

Czech University of Life Sciences Prague
Faculty of Economics and Management

agris *on-line*

Papers in Economics and Informatics



<http://online.agris.cz>

ISSN 1804-1930
X, 2018, 3

International scientific journal
Prague

Agris on-line Papers of Economics and Informatics

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

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

Editorial office

AGRIS on-line Papers in Economics and Informatics
Department of Economics of FEM CULS Prague
Kamýcká 129, 165 00 Praha-Suchdol
Czech Republic
Phone: +420 224 382 050, 056
E-mail: agrisonline(at)pef.czu.cz

Publisher

Faculty of Economics and Management
Czech University of Life Sciences Prague
Kamýcká 129, 165 00 Praha-Suchdol
Czech Republic
Reg. number: 60460709

ISSN 1804-1930

X, 2018, 3

30th of September 2018

Prague

Agris on-line
Papers in Economics and Informatics

ISSN 1804-1930

X, 2018, 3

Content:

F. O. Alegwu, G. C. Aye, B. Ch. Asogwa: Effect of Real Exchange Rate Volatility on Agricultural Products Export in Nigeria	3
J. M. Balogh, A. Jámbo: The Role of Culture, Language and Trade Agreements in Global Wine Trade	17
J. Borák, T. Vacek: Czech Foreign Wine Trade – Comparative Advantages Distribution in Relation to the European Union	31
M. Hoffmann, Y. Butenko, S. Traore: Evaluation of Satellite Imagery to Increase Crop Yield in Irrigated Agriculture	45
L. Kaňovská, E. Tomášková: Drivers for Smart Servitization in Manufacturing Companies	57
J. Masner, J. Jarolínek, E. Kánská: Novel Approach for Creation, Storage and Presentation of Online Information Content	69
M. Mizero, A. Karangwa, P. Burny, B. Michel, P. Lebailly: Agrarian and Land Reforms in Rwanda: Situation and Perspectives	79
L. Pilař, L. Kvasničková Stanislavská, G. Gresham, J. Poláková, S. Rojik, R. Petkov: Questionnaire vs. Social Media Analysis - Case Study of Organic Food	93
K. Pohlová, L. Smutka, A. Laputková, M. Svatoš: Czech Agrarian Foreign Trade According to the Degree of Processing	103
P. Polakovič, E. Šilerová, K. Hennyeyová, I. Slováková: Business Process Management in Linking Enterprise Information Technology in Companies of Agricultural Sector	119

Effect of Real Exchange Rate Volatility on Agricultural Products Export in Nigeria

Friday Otse Alegwu, Goodness C. Aye, Benjamin Chijioke Asogwa

Department of Agricultural Economics, University of Agriculture, Makurdi, Nigeria

Abstract

This study examines the effects of real exchange rate volatility on agricultural products export in Nigeria using annual time series data from 1970 to 2013. The long run, short run and causal effects of real exchange rate volatility on agricultural products export were evaluated. VECM was used to evaluate the effects of real exchange rate volatility on agricultural products export. The Augmented Dickey-Fuller (ADF) and Philip Perron (PP) unit root tests confirm that all variables were stationary in their first difference. Further investigation based on the Johansen co-integration tests indicates that one co-integration exists between exchange rate volatility and each of the agricultural products export while controlling for other variables. Exchange rate volatility has negative long run effect on all agricultural exports studied with the effect being strongest for coffee followed by rubber. The results based on Vector Error Correction Model (VECM) show evidence of negative but insignificant short run effects of real exchange rate volatility on agricultural products export. From the Granger causality test, there exists bidirectional causality between cocoa and real exchange rate volatility. The implications of these findings are drawn.

Keywords

Real exchange rate, volatility, overvaluation, undervaluation, agricultural products, export, effect.

Alegwu, F. O., Aye, G. C. and Asogwa, B. C. (2018) "Effect of Real Exchange Rate Volatility on Agricultural Products Export in Nigeria", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 3-15. ISSN 1804-1930. DOI 10.7160/aol.2018.100301.

Introduction

Agricultural commodity trade has played a prominent role in Africa's economic development. As suppliers of raw materials to western economies, African countries have continued to produce primary crops for export. Thus the agricultural exports sector is still the most important single activity for Africans (Amoro and Shen, 2013). Africa's agricultural commodity exports may be categorized into traditional and non - traditional. The prominent traditional export commodities include cocoa, palm oil, palm kernel, rubber, cotton, groundnut, kola nut among others. The non - traditional export commodities include pineapple, cashew, eggs, processed fruits, alcoholic beverages to mention but a few which have emerged as the most demanded products in the international markets (Nwachukwu, 2014).

Nigeria has a long history of thriving exports of top quality produce like cocoa, cotton, gum Arabic, sesame seed, rubber, ginger, pineapples, coffee and a host of others. Export markets

for these products exist in United States of America (USA), European Union, Gulf States, Japan, Singapore, China to mention but a few countries. Nigeria appears to have an added advantage over major agricultural producers and exporters in the Eastern and Southern Africa in terms of fertile land, proximity to traditional and terminal markets in Europe by air or by sea (Sasore, 2004).

In view of the poor performance of the agricultural sector in recent years and the impact of most of the economic reform programmes on agricultural supply in Nigeria, most commentary on the impact of adjustment on agriculture points to the fact that the reforms are showing the desired outcomes, but others think otherwise. Price reform is a necessary but insufficient condition for increased output (Abiodun and Salau, 2010). While supply response for food or export crops can be significant, aggregate supply response may be comparatively low, suggesting that at least some increased output might have occurred through switching of resources between them, with changing price incentives.

The volatile nature of exchange rates has become a major problem in estimating the scope and nature of trading behaviours and trade volumes extant between exporting and importing countries (Orden, 2002). The unpredictable nature of the exchange rate always leads risk-averse traders to reduce their trading activities with foreign countries and it is these traders' collective aversion which ultimately impacts the total trade of the nation in reducing exports and import volumes. As a result of reduced trading activities, the trade deficit becomes increasingly negative and nominal prices for agricultural and other primary commodities increase as a consequence of a flexible dollar.

So far there are a considerable numbers of studies on exchange rate volatility and aggregate trade. There are also sectoral studies and few studies specifically on agricultural trade and exchange rate volatility such as De Vita and Abbot, 2004; Awokuse and Yuan, 2006; Wang and Barrett 2007; Cho et al. 2002; Kandilov 2008 and Foragasi, 2011. However, there are no studies to the best of my knowledge on agricultural products export and real exchange rate volatility. In other words the current study contributes by disaggregating the agricultural export into various products as to ascertain which one(s) are actually driven by exchange rate volatility. On sectoral level analysis for example De Vita and Abbott (2004), observe that short-term volatility in exchange rate does not affect United Kingdom (UK) exports to the European Union (EU) both at the aggregate and sectoral levels. However, there are significant negative effects of long-term volatility on UK exports to the EU. The negative link is attributed to the difficulty to hedge against long-run fluctuations. Awokuse and Yuan (2006) examine the relationship between exchange rate volatility and US poultry exports using a panel data for 49 importing nations over two sub-periods: 1976-1985 and 1986-2000. Results based on fixed-effects model specification and three alternative measures of exchange rate volatility show that the choice of volatility measure matters and there is a positive relationship between exchange rate uncertainty and poultry exports.

Wang and Barrett (2007) analyzed the effect of exchange rate volatility on international trade flows by studying the case of Taiwan's exports to the United States from 1989-1999. They found that real exchange rate risk has insignificant effects in most sectors, although agricultural trade volumes appear highly responsive to real exchange rate volatility and the effect is negative. Cho et al. (2002) used panel data on bilateral trade and exchange rate volatility for the set of G-10

countries they investigate the effects of long-run real exchange rate volatility on agricultural trade in comparison to other sectors. They conclude that real exchange rate volatility has a significant negative effect on agricultural trade. The estimated impact on agricultural trade is much larger than the estimated impact on trade in other sectors and on aggregate trade. Kandilov (2008) using different index of uncertainty and data over the period 1974 to 1997 replicate these results. Specifically he found that exchange rate volatility had a negative impact on trade flows and the impact was larger in agricultural trade as compared to other sectors. Furthermore, he found a larger impact of exchange rate volatility on exports from developing countries than on exports from developed countries.

In his study of Hungarian agricultural exports to its export destination, Foragasi (2011) found a positive effect of nominal exchange rate volatility on agricultural trade between Hungary and 81 trade partners around the world for 9 years (1999-2008). He used the gravity model and panel data procedure in his analysis. He further concluded that because of the positive effect that exchange rate volatility has on agricultural trade flows, Hungarian agri-food entrepreneurs are not interested in joining the Euro-zone.

From the foregoing, it is noted that although there are a handful of studies on the relationship between exchange rate volatility and agricultural trade, none of these studies considered the individual agricultural products. Therefore, the main objective of this study is to examine the effect of real exchange rate volatility on agricultural products export in Nigeria. The specific objectives are to: examine the long run effect of real exchange rate volatility on agricultural products export in the study area; determine the short run effect of real exchange rate volatility on agricultural products export in Nigeria; analyze the causal relationship between real exchange rate volatility and agricultural products export in the study area.

The rest of this study is organized as follows: chapter 2 describes the materials used for investigation and the methodology, while chapter 3 presents the empirical results and discussion, and finally chapter 4 concludes the paper.

