hlavní mě:	CZ0101	Praha 1	500054	Praha 1	Nám. Repu	1078	1	11000
13	101201030021801	3.1.2012		CZ010	Hlavní město Praha								
14	101201030023002	3.1.2012		CZ010	Hlavní město Praha								
15	101201030052801	3.1.2012		CZ010	Hlavní město Praha								

Source: (ČOI, 2013)

Figure 1: Example of open data publishing in the format .xlsx.

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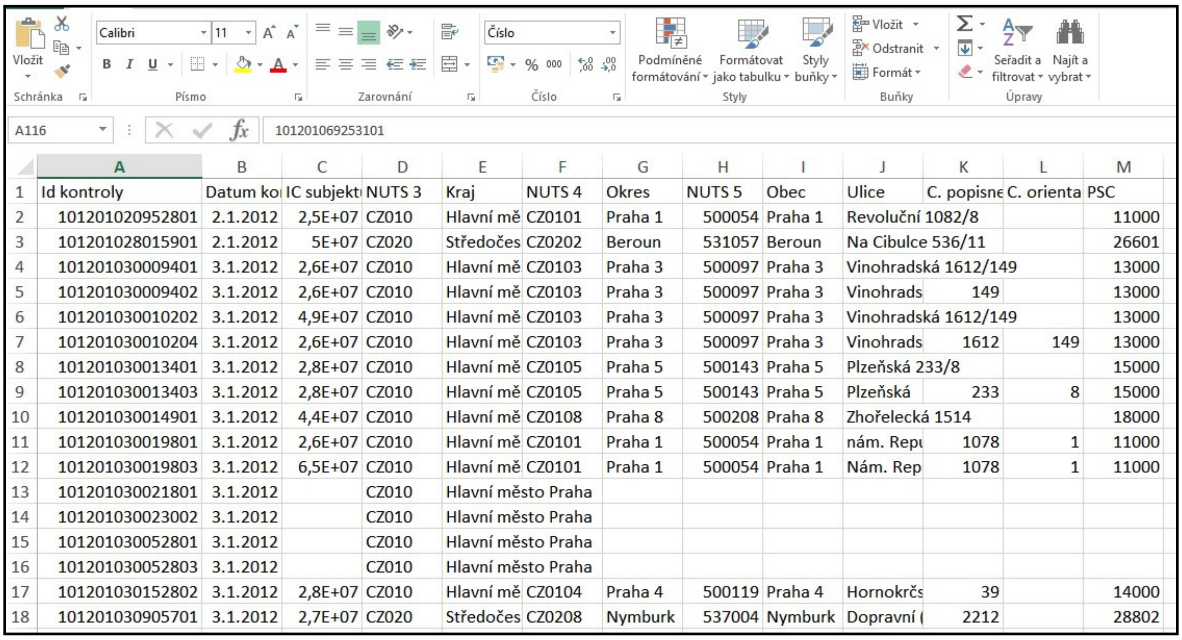
Source: (ČOI, 2013)

Figure 2: Example publishing open data in the format .csv.



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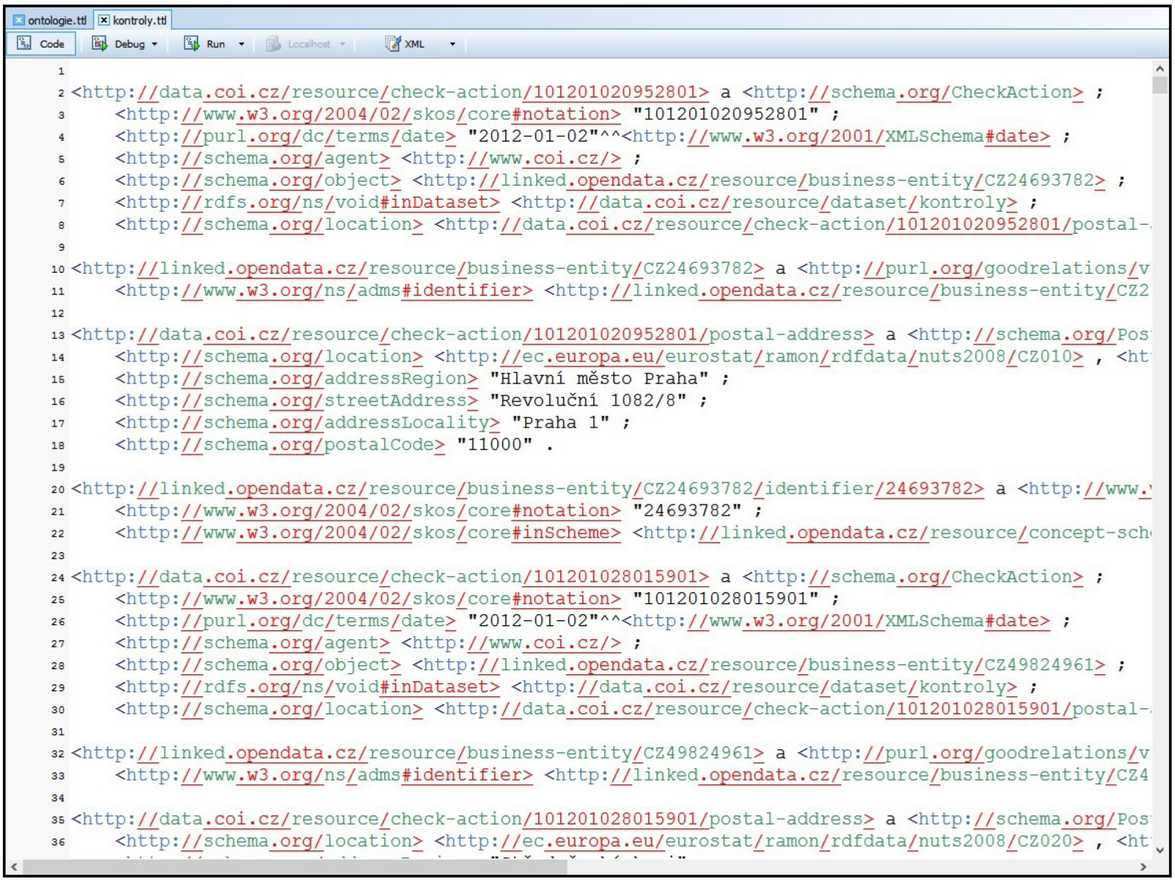
8	101201030013401	3.1.2012	2,8E+07	CZ010	Hlavní mě	CZ0105	Praha 5	500143	Praha 5	Plzeňská 233/8			15000
9	101201030013403	3.1.2012	2,8E+07	CZ010	Hlavní mě	CZ0105	Praha 5	500143	Praha 5	Plzeňská	233	8	15000
10	101201030014901	3.1.2012	4,4E+07	CZ010	Hlavní mě	CZ0108	Praha 8	500208	Praha 8	Zhořelecká 1514			18000
11	101201030019801	3.1.2012	2,6E+07	CZ010	Hlavní mě	CZ0101	Praha 1	500054	Praha 1	nám. Repu	1078	1	11000
12	101201030019803	3.1.2012	6,5E+07	CZ010	Hlavní mě	CZ0101	Praha 1	500054	Praha 1	Nám. Rep	1078	1	11000
13	101201030021801	3.1.2012		CZ010	Hlavní město Praha								
14	101201030023002	3.1.2012		CZ010	Hlavní město Praha								
15	101201030052801	3.1.2012		CZ010	Hlavní město Praha								
16	101201030052803	3.1.2012		CZ010	Hlavní město Praha								
17	101201030152802	3.1.2012	2,8E+07	CZ010	Hlavní mě	CZ0104	Praha 4	500119	Praha 4	Hornokrčs	39		14000
18	101201030905701	3.1.2012	2,7E+07	CZ020	Středočes	CZ0208	Nymburk	537004	Nymburk	Dopravní (	2212		28802

Source: (ČOI, 2013)