Materials and methods

Secondary data were employed for this study. The data are annual time series data covering 1970–2013. The data on agricultural products export were sourced from Food and Agriculture Organization (FAO)-STAT website, data on real

exchange rate, inflation rate and interest rate were sourced from Central Bank of Nigeria (CBN) Statistical Bulletin/Annual Report and World Bank database, data on trade openness index were also sourced from World Bank database. Exchange rate volatility is unobservable and hence was constructed from a GARCH(1, 1) model. All variables were transformed to their natural logarithm.

Both descriptive statistics and inferential statistics were used for analyzing the data. Descriptive statistics such as mean, standard deviation, percentage and kurtosis and skewness as well as graphs were employed. Further, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were also used to ascertain the time series properties (stationarity) of all the variables so as to avoid spurious regression. Other models used include Johansen's Maximum Likelihood Co-integration test to determine the long run relationship between real exchange rate volatility and agricultural products export. Vector Error Correction Model (VECM) was used for analyzing the short run effect of exchange rate volatility due to the existence of co-integration and the Granger Causality test was used to determine the causal links between the variables.

Vector error correction model

To estimate the short-run relationship between the variables, the vector error correction equation is specified for the case of existence of co-integration (long-run) relationship between for example cocoa export and real exchange rate volatility:

$$\Delta \ln EXCOC_t = \alpha_1 + \sum_{i=1}^p \beta_i \Delta \ln EXCOC_{t-i} + \sum_{i=1}^p \gamma_i \Delta \ln RERV_{t-i} + \sum_{i=1}^p \theta_i \Delta \ln INF_{t-i} + \sum_{i=1}^p \delta_i \Delta \ln INR_{t-i} + \sum_{i=1}^p \vartheta_i \Delta \ln TOP_{t-i} + \phi_1 \mu_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\Delta \ln RERV_t = \alpha_2 + \sum_{i=1}^p \pi_i \Delta \ln RERV_{t-i} + \sum_{i=1}^p \rho_i \Delta \ln EXCOC_{t-i} + \sum_{i=1}^p \sigma_i \Delta \ln INF_{t-i} + \sum_{i=1}^p \tau_i \Delta \ln INR_{t-i} + \sum_{i=1}^p \omega_i \Delta \ln TOP_{t-i} + \phi_2 \mu_{t-1} + \varepsilon_{2t} \quad (2)$$

where: $EXCOC$ = Cocoa export, $RERV$ = Real exchange rate volatility, INF = Inflation rate, INR = Interest rate, TOP = Trade openness, \ln = Natural Logarithm, Δ = Difference operator, μ_{t-1} = Error correction term, ϕ_i = Speed of adjustment, ε_{1t} and ε_{2t} = Error or random term.

It is important to note that the estimation was

carried out for each agricultural product export. Hence $EXCOC$ was replaced with $EXRUB$ (rubber export) or $EXCOT$ (cotton export) or $EXCOF$ (coffee export) depending on the one being analyzed. The specifications for the control variables are eliminated for brevity. The study used the VECM estimates and associated impulse response functions and variance decompositions to examine the relationships.

Granger causality test

The bivariate Granger causality test was used to explore the causality between real exchange rate volatility and the agricultural products export. An appropriate formulation or specifications of the co-integrated error-correction Granger causality between cocoa export ($EXCOC$) and real exchange rate volatility ($RERV$) were specified as:

$$\Delta \ln(EXCOC)_t = \alpha_1 + \sum_{i=1}^n \beta_i \Delta \ln(EXCOC)_{t-i} + \sum_{i=1}^m \delta_j \Delta \ln(RERV)_{t-j} + r_1 (EC_1)_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta \ln(RERV)_t = \alpha_2 + \sum_{i=1}^n c_i \Delta \ln(RERV)_{t-i} + \sum_{i=1}^m g_j \Delta \ln(EXCOC)_{t-j} + r_2 (EC_2)_{t-1} + \mu_t \quad (4)$$

where: Δ = first-difference operator, $EXCOC$ = Cocoa export, $RERV$ = exchange rate volatility, \ln = natural logarithm transformation; α_1 and α_2 = intercept, β_i , δ_j , g_j , and c_i = Coefficient, ε_t and μ_t = error or random terms, n and m = numbers of lag lengths chosen by the Akaike Information Criterion (AIC). After estimating the VAR, we examined the lag structure. This process yields results from several lag length selection criteria such as sequential modified LR test statistic, Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). The final selected lag order was then based on AIC though SIC produced relatively similar results as AIC. These two are usually more parsimonious and choose the well specified model asymptotically (Ivanov and Kilian, 2005). $(EC_1)_{t-1}$ and $(EC_2)_{t-1}$ = error correction terms which represent the lag residuals from the co-integration equations. If δ_j is significant but g_j is not, then there is a unidirectional causality from real exchange rate volatility to cocoa export. Conversely, if g_j is significant and δ_j is not, then there is a unidirectional causality from cocoa export to real exchange rate volatility. If both δ_j and g_j are significant, there is a bidirectional causality meaning real exchange rate volatility Granger causes cocoa export and vice versa. If both coefficients are not significant, there is no causality

running from any of the variables to the other. Again the Granger causality was examined for each pair of agricultural products export and real exchange rate volatility.

Results and discussion

Descriptive Statistics

The log plots of the respective time series are also presented in Figure 1. In general, the series do not tend to revert to their equilibrium level which may be an indication of unit root process. However, formal unit root will be applied in the next section.

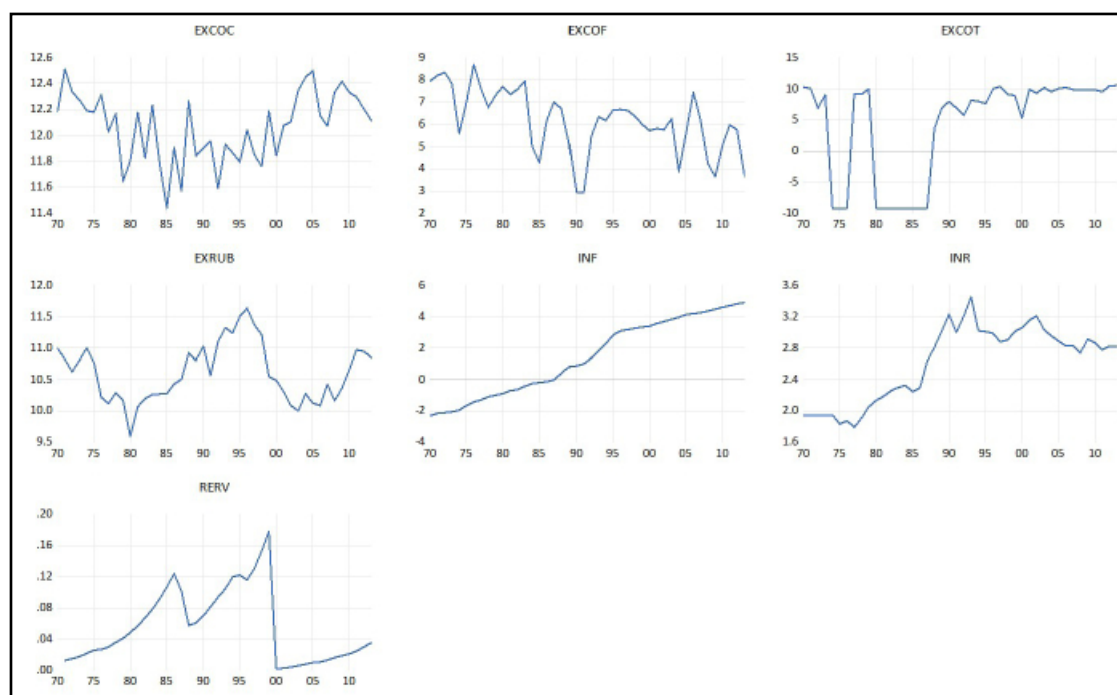
Unit root test

Table 1 presents the results of the unit root tests based on the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP). The tests were applied to each variable over the period of 1970-2013 both in level and at their first difference. The test statistics are compared against the Mackinnon (1991) critical values for the rejection or otherwise of the null hypothesis of unit root. Table 1 confirm that all variables: Cocoa export (EXCOC), Coffee export (EXCOF), Cotton export (EXCOT), Rubber export (EXRUB), Inflation rate (INF), Interest rate (INR), Real exchange rate volatility (RERV) and Trade openness (TOP) were non-stationary in their level form as evidenced by large p-values. This implies that one cannot reject the null hypothesis of unit root, that is, non-stationarity.

After differencing, the variables became stationary as the null hypothesis of unit root is rejected for all variables. This indicates that the variables are integrated of order 1, $I(1)$ and any attempt to specify the dynamic function of the variable in the level of the series will be inappropriate and may lead to problems of spurious regression in line with Mesike et al (2010). The econometric results of the model using the level of these series will not be ideal for policy making (Yusuf and Falusi, 1999) and such results cannot be used for prediction in the long-run. Johansen co-integration test therefore becomes appropriate for assessing the long- run relationship among variables.

Long run analysis between real exchange rate volatility and agricultural products export

The Johansen co-integration test was employed to test for the existence of long run relationship between real exchange rate volatility and the various agricultural products export. The co-integration test results are presented in table 2 for both the trace and max-eigen statistics. The co-integration test results for real exchange rate volatility and cocoa export are presented in the first panel of table 2. The results indicate that co-integration exists among the variables. This is indicated by the Max-Eigen statistics of 42.540 which is greater than the critical value of 33.877 as well as the trace statistic of 88.944 which is greater than the critical



Source: own processing

Figure 1: Logarithmic plots of the variables used for analysis.