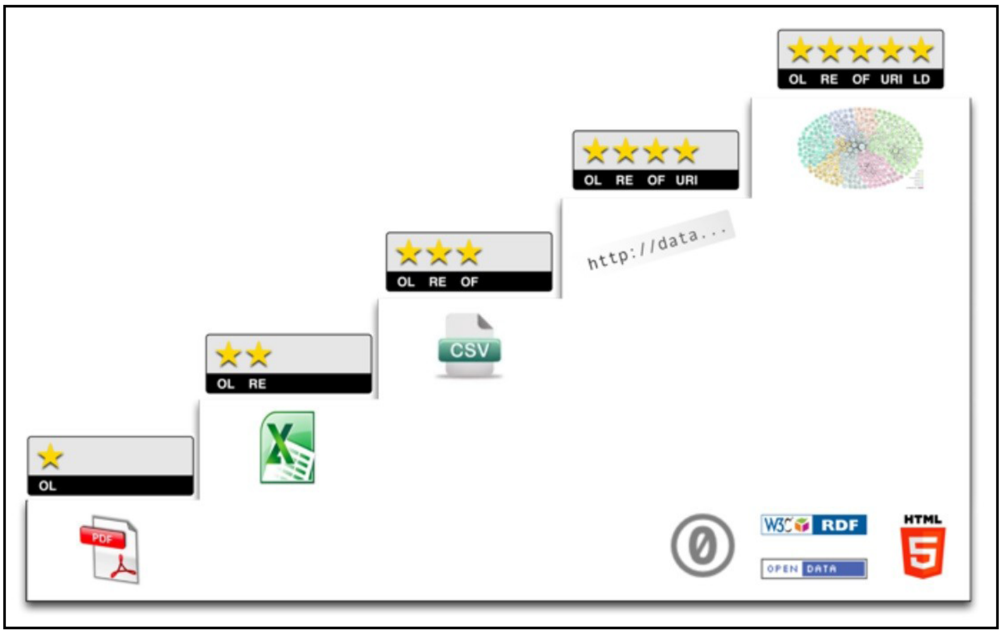
Figure 3: Example publishing open data in the format .ods.



```
<http://data.coi.cz/resource/check-action/101201020952801> a <http://schema.org/CheckAction> ;
    <http://www.w3.org/2004/02/skos/core#notation> "101201020952801" ;
    <http://purl.org/dc/terms/date> "2012-01-02"^^<http://www.w3.org/2001/XMLSchema#date> ;
    <http://schema.org/agent> <http://www.coi.cz/> ;
    <http://schema.org/object> <http://linked.opendata.cz/resource/business-entity/CZ24693782> ;
    <http://rdfs.org/ns/void#inDataset> <http://data.coi.cz/resource/dataset/kontroly> ;
    <http://schema.org/location> <http://data.coi.cz/resource/check-action/101201020952801/postal-

<http://linked.opendata.cz/resource/business-entity/CZ24693782> a <http://purl.org/goodrelations/v
    <http://www.w3.org/ns/adms#identifier> <http://linked.opendata.cz/resource/business-entity/CZ2

<http://data.coi.cz/resource/check-action/101201020952801/postal-address> a <http://schema.org/Pos
    <http://schema.org/location> <http://ec.europa.eu/eurostat/ramon/rdfdata/nuts2008/CZ010> , <ht
    <http://schema.org/addressRegion> "Hlavní město Praha" ;
    <http://schema.org/streetAddress> "Revoluční 1082/8" ;
    <http://schema.org/addressLocality> "Praha 1" ;
    <http://schema.org/postalCode> "11000" .

<http://linked.opendata.cz/resource/business-entity/CZ24693782/identifier/24693782> a <http://www.
    <http://www.w3.org/2004/02/skos/core#notation> "24693782" ;
    <http://www.w3.org/2004/02/skos/core#inScheme> <http://linked.opendata.cz/resource/concept-sch

<http://data.coi.cz/resource/check-action/101201028015901> a <http://schema.org/CheckAction> ;
    <http://www.w3.org/2004/02/skos/core#notation> "101201028015901" ;
    <http://purl.org/dc/terms/date> "2012-01-02"^^<http://www.w3.org/2001/XMLSchema#date> ;
    <http://schema.org/agent> <http://www.coi.cz/> ;
    <http://schema.org/object> <http://linked.opendata.cz/resource/business-entity/CZ49824961> ;
    <http://rdfs.org/ns/void#inDataset> <http://data.coi.cz/resource/dataset/kontroly> ;
    <http://schema.org/location> <http://data.coi.cz/resource/check-action/101201028015901/postal-

<http://linked.opendata.cz/resource/business-entity/CZ49824961> a <http://purl.org/goodrelations/v
    <http://www.w3.org/ns/adms#identifier> <http://linked.opendata.cz/resource/business-entity/CZ4

<http://data.coi.cz/resource/check-action/101201028015901/postal-address> a <http://schema.org/Pos
    <http://schema.org/location> <http://ec.europa.eu/eurostat/ramon/rdfdata/nuts2008/CZ020> , <ht
```

Source: (ČOI, 2013)

Figure 4: Example publishing open data in the format .rdf.