Variable	ADF		PP	
	Level	First difference	Level	First difference
EXCOC	-1.161	-6.147***	-0.112	-14.699***
	-0.681	0.000	-0.639	0.000
EXCOF	-2.318	-8.003***	-1.273	-6.741***
	-0.171	0.000	-0.184	0.000
EXCOT	-2.324	-6.522***	-2.380	-9.343***
	-0.169	0.000	-0.153	0.000
EXRUB	-2.048	-6.607***	-2.182	-6.610***
	-0.266	0.000	-0.216	0.000
INF	-0.725	-3.243**	-0.576	-3.075**
	-0.829	-0.024	-0.865	-0.036
INR	-1.405	-6.207***	-1.434	-6.222***
	-0.571	0.000	-0.557	0.000
RERV	-2.202	-6.533***	-2.240	-6.623***
	-0.209	0.000	-0.196	0.000
TOP	-1.310	-6.481***	-1.310	-6.481***
	-0.616	0.000	-0.616	0.000

Note: ** and *** denote rejection of the null hypothesis at 5% and 1% significance level respectively based on the Mackinnon critical values. P-values of corresponding test statistic are given in parenthesis.

Source: author's computation from E-views (2016)

Table 1: Unit root test results.

Exchange rate volatility and cocoa export							
Trace test				Maximum eigen value test			
Ho	H1	Statistic	5% CV	Ho	H1	Statistic	5% CV
$r = 0$	$r \geq 1$	88.944**	69.819	$r = 0$	$r = 1$	42.540**	33.877
$r \leq 1$	$r \geq 2$	46.404	47.856	$r = 1$	$r = 2$	21.750	27.584
$r \leq 2$	$r \geq 3$	24.654	29.797	$r = 2$	$r = 3$	13.297	21.132
$r \leq 3$	$r \geq 4$	11.357	15.495	$r = 3$	$r = 4$	8.027	14.265
$r \leq 4$	$r \geq 5$	3.33	3.842	$r = 4$	$r = 5$	3.330	3.842
Exchange rate volatility and coffee export							
Trace test				Maximum eigen value test			
Ho	H1	Statistic	5% CV	Ho	H1	Statistic	5% CV
$r = 0$	$r \geq 1$	84.324**	69.819	$r = 0$	$r = 1$	42.037**	33.877
$r \leq 1$	$r \geq 2$	42.287	47.856	$r = 1$	$r = 2$	19.865	27.584
$r \leq 2$	$r \geq 3$	22.422	29.797	$r = 2$	$r = 3$	12.459	21.132
$r \leq 3$	$r \geq 4$	9.963	15.495	$r = 3$	$r = 4$	6.923	14.265
$r \leq 4$	$r \geq 5$	3.040	3.842	$r = 4$	$r = 5$	3.04	3.842
Exchange rate volatility and cotton export							
Trace test				Maximum eigen value test			
Ho	H1	Statistic	5% CV	Ho	H1	Statistic	5% CV
$r = 0$	$r \geq 1$	100.073**	69.819	$r = 0$	$r = 1$	50.623**	33.877
$r \leq 1$	$r \geq 2$	49.450	47.856	$r = 1$	$r = 2$	22.877	27.584
$r \leq 2$	$r \geq 3$	26.573	29.797	$r = 2$	$r = 3$	13.488	21.132
$r \leq 3$	$r \geq 4$	13.085	15.495	$r = 3$	$r = 4$	7.706	14.265
$r \leq 4$	$r \geq 5$	5.377	3.842	$r = 4$	$r = 5$	5.380	3.842

Note: ** denotes rejection of the hypothesis at the 5% level based on MacKinnon-Haug-Michelis (1999) critical values. Both the trace and max eigen value indicate 1 co-integration equation at 5 % level of significance for each of the export products.

Source: author's computation from E-views (2016).

Table 2: Johansen co-integration test results (to be continued).

Exchange rate volatility and rubber export							
Trace test				Maximum eigen value test			
Ho	H1	Statistic	5% CV	Ho	H1	Statistic	5% CV
$r = 0$	$r \geq 1$	70.169**	69.819	$r = 0$	$r = 1$	33.953**	33.877
$r \leq 1$	$r \geq 2$	36.216	47.856	$r = 1$	$r = 2$	14.996	27.584
$r \leq 2$	$r \geq 3$	21.220	29.797	$r = 2$	$r = 3$	9.593	21.132
$r \leq 3$	$r \geq 4$	11.628	15.495	$r = 3$	$r = 4$	7.316	14.265
$r \leq 4$	$r \geq 5$	4.311	3.842	$r = 4$	$r = 5$	4.311	3.842

Note: ** denotes rejection of the hypothesis at the 5% level based on MacKinnon-Haug-Michelis (1999) critical values. Both the trace and max eigen value indicate 1 co-integration equation at 5 % level of significance for each of the export products.

Source: author's computation from E-views (2016).

Table 2: Johansen co-integration test results (continuation).

value of 69.819 at 5% level of significance. The long run co-integration test in table 2 shows that 1 co-integration equation exists between real exchange rate volatility and cocoa exports while controlling for other potential determinants of the latter. Based on this, the null hypothesis of no co-integration between real exchange rate volatility and cocoa export is rejected.

The co-integration test results for real exchange rate volatility and coffee export are presented in the second panel of table 2. The results indicate that co-integration exists among the variables. This is indicated by the Max-Eigen statistics of 42.037 which is greater than the critical value of 33.877 as well as the trace statistics of 84.324 which is greater than the critical value of 69.819 at 5% level of significance. The long run co-integration test in table 2 shows that 1 co-integration equation exists between real exchange rate volatility and coffee exports while controlling for other potential determinants of the latter. Therefore, the null hypothesis of no co-integration between real exchange rate volatility and coffee export is rejected.

Also, the co-integration test results for real exchange rate volatility and cotton export are presented in the third panel of table 2. The results indicate that co-integration exists among the variables. This is indicated by the Max-Eigen statistics of 50.623 which is greater than the critical value of 33.877 as well as the trace statistics of 100.073 which is greater than the critical value of 69.819 at 5% level of significance. The long run co-integration test in table 2 shows that 1 co-integration equation exist between real exchange rate volatility and cotton exports while controlling for other potential determinants of the latter. Based on this, the null hypothesis of no co-integration between real exchange rate volatility and cotton export is rejected.

Lastly, co-integration test results for real exchange

rate volatility and rubber export are presented in the fourth panel of table 2. The result shows that co-integration exists among the variables. This is indicated by the Max-Eigen statistics of 33.953 which is greater than the critical value of 33.877 as well as the trace statistics of 70.169 which is greater than the critical value of 69.819 at 5% level of significance. The long run co-integration test in table 2 indicates that 1 co-integration equation exists between real exchange rate volatility and rubber exports while controlling for other potential determinants of the latter.

The existence of co-integration among real exchange rate volatility and the various agricultural products exports and their fundamentals necessitated the specification of vector error correction model (VECM). Empirical estimates for the long run relationship between real exchange rate volatility and agricultural products are presented in table 3. It is noted that due to normalization process in the cointegrating vector with the export variables coefficients set to 1, the sign on the coefficients for the rest of the variables have been reserved.

The long run estimates presented in the first column of table 3 indicates that, a 1% increase in trade openness (TOP) will result to 0.808% increase in cocoa export (EXCOC), this implies that more trade openness led to increase in cocoa export in Nigeria. A 1% increase in interest rate (INR) decreases cocoa export by 0.655%. Furthermore, a 1% increase in inflation (INF) result to 0.038% decrease in cocoa export. Lastly, a 1% increase in real exchange rate volatility (RERV) leads to 1.357% decrease in cocoa export. It is evident from the result that all the variables (TOP, INR, INF and RERV) have significant long run effect on cocoa export. TOP, INR and RERV were significant at 1% while INF was significant at 10%.

The second column of table 3 shows the estimates of the long run effect of real exchange rate volatility on coffee export (EXCOF). The result shows that,

	EXCOC	EXCOF	EXCOT	EXRUB
TOP(-1)	0.808*** (0.132) [6.133]	-0.227 0.833 [0.273]	15.943*** (3.978) [4.008]	2.793*** (0.469) [5.957]
INR(-1)	-0.655*** (0.118) [-5.533]	1.708** 0.771 [-2.217]	-9.752*** (3.560) [-2.740]	-1.510*** (0.430) [-3.511]
INF(-1)	-0.038* (0.021) [-1.832]	0.06 0.126 [0.476]	0.846 (0.592) [1.431]	-0.276*** (0.071) [-3.898]
RERV(-1)	-1.357*** (0.477) [-2.848]	-9.289*** -3.155 [-2.944]	-5.763 (13.647) [-0.422]	-8.798*** (1.804) [-4.876]
C	-13.377	-10.356	-17.945	-12.648

Note: *, ** and *** indicate significance at 10%, 5% and 1% level, respectively. Standard errors are in parenthesis while t-values are in brackets. Lag selections were done based on the AIC and SIC.
Source: author's computation from E-views (2016).

Table 3: Long run effect of real exchange rate volatility on agricultural products export.

a 1% increase in trade openness result in 0.227% decrease in coffee export (EXCOF). However, a 1% increase in interest rate results to 1.708% increase in coffee export (EXCOF). Furthermore, a 1% increase in inflation rate increases coffee export (EXCOF) by 0.060%. A 1% increase in real exchange rate volatility result to 9.289% decrease in coffee export (EXCOF). The result further revealed that among the variables of interest, it is only INR and RERV that had significant long run effect on coffee export. INR and RERV were significant at 5% and 1% respectively.

Empirical estimates for the long run effect of real exchange rate volatility on cotton export are reported in third column of table 3. This result indicates that, a 1% increase in trade openness result to 15.943% increase in cotton export (EXCOT). Also, a 1% increase in interest rate decreases cotton export (EXCOT) by 9.752%. Furthermore, a 1% increase in inflation results to 0.846% increase in cotton export. A 1% increase in real exchange rate volatility leads to 5.763% decrease in cotton export. It is however observed that only INR and RERV had significant long run effect on cotton export with the former being significant 5% while the latter is significant at 1%.

The long run estimate of the effect of real exchange rate volatility on rubber export (EXRUB) is presented the fourth column of table 3. The result indicates that, a 1% increase in trade openness leads to increase in rubber export by 2.793%. Also, a 1% increase in interest rate results in 1.510% decrease in rubber export. Similarly, a 1% increase in inflation rate results in 0.275%

decrease in rubber export. Also, a 1% increase in real exchange rate volatility result in 8.797% decrease in rubber export. All the variables (TOP, INR, INF and RERV) have significant long run effect on rubber export at 1% level.

Short run effect of real exchange rate volatility on agricultural products export

The short run estimates of the vector error correction model (VECM) are presented in Table 4 for each agricultural product exports. In the short run, the error correction term (ECT) for the EXCOC equation is rightly signed (-0.507) as revealed in column 2. This signifies that there is a high speed of adjustment towards equilibrium. The coefficient of Determinants (R^2) of 0.520 indicates that 52% of the variation in cocoa export is attributed to the variables included in the VECM while the remaining 48% are due to other variables that are not included in the model.

From column 2, it is evident that a 1% increase in trade openness in the past year resulted to 0.630% decrease in cocoa export in the current year. Also, a 1% increase in trade openness in the past two years resulted to 0.283% increase in cocoa export in the current year. The result further revealed that the short run effect of trade openness over the previous years on cocoa export in the current year is negative in the first year and positive in the second year but not significant in both years. This implies that while cocoa exports responds negatively to trade policy shock in the first year, it response to the same trade policy in the second year was positive.

Also, a 1% increase in interest rate in the past one year resulted to 0.010% increase in cocoa export in the current year. That is to say, as the interest rate increases the volume of cocoa commodity exports also increases. A 1% increase in interest rate in the past two years resulted to 0.298% decrease in cocoa export in the current year. The result shows that the previous year short run effects of interest rate on the cocoa export are not significant. This result contradicts the empirical findings by Onyenweaku and Madu (1991) on the supply response of Nigeria's cocoa that posted evidence of negative output even in the face of rising producer price. Similarly, a 1% increase in inflation rate during the first year resulted to 0.237% decrease in cocoa export in the current year. That is to say, increase in inflation rate in the first year discourages cocoa export in the current year. Also, a 1% increase in inflation rate in the past two years leads to 0.012% increase in cocoa export in the current year. This implies that the previous two year's values of inflation rate enhanced cocoa export supply.

Furthermore, a 1% increase in real exchange rate volatility in the past one year leads to 0.420% decrease in cocoa export in the current year. During the second year, a 1% increase in real exchange rate volatility leads to 0.293% decrease in cocoa export. The result also revealed that the short run effect of real exchange rate volatility in the past years is jointly negative but not significant. These negative coefficients may likely mean that the previous year's exchange rate was not favourable to encourage cocoa exports supply in the current year. This result consolidates the findings of Adubi and Okumadewa (1999), they argued that the more volatile the exchange rate is, the higher the risk associated with the variable. It is also noted from the result that a 1% increase in cocoa export in the first one year resulted to 0.253% decrease in current cocoa export in the current year. Also, a 1% increase in cocoa export in the past two years resulted to 0.155% decrease in current cocoa export in the current year. The result further revealed that the short run effects of cocoa export in the previous year on current cocoa exports are both negative and not significant.

Results in column 3 shows that in the short run the error correction term (ECT) for the EXCOF equation is rightly signed (-0.911) and significant at 1%. This signifies that there is a high speed of adjustment towards equilibrium whereby about 91% of the disequilibria is removed in one period. The coefficient of Determinants (R^2) of 0.506 indicates that the variables included

in the EXCOC equation contributes to about 51% of its variation. The result revealed that in the short run, a 1% increase in trade openness (TOP (-1)) a year ago resulted to 1.106% decrease in coffee export (EXCOF) in the current year. From the result it is also evident that the short run effect of the explanatory variable (TOP) over the previous year is negative but not significant.

Also a 1% increase in interest rate (INR (-1)) in the previous year's amount to 1.273% decrease in coffee export (EXCOF) in the current year. This result revealed that the previous year's effect of interest rate on the coffee export seems to be negative in the short run but not significant.

In the case of inflation, a 1% increase in the first year results to 1.449% decrease in coffee export in the current year. The result shows that the short run effect of previous year's inflation on coffee export is negative and significant at 10%. From the result also, a 1% increase in the real exchange rate volatility in the first year resulted to 7.171% decrease in coffee export in the current year. This result revealed that the short run relationship is negative in the first year but not significant. Lastly, a 1% increase in coffee export in the first year resulted to 0.571% increase in the coffee export in the current year and the effect is significant at 1%.

In the short run, the error correction term (ECT) which measures the speed of adjustment towards equilibrium is negative in the cotton export (EXCOT) equation in column 4, significant at 1% level and less than one, which is appropriate. The result justifies the use of ECM specification of the model. One important finding is the statistical significance of the ECM suggesting that cotton export adjust to correct disequilibrium between itself and its determinants. The coefficient of the ECM revealed that the speed with which cotton export adjust to real exchange rate volatility is 97% in the short run. The result also shows that the coefficient of determinant (R^2) of cotton export is 0.718, thus the included variables explain 71.80% of the variations in the cotton export.

The short run result shows that a 1% increase in trade openness in the first year leads to 18.989% decrease in cotton export in the current year. And in the second year, a 1% increase in trade openness resulted to 3.330 decrease in cotton export in the current year. This study disagree with the findings of (Agbeyegbe et al. 2004) who noted that trade openness as a policy help in removal of non-tariffs obstacles to imports, the rationalization and lowering of tariffs, establishment of market

Error Correction:	EXCOC	EXCOF	EXCOT	EXRUB
CointEq1	-0.507 (0.319) [-1.590]	-0.911*** 0.163 [-5.599]	-0.967*** (0.146) [-6.622]	-0.221** (0.097) [-2.281]
TOP(-1)	-0.63 (0.409) [-1.538]	-1.106 1.106 [-1.000]	-18.989*** (4.903) [-3.873]	-0.537 (0.399) [-1.344]
TOP(-2)	0.283 (0.366) [0.775]	- - -	-3.33 (4.812) [-0.692]	- - -
INR(-1)	0.010 (0.298) [0.035]	-1.273 1.124 [-1.133]	0.751 (4.530) [0.166]	-0.535 (0.345) [-1.550]
INR(-2)	-0.298 (0.280) [-1.002]	- - -	-8.322** (4.203) [-1.980]	- - -
INF(-1)	-0.237 (0.417) [-0.568]	-1.449* 0.769 [-1.883]	3.248 (5.756) [0.564]	0.018 (0.361) [0.049]
INF(-2)	0.012 (0.382) [0.031]	- - -	7.028 (5.877) [1.196]	- - -
RERV(-1)	-0.42 (1.371) [-0.306]	-7.171 5.364 [-1.338]	-27.201 (19.596) [-1.388]	-0.136 (1.478) [-0.092]
RERV(-2)	-0.292 (1.274) [-0.229]	- - -	-9.541 (19.839) [-0.481]	- - -
EXCOC(-1)	-0.253 (0.296) [-0.853]	0.571*** 0.159 [3.597]	0.292** (0.121) [2.422]	0.156 (0.187) [0.832]
EXCOC(-2)	-0.155 (0.208) [-0.745]	- - -	0.359*** (0.116) [3.107]	- - -
C	0.048 (0.087) [0.556]	-0.05 -0.268 [-0.188]	-1.026 (1.136) [-0.903]	0.026 (0.078) [0.337]
R-squared	0.520	0.506	0.718	0.159
Adj. R-squared	0.332	0.418	0.607	0.011
F-statistic	2.760	5.798	6.479	1.071

Note: *, ** and *** indicate significance at 10%, 5% and 1% level, respectively. Standard errors are in parenthesis while t-values are in brackets. Lag selections were done based on the AIC and SIC.

Source: author's computation from E-views (2016).

Table 4: Short run effect of real exchange rate volatility on agricultural products export.

mechanism as a medium of foreign exchange rate determination and removal of fiscal disincentives and regulatory measures that prevent exports. From the result, the short run effects of trade openness in the previous years are both negative but jointly significant at 1% level. This implies

that policy of trade openness did not favour export supply of the commodity (cotton) in the past years. Also, a 1% increase in interest rate in the past one year resulted to 0.751% increase in cotton export in the current year. In the second year, a 1% increase in interest rate resulted to 8.322%

decrease in cotton export in the current year. The short run effect of interest rate on cotton export is positive but not significant in the first year and negative but significant at 5% level in the second year. The result further revealed that a 1% increase in inflation rate in the past one year resulted to 3.248% increase in cotton export in the current year. Also, a 1% increase in inflation rate results to 7.028% increase in cotton export in the current year. From the result, it is evident that the short run effects of inflation rate over the previous years on cotton export in the current year is jointly positive but not significant.