Source: (Berners-Lee, 2012)

Figure 5: Degree of openness of the open data.

HW is *quality and level* of hardware on part of the recipient.

Open data economy (economy based on open data) is often mentioned in conjunction with open data (Taggart, Peltola, 2010). There is no doubt that the agricultural sector must be a part of this economy. If agriculture should become a full-fledged part of this economy, it must accept open data. Current level of e-government in agriculture introduces a great opportunity to promote open data (Rysová et al., 2013).

Agricultural e-government as an opportunity to promote open data

In the Czech Republic, there is a good quality of e-government in the agriculture facilitated by the Czech Ministry of Agriculture (Rysová et al., 2013). Similarly to a classic e-government, this variant is being constantly developed in terms of its complexity and gradually aspires to the highest level, i.e. the level of a full-fledged e-government characterized by its relevant openness. The core component of the agricultural e-government in the Czech Republic is eAGRI portal maintained by the Ministry of Agriculture. In conjunction with the public sector, the need of so-called open e-government has been accented recently and the same variant should be considered in the case of an agricultural e-government, which means an open agricultural e-government. Its current level has all the capabilities to reach such quality (Figure 6).

An obvious need of value-added information dedicated to decision making in small and medium agricultural companies was identified during the previous research (Rysová et al., 2013). A lack of this information can be easily eliminated by open data through the open agricultural e-government. The gained information can then help the recipients (agricultural companies) to decide which suppliers to choose, how much to pay for their services or goods etc. This awareness then brings a greater strength in negotiations to the agricultural companies. It is worth to note that small and medium agricultural companies have gained focus of the European institutions not only from the viewpoint of subsidies but also the information support of their activities.

One of the objectives of agricultural e-government should be a relevant contribution to the satisfaction of the existing information needs. This means not only to gather the data from the agricultural companies, but also give the information back to these companies with some relevant added value. The added value may be the aggregation and analysis of the data. In this context, it can be concluded that the untapped potential of the current level of agricultural e-government can consist also in this function.

Source: (MZe, 2014)

Figure 6: Front page of the eAGRI Portal, the core component of agricultural e-government.

eAGRI Portal, as the core component of agricultural e-government, provides a wide range of opportunities for the proliferation of open data. One of these opportunities is the component "Evidence of the use of fertilizers and plant protection products". Within this application the users provide the Ministry of Agriculture with the data about these matters (Figure 7).

The data gathered by the application are then aggregated by the institution. It is possible to increase data value by analyses using a specialized software. After this evaluation the data can be returned to the source subjects who can use them to improve their decisions. The companies will learn which product is used regularly in their region or area, and thus is probably efficient. An information support like that can save a significant amount of money, because the cost of fertilizers and plant protection products is high and a wrong selection can result in a great loss. The eAGRI Portal offers a number of additional options of data evaluation and publishing that would be of great utility.

The disposition to use the eAGRI Portal in the way described above exists and is documented by the results of the above mentioned research project IGA nr. 20131038 at FEM CULS in Prague presented by the following Graph 3.

The open data stimulus in the agricultural sector

The supposed savings in the agricultural sector can represent only the first step of the economic benefit of open data. The prosperity of the economic subjects and the whole sector can be enhanced by activities that will bring new values (i.e. data with added value) that the agricultural companies will be willing to pay for. It is in the interest of the Ministry of Agriculture to make the data available to all parties with as low legal and licensing restrictions as possible and also in the highest possible technical quality. If the data are accessible in real time through a well-designed API, the number of interested subjects will be probably higher than in the case where the data are incomplete or only in basic Excel sheets.