More so, a 1% increase in real exchange rate volatility in the past one year resulted to 27.201% decrease in cotton export in the current year. In the second year, a 1% increase in real exchange rate volatility resulted to 9.541% decrease in cotton export in the current year. The result further shows a negative and as well as not significant short run effects of real exchange rate volatility on cotton export in the first and second year. This implies that as the exchange rate increases, most cotton farmers in Nigeria stop productivity and this reduced the volume of cotton exports drastically. This result supports the findings of Oluremi (1998) that both real exchange rate misalignment and volatility adversely discourage growth in the non-oil sector, in which the agriculture is the dominant sector. Based on his empirical findings he posits that Nigerian producers are less risk averse and would react to any adverse exchange rate movement by reducing production.

Lastly, a 1% increase in cotton export in the past one year resulted to 0.292% increase in cotton export in the current. Also, a 1% increase in cotton export in the past two years resulted to 0.359% increase in cotton export in the current year. From the result, it is evident that the short run effect of cotton export in the past years are both positive and jointly significant at 5% level in the past one year and at 1% level in the past two years respectively on cotton export in the current year. Column 5 indicates that, in the short run, the error correction term (ECT) in the rubber export (EXRUB) equation is negatively signed (-0.221) and significant at 5%. This implies that the speed of adjustment towards equilibrium is relatively slow as only about 22% of the disequilibria is removed in one period. The coefficient of determinant (R^2) of 0.159 indicates that only 16% of variations rubber export is jointly explained by the variables included in the VECM. The coefficient of determinant (R^2) value for rubber export seem relatively low, but as opined by Gujarati (2008:222), a low R^2 value

should not be of serious concern but accentuation should be given to the significance of the regressors estimates as well as the model in general.

From column 5, a 1% increase in trade openness in the past one year resulted to 0.537% decrease in rubber export in the current year. Also, a 1% increase in interest rate in the past one year resulted to 0.535% decrease in rubber export in the current year. This negative coefficient of trade openness and interest rate shows that both variables during the study period did not favour rubber export supply. A 1% increase in inflation rate in the past one year also resulted to 0.018% increase in rubber export in the current year. Similarly, a 1% increase in real exchange rate volatility in the past one year amount to 0.136% increase in rubber export in the current year. Also, a 1% increase in rubber export in the past one year resulted to 0.156% increase in rubber export in the current year.

The result further revealed that among the explanatory variables, real exchange rate volatility, trade openness and interest rate shows a negative short run effect on the dependent variable (rubber export) in the current year. Inflation rate and rubber export in the past one year on the hand shows a positive short run effect. Although none of these explanatory variable is said to be significant. This result is in line with Nwachukwu (2014) who believed that low short run and long run elasticities of supply imply that the producers of rubber in Nigeria did not make significant short run and long run production adjustment in response to changes in prices. The result also consolidates the findings of Mesike et al. (2010) who also had low elasticities in his supply response study of rubber farmers.

Granger causality test result

The Granger Causality result in table 5 between real exchange rate volatility (RERV) and cocoa export (EXCOC) shows a bidirectional causality that run from real exchange rate volatility (RERV) to cocoa export (EXCOC) and vice versa. These findings imply that the past values of RERV can be used to forecast or predict the current values of EXCOC and the past values of EXCOC can be used to predict the current values of RERV. In the same vein, unidirectional causality was equally observed in the relationship between real exchange rate volatility (RERV) and rubber export (EXRUB) i.e. the latter Granger causes the former but not vice versa. In this case the past values of EXRUB can be used to predict the current values of RERV. The null hypothesis of no Granger causality cannot be rejected in the case of cotton

export (EXCOT) and coffee export (EXCOF). These results confirm the lack of significant short run effect of exchange rate volatility on these agricultural product exports.

Null hypothesis	Chi-square	P-value	Decision
RERV does not Granger cause EXCOC	10.322	0.001	Reject
EXCOC does not Granger cause RERV	5.924	0.014	Reject
RERV does not Granger cause EXCOF	0.065	0.798	Accept
EXCOF does not Granger cause RERV	0.118	0.732	Accept
RERV does not Granger cause EXCOT	0.308	0.579	Accept
EXCOT does not Granger cause RERV	0.022	0.882	Accept
RERV does not Granger cause EXRUB	0.778	0.378	Reject
EXRUB does not Granger cause RERV	3.266	0.071	Accept

Source: author's computation from E-views (2016)

Table 5: Granger causality test result.

Overall the findings in this study are largely consistent with De Vita and Abbott (2004) for the UK sectoral level analysis who found insignificant short run effect of exchange rate volatility but significant long run effect on sectoral (manufacturing, food and beverage and basic materials) exports. They are also consistent with Wang and Barrett (2007) for Taiwan, Cho et al. (2002) G-10 countries and Kandilov (2008) on developing and developed countries who all found significant negative effect of exchange rate volatility on aggregate agricultural exports. However our findings contrasts results by Awokuse and Yuan, 2006 on U.S. poultry exports who found a positive relationship between exchange rate volatility and poultry exports.

Corresponding authors:

Friday Otse Alegwu

Department of Agricultural Economics, University of Agriculture Makurdi, P.M.B 2373, Nigeria

E-mail: otsealegwu@gmail.com

References

- [1] Abiodun, E. O. and Salau, S. A. (2010) "Agricultural Response to Prices and Exchange Rate In Nigeria: Application of Co-integration and Vector Error Correction Model (VECM)", *Journal of Agricultural Sciences*, Vol. 1, No. 2, pp. 73-81. ISSN 0976-6898. DOI 10.1080/09766898.2010.11884656.
- [2] Adubi, A. A. and Okunmadewa, F. (1999) "Price exchange rate volatility and Nigeria's agricultural trade flows: A dynamic analysis", African Economic Research Consortium (AERC), Research paper 87, Nairobi March 1999. ISSN 1824-2979.

Conclusion

The aim of this study is to examine the effect of real exchange rate volatility on agricultural products export in Nigeria. Results indicate that one co-integration exists between exchange rate volatility and each of the agricultural products export while controlling for other variables implying that stable long run equilibrium exists among the variables of interest. Exchange rate volatility has negative long run effect on all agricultural exports studied with the effect being strongest for coffee followed by rubber. Results based on the VECM framework shows evidence of negative short run effect of real exchange rate volatility on agricultural products export. The Granger causality test results revealed that there is bidirectional causality between cocoa export and exchange rate volatility. Overall, we found that exchange rate volatility has no significant effect on agricultural products export while it has a long run effect on it. This finding has important implication. The lack of significant effect of exchange rate volatility on agricultural products exports may be due to adjustment or switching costs involved in selling into foreign markets. It could also be that exporters can easily and less expensively insure or hedge against short term risks through forward looking market trading. However, the significant effect in the long term could be seen as inability of the exporters to hedge against long term risks since these may be more costly to do relative to the short term risks. The study recommends measures that will promote greater exchange rate stability and improve terms of trade conditions. Also measures that would enable agricultural products exporters to insure against both short and long term risks effectively would be helpful.

- [3] Agbeyegbe, T., Stotsky, J. and Woldemariam, A. (2004) "Trade liberalization, Exchange Rate Change and Tax Revenue in sub-Sahara Africa", Hunter College Department of Economics Working Papers No. 4/173. ISBN/ISSN 9781451858983/1018-5941. DOI 10.1016/j.asieco.2005.09.003.
- [4] Amoro, G. and Shen, Y. (2013) "The Determinants of Agricultural Export: Cocoa and Rubber on Cote d'Ivoire", *International Journal of Economics and Finance*, Vol. 5, No. 1, pp. 228 – 233. E-ISSN 1916-9728, ISSN 1916-971X. DOI 10.5539/ijef.v5n1p228.
- [5] Awokuse, T. O. and Yuan, Y. (2006) "The impact of Exchange Rate Volatility on U.S. Poultry Exports", *Agribusiness*, Vol. 22, No. 2, pp. 233–245. E-ISSN 1520-6297. DOI 10.1002/agr.20082.
- [6] Cho, G., Sheldon, I. and McCorriston, S. (2002) "Exchange Rate Uncertainty and Agricultural Trade", *American Journal of Agricultural Economics*, Vol. 84, No. 4, pp. 931-942. E-ISSN 1467-8276, ISSN 0002-9092. DOI 10.1111/1467-8276.00044.
- [7] De Vita, G. and Abbott, A. (2004) "The Impact of Exchange Rate Volatility on UK exports to EU Countries", *Scottish Journal of Political Economy*, Vol. 51, No.1, pp. 62-81. E-ISSN 1467-9485. DOI 10.1111/j.0036-9292.2004.05101004.x.
- [8] Foragasi, J. (2011) "*The Effect of Exchange Rate Volatility upon Foreign Trade of Hungarian Agricultural Products*", Research Institute of Agriculture Economics - Hungarian Academy of Sciences; Studies in Agricultural Economics, No. 113, pp. 85-96. ISBN 14182106.
- [9] Gujarati, D. N. (2008) "Basic Econometrics 4th Edition", New York: McGraw-Hill, pp. 222. ISBN 0072427922.
- [10] Ivanov, V. and Kilian, L. (2005) "A Practitioner's Guide to Lag Order Selection for VAR Impulse Response Analysis", *Studies in Nonlinear Dynamics & Econometrics*, Vol. 9, No. 1, pp. 1-34. ISSN 1558-3708. E-ISSN 1558-3708. DOI 10.2202/1558-3708.1219.
- [11] Kandilov, I. T. (2008) "The effects of exchange rate volatility on agricultural trade", *American Journal of Agricultural Economics*, Vol. 90, No. 2, pp. 1028-1043. E-ISSN 1467-8276. DOI 10.1111/j.1467-8276.2008.01167.x.
- [12] Mackinnon, J. G. (1991) "Critical Values for Cointegration Tests", Chapter 13, In R. F. Engle and C. W. J. Granger (Eds.) "*Long-run Economic Relationships: Readings in Cointegration*", pp. 267-276. Oxford: Oxford University Press.
- [13] Mackinnon, J. G., Haug, A. A. and Michelis, L. (1999) "Numerical distribution functions of Likelihood ratio tests for Cointegration", *Journal of Applied Econometrics*, Vol. 14, No. 5, pp. 563-577. E-ISSN 1099-1255. DOI 10.1002/(SICI)1099-1255(199909/10)14:5<563::AID-JAE530>3.0.CO;2-R.
- [14] Mesike, C. S., Okoh, R. N. and Inoni, O. E. (2010) "Supply Response of Rubber Farmers in Nigeria: An Application of Vector Error Correction Model", *Journal of American Science*, Vol. 6, No. 9, pp. 52-56. ISSN 1545-1003. DOI 10.3923/aj.2010.146.150.
- [15] Nwachukwu, N. J. (2014) "Dynamics of Agricultural Exports in Sub-Sahara Africa: An Empirical Study of Rubber and Cocoa from Nigeria", *International Journal of Food and Agricultural Economics*, Vol. 2, No. 3, pp. 91-104. ISSN 2147-8988.
- [16] Oluremi, O. (1998) "Real Exchange Rate Movements and Export Growth: Nigeria, 1960- 1990", Paper 82, Nairobi: African Economic Research Consortium. [Online]. Available: <http://opendocs.ids.ac.uk/handle/123456789/2224> [Accessed: 20 Feb 2018].
- [17] Onyenweaku, C. E. and Madu, E. N. (1991) "Perennial Crop supply Response: The Case of Nigeria Cocoa", Paper Presented at the 1st International Conference on Tree Crops, MANR, Imo State.
- [18] Orden, D. (2002) "Exchange Rate Effects on Agricultural Trade", *Journal of Agricultural and Applied Economics*, Vol. 34, No.2, pp. 303-312. ISSN 1074-0708, E-ISSN 2056-7405. DOI 10.1017/S1074070800009056.
- [19] Sasore, G. M. (2004) "Nigeria's Export Trade of Agricultural Commodities: Quality Control and Standards", A Paper presented at *Nigeria National Crop Outlook Conference*, Durbar Hotel, Kano. 26 – 27th May, 2004.

- [20] Wang, K. and Barrett, C. (2007) “Effect of Exchange Rate Volatility on Export Volumes”, *Journal of Agricultural and Resource Economics*, Vol. 32, No. 2, pp. 225-255. ISSN 1068-5502.
- [21] Yusuf, S. A. and Falusi, A. O. (1999) “Incidence analysis of the effects of liberalized trade and exchange rate policies on cocoa in Nigeria: An ECM Approach”, *Journal of Rural Economic Development*, Vol.13, No. 2, pp. 3-14. [Online]. Available: <http://www.jstor.Org/stable/40987362> [Accessed: 4 March 2018]. ISSN 1813-2235, E-ISSN 1814-960X.

The Role of Culture, Language and Trade Agreements in Global Wine Trade

Jeremiás Máté Balogh, Attila Jámbor

Corvinus University of Budapest, Hungary

Abstract

In the progressively globalising world, wine trade is changing shape. In recent decades, major wine producers have suffered a remarkable drop in their domestic wine consumption, while New World wine producers have increased their production potential and induced new demand in foreign markets. These changes have been accompanied by a geographical relocation of wine consumption and trade. The aim of our paper is to analyse the effect of cultural-geographical proximity, free trade and the role of linguistic similarity on bilateral wine trade in the world major wine producer countries, employing balanced panel gravity model. Regression results suggest that larger countries export more wine, while transport costs increase in line with geographical distance, especially for landlocked trading partners. Moreover, global wine export costs are lower if trading partners are culturally similar; have the same religion or both are members of the WTO or have regional trade agreements.

Keywords

Wine trade, cultural proximity, language clusters, gravity model.

Balogh, J. M. and Jámbor, A. (2018) "The Role of Culture, Language and Trade Agreements in Global Wine Trade", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 17-29. ISSN 1804-1930. DOI 10.7160/aol.2018.100302.

Introduction

In the last century, global wine market has progressively been developed. Approximately one million winemakers are producing around 3 billion cases of wine each year (Stanley, 2013) at the global level. The international demand for wine is rising year by year and the world wine industry has also changed to a great extent.

However, European traditional wine producers such as France, Italy and Spain have suffered a remarkable drop in their domestic wine consumption since the 1980s, mainly due to changing wine policy regulations, while New World wine producers have increased their production potential and induced new demand in foreign markets (Cembalo et al., 2014). Consequently, the USA, Australia, Chile, New Zealand, and South Africa have gained increasing market shares both in volumes and in values exported (Morrison and Rabellotti, 2014) in the global wine market.

These changes have been accompanied by a geographical relocation of demand (Aizenman and Brooks, 2008), creating new challenges

and opportunities for international trade. To date, almost half of the wines are consumed outside of a country of production that is rarely associated with an extra trade cost (Dal Bianco et al., 2015).

Consequently, the objective of our paper is to investigate the factors influencing international trade among the major global wine market players and their trading partners as well as to reveal the cultural-linguistic factors behind wine trade flows.

According to Tinbergen (1962), the size of bilateral trade flows can be approximated by the so-called "gravity equation", mimicking Newton's famous gravity theory. The gravity equation provides evidence for the relationship between the size of economies, the distance between them and the number of products traded.

There are a number of research dealing with international wine trade using gravity equation models (Pinilla and Serrano 2008, Dascal et al., 2002, De Blasi et al., 2007, Dal Bianco et al., 2013; 2015, Lombardi et al., 2016). However, these models are generally using the basic model with common variables. In this paper, we aim

to use a more sophisticated model as we are especially interested in the effect of cultural and geographical variables as well as language clusters on bilateral wine trade of major global wine producer countries.

We estimate the standard gravity equation for the analysis and employ several different estimation methods such as OLS, Random Effects, Pseudo Poisson Maximum Likelihood (PPML) and Heckman two-stage approach suggested by the literature in order to estimate the gravity regression for the wine trade.

The aim of our paper is to analyse the effect of cultural-geographical proximity, free trade and the role of linguistic similarity on bilateral wine trade in the world major wine producer countries, employing balanced panel gravity model.

In doing so, the paper is structured as follows. The first section describes the theoretical background behind gravity models, including its application to the wine trade, followed by the demonstration of our methods used. The fourth section shows our econometric specification, followed by the discussion of the results. The last section concludes.

Materials and methods

Gravity models have been used to refer to a variety of different specifications to determine bilateral trade flows and estimate factors influencing trade costs. A number of slightly different specifications of the gravity equation exist in the trade literature. Moreover, the gravity equation can be derived from several theory-consistent estimation methods.

Most of the gravity models work with a single factor of production, factor income and hence Gross Domestic Products (GDP). Gravity models can be divided into the category of “demand-side” or “supply-side” derivations (Head and Mayer, 2013). The earliest modern application of the gravity equation for trade was made by Anderson (1979). The gravity equation is based on standard symmetric Dixit-Stiglitz-Krugman monopolistic competition assumptions derived by multiple authors. It assumes that each country has firms supplying one variety to the world from a home-country production site. Utility features a constant elasticity of substitution between all varieties available in the world (Head and Mayer, 2013). Eaton and Kortum (2002) derive a gravity equation from the constant elasticity of substitution based on the approaches in approximately every respect and the results they

obtain show a remarkable similarity. According to Bergstrand (1985, 1989), the gravity model is a direct implication of the monopolistic competition model of Paul Krugman (1980). Helpman et al. (2008) and Chaney (2008) obtained gravity model from a theoretical model of international trade in differentiated goods with firm heterogeneity.

Only a limited number of articles are available in international trade literature that investigates wine trade by gravity equation models concerning the European Union or South American wine trade.

Pinilla and Serrano (2008) analysed the long-term determinants of Spanish table wine exports by gravity panel data estimation technique between 1871 and 1935. The results of their model showed that Spanish table wine was exported to countries with large growing markets that were close both culturally and geographically.

Dascal et al. (2002) employed a gravity model approach in order to analyse the main factors affecting the trade flows of wine in EU-12 countries for the period 1989-1997. Their results revealed that wine trade was positively influenced by an increase of GDP per capita, since greater income promotes trade.

De Blasi et al. (2007) examined the magnitude of trade flows for high quality wine from Italy to its main importing countries analysed by the gravity model. They concluded that the enlargement of the EU provided better opportunities for high quality Italian wine exporters.

Dal Bianco et al. (2013) analysed the Argentinean wine industry also by using the gravity model. They concluded that wine flows can be basically explained by the importer countries’ economic and political characteristics. In addition, the lack of free trade agreements with the European Union and North America revealed a significant weakness for Argentinean wineries.

Dal Bianco et al. (2015) investigated the impact of trade barriers on the world wine trade focusing on trade costs impeding exports, including transport, tariffs, technical barriers and sanitary and phytosanitary standards. Their gravity model was estimated using data from the main importing and exporting countries between 1997 and 2010. Their results identify which regulations can adversely affect trade providing useful information to policy-makers involved in negotiations on trade frictions.

Lombardi et al. (2016) analysed the intra-EU trade of the world’s major wine exporters such as Italy,

France, and Spain employing augmented version of the gravity model. They took into account effects of transportation costs, as well as demand and supply gaps between origin and destination countries, on the size of bilateral trade flows.