The anticipated stimulus for the agricultural sector must be based on the elementary classification of subjects of the business model connected with open data and the roles of the subjects will be (Howard, 2013):

- **Suppliers**

Suppliers are the subjects who supply open data, although this activity is not necessarily their primary objective or the source of their profit. Publishing the data could be a part of their broader strategy to increase the trust of their customers and to strengthen their integrity. This business model includes primarily the companies who provide open data for better decisions of customers on the market. In the agricultural sector, this subject should be covered by the Ministry of Agriculture, and its primary objective should be the transparency of the whole sector.

- **Aggregators**

These institutions should collect and process the data. The core of their business will be in creating an added value by aggregating and processing the data and storing them in appropriate databases.

- **Developers**

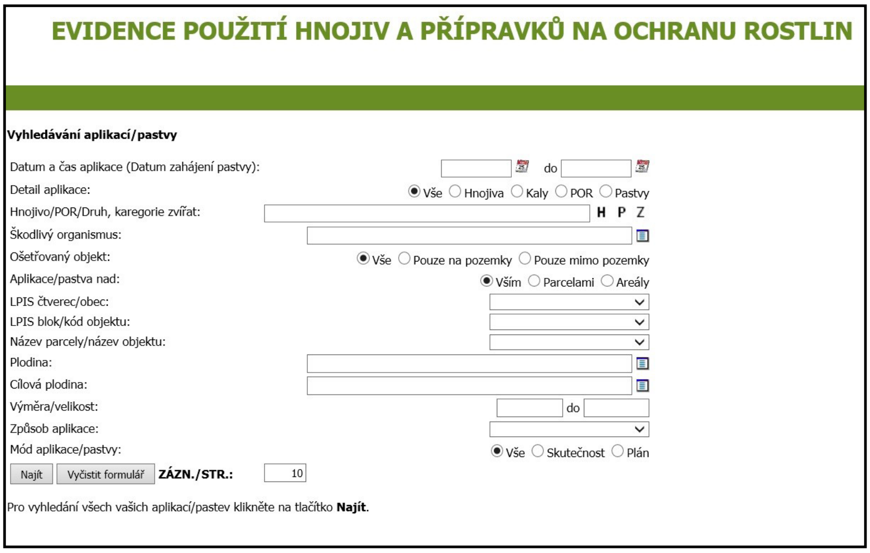
These subjects should create mobile, web or information terminal (kiosk) applications and their target group will be end users. The applications can be offered free of charge or for a one-time payment for the download or use.

- **Enrichers**

These subjects should add some expert opinion to the data and this expertise should be offered as a service to the clients. Thus the original data will be enriched by some relevant added value that will be helpful to the customers.

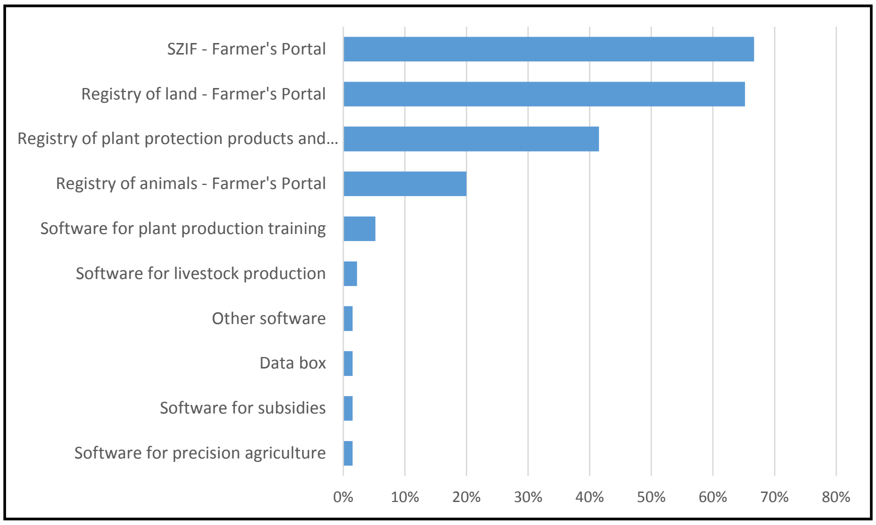
- **Enablers**

This category brings the tools, methods



Source: (MZe, 2014)

Figure 8: The application Evidence of the use of fertilizers and plant protection products as a part of the eAGRI Portal.