However, these studies analysed only a region or a part of the world wine trade and they did not take into account the wine trade of the major world wine exporter countries. In addition, the effect of cultural similarity on wine trade has not yet been investigated either.

We employ a standard gravity model for a sample of world wine trade. The standard formula of gravity equation can be calculated as follows (Anderson and van Wincoop's, 2003):

$$X_{ij} = G * S_i * M_j * \varphi_{ij} \quad (1)$$

where X_{ij} is the value of exports from i to j,

M_j denotes importing country's GDP,

S_i comprises exporter's GDP,

G is a variable that does not depend on i or j such as the level of world liberalization,

φ_{ij} represents the ease of exporter i to access the market of j.

The log-linear model of gravity equation can be calculated by taking the natural logarithms of these variables (Bacchetta et al., 2012):

$$\ln X_{ij} = \ln G + \ln S_i + \ln M_j + \ln \varphi_{ij} \quad (2)$$

A number of variables are generally used to capture trade costs such as bilateral distance, islands-landlocked countries, common borders, common language or cultural features such as colonial history, common religion that are usually thought to be stable over time (Bacchetta et al., 2012).

As culture shifts over time, it may change more when countries are more exposed to international trade - therefore, it is important to consider culture-based measures (Head and Mayer, 2013). In addition, trade costs are probably lower for countries whose have a common language or other relevant cultural character because they are likely to know more about each other and understand better each other's culture or business practices (Bacchetta et al., 2012).

Sharing a religion has also been shown to raise trade (Kang and Fratianni 2006, Linders and de Groot 2006). Religious similarity is a variable created from data on religion by La Porta et al. (1999), who provide the percentage of a country's residents

identified as Catholic, Protestant, Muslim, or Other.

The relationship between physical and cultural distance also deserves attention in gravity models. Countries tend to group together geographically because culture spreads first to those areas nearest to its origin (Ronen and Shenkar, 1985).

However, cultural proximity and geographic proximity are not necessarily related. Three countries pertaining to the Anglo-Saxon cluster such as Australia, the UK, and the United States are located in three different continents due to colonization and immigration (Ronen and Shenkar, 1985).

To measure cultural distance between the home and the host country, Ronen and Shenkar (1985) and Triandis (1994) clustered countries based on their relative similarities along four different dimensions, i.e., language, geography, wealth, and religion. In addition, Ronen and Shenkar synthesize eight previous studies that classify countries according to aspects such as prevalent needs, values, and work attitudes. We used clusters of countries that present similar cultural characteristics to home country by the work of Filippaios and Rama (2011).

Tariff barriers are also generally included in the form of dummies for the existence of regional trade agreements (RTAs) or use of WTO membership.

Literature suggests several ways to estimate gravity models from linear pooled OLS to nonlinear PPML. The standard gravity equation and other multiplicative models (such as the Cobb-Douglas production function) can be estimated with OLS. However, Santos and Tenreyro (2006) found many problems of this simple approach and argued that Pseudo-Poisson maximum likelihood (PPML) was a smart alternative to linear-in-logs OLS for multiplicative models like the gravity equation. A useful feature of the PPML is that it permits the inclusion of zero trade values as well. In this paper, we employ heteroscedasticity robust panel estimation, including zero trade flows and country-time fixed effects for bilateral wine export.

Based on the empirical evidence of wine gravity literature the following hypotheses are tested here:

H1: The standard gravity model can be applied to world wine trade.

Standard gravity models generally argue that bilateral trade is inversely related to geographical distance, e.g. trade volumes decrease with distance.

However, it is also interesting to analyse how geographical distance is related to the costs of trade, especially in the case of a landlocked country. This situation makes trade cost higher because sea access enables water transport to reduce costs (Bacchetta et al., 2012). We employ simple distance of most populated cities in km as a proxy for geographical distance, while we use a dummy variable for landlocked countries. Data come from the CEPII database and a positive relationship is expected.

H2: Culturally similar countries trade more wine.

Lower trade barriers stimulate trade by reducing trade costs (Bacchetta et al., 2012, p. 106). We test this argument for wine trade by using proxies for cultural similarities like the common language, past colonial history or common religion, available at the CEPII database. Again, a positive relationship is expected.

H3: Members of the same language cluster will trade more wine with each other.

It seems to be evident that a common language generally makes trade easier. This assumption is tested here by using the language clusters available in the CEPII database. A religion variable derived from data of La Porta et al. (1999). To measure the cultural distance between the home and the host country, we employed language classification variables (see Appendix 1) from the work of Ronen and Shenkar (1985) in Filippaios and Rama (2011). A positive relationship is expected, too.

H4: Trade agreements encourage global wine trade.

The liberalisation of global wine trade leads to a higher number of different quality wines available on shelves. Here we test whether this relationship holds for all the major wine exporter countries. A dummy variable is used for WTO membership and the existence of regional trade agreements between trading partners. Information on WTO membership can be found on the WTO website (WTO, 2013). Data on the regional trade agreement (RTA) variable comes from International Economics Data and Programs of José de Sousa (De Sousa, 2014). We expect to have a positive relationship here.

Our strongly balanced panel dataset includes bilateral trade data of 32 considerable wine exporter countries and their 216 trading partners (Appendix 2) between 2000-2012, giving 48 802 observations. The dependent variable of the model comes

from bilateral wine export data of the World Bank World Integrated Trade Solution (WITS) database in HS-6 level, for product code 2204: wine of fresh grapes, including fortified wines; grape must (World Bank, 2014a). Table 1 summarises all the variables used.

We employ four different estimation methods: pooled OLS and Random Effects suggested by Baier and Bergstrand (2009), PPML by Santos and Tenreiro (2006) and the Heckman two-stage approach (Heckman, 1979). In all models, country fixed effect are included by country-pairs and time fixed effects by year dummies. To avoid dropping zero trade values by using logarithm form, we added a small value of 1 dollar to zero trade flows. The following models were estimated (note that in PPML models wine export are used in levels instead of the logarithm form):

$$\ln \text{wine export}_{ij} = \alpha + \beta_1 \ln \text{GDPexp}_i + \beta_2 \ln \text{GDPimp}_j + \beta_3 \ln \text{dist}_{ij} + \beta_4 \text{comlang_off}_{ij} + \beta_5 \text{comcol}_{ij} + \beta_6 \text{colony}_{ij} + \beta_7 \text{religion}_{ij} + \beta_8 \text{landlocked}_{ij} + \beta_9 \text{WTO}_{ij} + \beta_{10} \text{RTA}_{ij} + D_i \text{exp dummies}_i + D_j \text{imp dummies}_j + D_i \text{time dummies}_{ij} + u_{ij} \quad (3)$$

$$\ln \text{wine export}_{ij} = \alpha + \beta_1 \ln \text{GDPexp}_i + \beta_2 \ln \text{GDPimp}_j + \beta_3 \ln \text{dist}_{ij} + \beta_4 \text{comlang_off}_{ij} + \beta_5 \text{comcol}_{ij} + \beta_6 \text{colony}_{ij} + \beta_7 \text{religion}_{ij} + \beta_8 \text{landlocked}_{ij} + \beta_9 \text{WTO}_{ij} + \beta_{10} \text{RTA}_{ij} + \beta_{11} \text{Anglo-saxon}_{ij} + \beta_{12} \text{Germanic}_{ij} + \beta_{13} \text{LatinAm}_{ij} + \beta_{14} \text{LatinEU}_{ij} + D_i \text{exp dummies}_i + D_j \text{imp dummies}_j + D_i \text{time dummies}_{ij} + u_{ij} \quad (4)$$

$$\ln \text{wine export}_{ij} = \alpha + \beta_1 \ln \text{GDPexp}_i + \beta_2 \ln \text{GDPimp}_j + \beta_3 \ln \text{dist}_{ij} + \beta_4 \text{comcol}_{ij} + \beta_5 \text{colony}_{ij} + \beta_6 \text{religion}_{ij} + \beta_7 \text{landlocked}_{ij} + \beta_8 \text{WTO}_{ij} + \beta_9 \text{RTA}_{ij} + \beta_{10} \text{Anglo-saxon}_{ij} + \beta_{11} \text{Germanic}_{ij} + \beta_{12} \text{LatinAm}_{ij} + \beta_{13} \text{LatinEU}_{ij} + D_i \text{exp dummies}_i + D_j \text{imp dummies}_j + D_i \text{time dummies}_{ij} + u_{ij} \quad (5)$$

Independent variables	Description	Data sources	Exp. sign
lnGDPexp	GDP of wine exporter (GDP in current US dollar)	World Bank (2014b)	+
lnGDPimp	GDP of wine importer (GDP in current US dollar)	World Bank (2014b)	+
Indist	distance: simple distance of most populated cities in km	CEPII (2013)	-
Independent dummy variables	Description	Data sources	Exp. sign
comlang_off	common official language: 1 if trader countries have common official primary language, 0 otherwise	CEPII (2013)	+
comcol	common colonizer: 1 for common colonizer post 1945, 0 otherwise	CEPII (2013)	+
colony	1 if traders were ever in colonial relationship, 0 otherwise	CEPII (2013)	+
landlocked	landlocked country: 1 if both traders are landlocked, 0 otherwise	CEPII (2013)	-
religion	1 if common main religion for both countries, 0 otherwise	La Porta et al. (1999)	+
RTA	1 if traders have regional trade agreements, 0 otherwise	José de Sousa (2014)	+
WTO	WTO: 1 if both traders are member of WTO, 0 otherwise	WTO (2013)	+
Language classification	Description	Data sources	Exp. sign
Anglo-Saxon	1 if trader countries belonging to Anglo-Saxon cluster, 0 otherwise (Filippaios and Rama 2011)	Ronen and Shenkar (1985)	+
Germanic	1 if trader countries belonging to Anglo-Saxon cluster, 0 otherwise (Filippaios and Rama 2011)	Ronen and Shenkar (1985)	+
Latin American	1 if trader countries belonging to Latin American cluster, 0 otherwise (Filippaios and Rama 2011)	Ronen and Shenkar (1985)	+
Latin European	1 if trader countries belonging to Latin European cluster, 0 otherwise (Filippaios and Rama 2011)	Ronen and Shenkar (1985)	+

Source: own composition

Table 1: Description of independent variables.