Source: own work

Graph 3: Training courses on the usage of the eAGRI Portal components.

and technologies that make the open data accessible for processing. Working with the data requires certain skill, whether on the side of the Ministry of Agriculture, which should publish the data, or the side of the parties who want to process them. It is important for potential users, if the data are available through a complex API (an intelligent interface) or as huge data files for download.

Conclusion

Gaining the full potential of open data in the agricultural sector assumes a good answer to the following questions:

- How can the transparency of open data help the agricultural companies in their business activities?
- Which data should be published?
- What quality must meet these data?
- How to efficiently make this data available in electronic form?
- Which facilities should be built for these purposes at the lower and middle management levels of the agricultural sector?

- How to educate the officials at the Ministry of Agriculture and the middle managers of the agricultural companies to be attracted to open data?
- How to solve the dilemma between the publication of agricultural open data and the protection of strategic and personal data (Kučera, Chlapek, 2014)?
- Should the agricultural companies serve as and example and open their own data or should they support the existing activities on agricultural portals?
- How to support the companies to take part in open data?

If the above questions are successfully answered, the following benefits for the agricultural sector can be expected:

- transparency of the whole agricultural sector, agricultural companies and their activities,
- relevant information support for their strategic and tactic decision making.

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References

[1] Arzberger, P., Schroeder, P., Beaulieu, A., Bowker, G., Casey, K., Laaksonen, L., Moorman, D., Uhlir, P., Wouters, P. An International Framework to Promote Access to Data. Science. 2004, Vol. 303, No. 5665, p. 1777-1778. ISSN 00368075.

[2] Berners-Lee, Tim. 5 Star Open Data. 2012. [Online] Available: http://5stardata.info/ [Accessed: 25 Nov. 2012].

[3] Bertot, J. C., Choi, H. Big data and e-government: Issues, policies, and recommendations. ACM, 2013. p. 1-10. ISBN 978-145032057-3.

[4] Charvat, K., Esbri, M. A., Mayer, W., Campos, A., Palma, R., Krivanek, Z. FOODIE - Open data for agriculture. IEEE Computer Society, 2014. ISBN 978-190582444-1.

[5] Chui, M., Manyika, J., Van Kuiken, S. What Executives should Know about Open Data. McKinsey Quaterly. 2014, Iss. 1, p. 102-105. ISSN 0047-5394.

[6] ČOI. Open Data - Databáze Kontrol, Sankcí a Zákazů. Česká obchodní inspekce, 2013. [Online] Available: http://www.coi.cz/cz/spotrebitel/open-data-databaze-kontrol-sankci-a-zakazu [Accessed: 14 Dec. 2013].

[7] Cremin, J. D. Linking laboratory instruments for simulation: Comma separated variable files. ASEE, 2001. p. 6869-6875. ISBN 01901052.

[8] Dengel, A. The Role of Linked Data in Agriculture. Interview with Johannes Keizer, Information Systems Officer at the Food and Agriculture Organization of the United Nations. Organ des Fachbereichs "Künstliche Intelligenz" der Gesellschaft für Informatik e.V. Springer-Verlag Berlin Heidelberg, 2013. November 2013, Vol. 27, No. 4, p. 363-364.

[9] Fu, Z., Sun, X., Zhou, L., Shu, J. New forensic methods for OOXML format documents. Springer Verlag, 2014. p. 503-513. ISBN 03029743.

[10] G-8. G-8 Open Data for Agriculture Conference Aims to Help Feed a Growing Population and Fulfill New Alliance for Food Security and Nutrition Commitment. Lanham, United States, Lanham: Federal Information & News Dispatch, Inc., Apr. 29, 2013, 2013 ProQuest Central.

[11] Howard, A. Governments Looking for Economic ROI must Focus on Open Data with Business Value. O'Reilly Radar, February 25, 2013. [Online] Available: http://radar.oreilly.com/2013/02/roi-open-data-economy-value.html [Accessed: 16 Sept. 2014].

[12] Janssen, M., Charalabidis, Y., Zuiderwijk, A. Benefits, Adoption Barriers and Myths of Open Data and Open Government. Information Systems Management. 2012, Vol. 29, No. 4, p. 258-268. ISSN 1058-0530.

[13] Kjellberg, A., Werneman, A. Business Innovation – Innovative Teams, Competence Brokers and Beehive Structures – in a Sustainable Work Organisation. CIRP Annals - Manufacturing Technology. 2000, Vol. 49, No. 1, p. 355-358. ISSN 0007-8506.

[14] Klyne, G., Carroll, J. J. Resource Description Framework (RDF): Concepts and Abstract Syntax. 2006.

[15] Kučera, J., Chlapek, D. Benefits and Risks of Open Government Data. Journal of Systems Integration. 2014, Vol. 5, No. 1, p. 30-41. ISSN 1804-2724.

[16] Luna-Reyes, L. F., Bertot, J. C., Mellouli, S. Open Government, Open Data and Digital Government. Government Information Quarterly. 2014, Vol. 31, No. 1, p. 4-5. ISSN 0740-624X.

[17] MZe. Portál Farmáře (eAGRI). Ministry of Agriculture CR, 2014 [Online] Available: http://eagri.cz/public/web/mze/farmar/ [Accessed: 17 Sept. 2014].

[18] Open Government Standards, 2012. [Online] Available: http://www.opengovstandards.org [Accessed: 20 Sept. 2012].

[19] Říhová, Z. Informační zabezpečení a organizační změny. University of Economics Prague, 1996. p. 99. ISBN 80-7079-535.

[20] Rysová, H., Kubata, K., Tyrychtr, J., Ulman, M., Šmejkalová, M., Vostrovský, V. Evaluation of Electronic Public Services in Agriculture in the Czech Republic. Acta Universitatis Agriculturae Et Silviculturae Mendelianae Brunensis. 2013, Vol. LXI, No. 2, p. 473-479. ISSN 1211-8516.

[21] SVS. Mapové výstupy z kontrolní činnosti státní veterinární správy. State Veterinary Administration, 2014. [Online] Available: http://eagri.cz/public/app/svs_pub/mapy_vk/#mapa=E07&obdobi=R2014 [Accessed 16 Sept. 2014].

[22] Taggart, Ch., Peltola, V. OpenCorporates: Why we'Re Crying Out for this Database of Companies. The Guardian, 20 December 2010, 2010 [Online] Available: http://www.theguardian.com/news/datablog/2010/dec/20/open-corporates-chris-taggart [Accessed: 16 Sept. 2014].

[23] Tinholt, D. The Open Data Economy, Unlocking Economic Value by Opening Government and Public Data. Capgemini Consulting Analysis, 2013 [Online] Available: http://www.capgemini-consulting.com/resource-file-access/resource/pdf/opendata_pov_6feb.pdf [Accessed: 16 Sept. 2014].

[24] Vostrovský, V., Tyrychtr, J., Ulman, M. The Potential of Agricultural eGovernment. MMK 2013 International Masaryk Conference for Ph.D. Students And Young Researchers. Ed. on-line: Magnanimitas, 2013. ISBN 978-80-87952-00-9.

[25] Weir, R. OpenDocument Format: The Standard for Office Documents. Internet Computing, IEEE. 2009, Vol. 13, No. 2, p. 83-87. ISSN 1089-7801.

[26] Zins, Ch. Conceptual Approaches for Defining Data, Information, and Knowledge. Journal of the American Society for Information Science and Technology. 2007, Vol. 58, No. 4, p. 479-493. [Online] Available: http://dx.doi.org/10.1002/asi.20508. [Accessed: 5 Jan. 2015]. ISSN 1532-2890.

[27] Zuiderwijk, A., Choenni, S., Meijer, R., Alibaks, R. S. Socio-Technical Impediments of Open Data. Electronic Journal of E-Government. 2012, Vol. 10, No. 2, p. 156-172. ISSN 1479-439X.

[28] Zuiderwijk, A., Janssen, M. Open Data Policies, their Implementation and Impact: A Framework for Comparison. Government Information Quarterly. 2014, Vol. 31, No. 1, p. 17-29. ISSN 0740-624X.

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