Results and discussion

Table 2 summarises the results obtained by OLS and random effect estimations. The majority of the variables are highly significant. Regarding the first hypothesis, the common general gravity model applies for global wine trade with positive values for GDP and negative ones for distance. This means that economically bigger countries trade more with each other and as usual, distance and trade values are negatively related. According to our results, this also holds for our sample, meaning that distance discourages global wine trade.

As to the second hypothesis, cultural similarity seems to have a positive impact on wine trade in both models as expected. In other words, countries having similar cultural backgrounds trade more wine compared to those with different cultural background. However, language cluster results do not appear to be evident as just the Latin American cluster provides positive and significant results, questioning the original hypothesis.

Last but not least, the effects of regional trade

agreements are positive and significant in the OLS model but not in the RE model. This is especially important in times when the role of free trade agreements has continuously been increasing. It seems that wine has been more traded regionally than globally. Generally, our results are in line with the literature except for language clusters.

Results obtained by the PPML estimation are summarised in Table 3 and they are consistent with the OLS model results described above. However, the PPML models highly confirm a positive role of language clusters and less trading costs between Anglo-Saxon, Germanic, Latin American and Latin European countries, supporting our third hypothesis. In other words, countries speaking similar languages tend to have traded more wine between 2000 and 2012 than those speaking a different language. Moreover, it seems that similar languages are also associated with less trade costs. The additional effect of language clusters (PPML model 2) reveals that in the case of Latin American countries, trade effect is the highest in line with OLS and random effect models.

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	Random	Random	Random
VARIABLES	lnexport_adj	lnexport_adj	lnexport_adj	lnexport_adj	lnexport_adj	lnexport_adj
lnGDPexp	0.227* (0.121)	0.228* (0.121)	0.228* (0.122)	0.202 (0.136)	0.202 (0.136)	0.203 (0.136)
lnGDPimp	1.346*** (0.101)	1.347*** (0.101)	1.349*** (0.102)	1.299*** (0.122)	1.300*** (0.122)	1.300*** (0.122)
Indist	-1.894*** (0.0358)	-1.856*** (0.0387)	-1.983*** (0.0385)	-2.040*** (0.0893)	-2.005*** (0.0969)	-2.140*** (0.0974)
comlang_off	1.697*** (0.0732)	1.603*** (0.0766)		1.731*** (0.191)	1.640*** (0.199)	
comcol	2.960*** (0.248)	2.965*** (0.248)	2.978*** (0.247)	3.062*** (0.732)	3.070*** (0.732)	3.090*** (0.730)
colony	2.512*** (0.0965)	2.571*** (0.0980)	3.335*** (0.0910)	2.515*** (0.252)	2.577*** (0.256)	3.360*** (0.248)
religion	1.168*** (0.0737)	1.140*** (0.0739)	1.264*** (0.0741)	1.185*** (0.185)	1.156*** (0.186)	1.284*** (0.188)
landlocked	-0.540*** (0.145)	-0.565*** (0.148)	-0.519*** (0.149)	-0.481 (0.371)	-0.512 (0.373)	-0.463 (0.378)
WTO	1.477*** (0.457)	1.529*** (0.459)	1.651*** (0.480)	1.707 (1.292)	1.766 (1.303)	1.945 (1.409)
RTA	0.606*** (0.0703)	0.615*** (0.0704)	0.654*** (0.0707)	-0.105 (0.109)	-0.103 (0.109)	-0.0983 (0.109)
AngloSaxon		0.0402 (0.153)	0.778*** (0.152)		-0.0250 (0.462)	0.732 (0.462)
Germanic		-0.0658 (0.146)	-0.0116 (0.148)		-0.0877 (0.397)	-0.0323 (0.406)
LatinAmerican		1.285*** (0.155)	2.072*** (0.152)		1.304*** (0.380)	2.113*** (0.378)
LatinEuropean		-0.192 (0.120)	-0.185 (0.121)		-0.198 (0.286)	-0.191 (0.290)
Constant	-24.56*** (3.954)	-24.89*** (3.952)	-23.91*** (3.981)	-19.38*** (5.096)	-19.71*** (5.114)	-17.99*** (5.156)
Observations	45,421	45,421	45,421	45,421	45,421	45,421
R-squared	0.593	0.593	0.589	0.592	0.592	0.587
Number of country pairs				3,539	3,539	3,539
exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
importer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: to avoid dropping zero trade flows lnexport_adj was calculated by adding 1 USD to 0 trade values.

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: own calculation based on Word Bank (2014a, 2014b), CEPII (2013), De Sousa (2014), La Porta et al. (1999), Filippaios and Rama (2011) and WTO (2013) databases

Table 2: Results of OLS and Random effects estimation.

	(1)	(2)	(3)
	PPML	PPML	PPML
VARIABLES	exportvalue	exportvalue	exportvalue
lnGDPexp	0.152 (0.187)	0.156 (0.184)	0.167 (0.186)
lnGDPimp	0.948*** (0.179)	0.949*** (0.179)	0.949*** (0.179)
Indist	-0.352*** (0.0828)	-0.330*** (0.0879)	-0.375*** (0.0843)
comlang_off	0.763*** (0.153)	0.561*** (0.185)	
comcol	2.886*** (0.801)	2.996*** (0.830)	2.973*** (0.772)
colony	0.514** (0.239)	0.520** (0.243)	0.672*** (0.236)
religion	0.650** (0.261)	0.573** (0.279)	0.636** (0.259)
landlocked	-1.341** (0.547)	-0.879 (0.607)	-0.584 (0.628)
WTO	2.512*** (0.855)	2.503*** (0.882)	2.494*** (0.922)
RTA	0.441** (0.202)	0.425** (0.200)	0.440** (0.194)
AngloSaxon		0.344 (0.269)	0.743*** (0.208)
Germanic		0.626* (0.372)	0.825** (0.408)
LatinAmerican		1.016*** (0.246)	1.170*** (0.277)
LatinEuropean		0.462* (0.257)	0.458* (0.263)
Constant	-11.46 (7.047)	-12.03* (6.969)	-11.42* (6.907)
Observations	45,421	45,421	45,421
Pseudo R-squared	0.869	0.871	0.862
exporter fixed effects	Yes	Yes	Yes
importer fixed effects	Yes	Yes	Yes
time fixed effects	Yes	Yes	Yes

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: own calculation based on Word Bank (2014a, 2014b), CEPII (2013), De Sousa (2014), La Porta et al. (1999), Filippaios and Rama (2011) and WTO (2013) databases

Table 3: PPML estimation results for wine export.

Table 4 presents the Heckman two-stage estimation using sample selection variable (export dummy variable: it is equal to 1 if the value of export is positive and 0 otherwise). As to the Heckman estimation, the first and second stage produce similar results as the empirical literature suggest: almost all coefficients are significant and have

the expected signs. This is probably the most valid model, confirming previous results. However, the mill's lambdas are also significant in all models, suggesting selection bias of zero trade. It implies that zero trade flows may represent missing values instead of the absence of trade in the sample.

	(1)		(2)		(3)	
	heckman		heckman		heckman	
VARIABLES	lnexport_adj	exportdummy	lnexport_adj	exportdummy	lnexport_adj	exportdummy
lnGDPexp	0.884*** (0.0312)	0.162*** (0.00370)	0.833*** (0.0255)	0.164*** (0.00372)	0.581*** (0.0175)	0.164*** (0.00372)
lnGDPimp	0.841*** (0.0289)	0.154*** (0.00303)	0.772*** (0.0234)	0.154*** (0.00306)	0.501*** (0.0152)	0.154*** (0.00306)
Indist	-0.366*** (0.0369)	-0.102*** (0.00889)	-0.243*** (0.0307)	-0.0793*** (0.00940)	-0.111*** (0.0226)	-0.0793*** (0.00940)
comlang_off	2.218*** (0.103)	0.424*** (0.0216)	1.628*** (0.0824)	0.366*** (0.0224)		0.366*** (0.0224)
comcol	1.507*** (0.254)	0.0105 (0.0563)	1.711*** (0.212)	0.0466 (0.0563)	1.797*** (0.178)	0.0466 (0.0563)
colony	1.010*** (0.120)	0.265*** (0.0353)	1.141*** (0.103)	0.312*** (0.0356)	1.235*** (0.0762)	0.312*** (0.0356)
religion	1.458*** (0.0862)	0.293*** (0.0199)	1.117*** (0.0680)	0.247*** (0.0203)	0.780*** (0.0495)	0.247*** (0.0203)
landlocked	-1.890*** (0.0732)	-0.264*** (0.0144)	-1.779*** (0.0611)	-0.250*** (0.0147)	-1.409*** (0.0457)	-0.250*** (0.0147)
WTO	1.303*** (0.0970)	0.297*** (0.0174)	1.086*** (0.0786)	0.284*** (0.0175)	0.447*** (0.0587)	0.284*** (0.0175)
RTA	1.907*** (0.0951)	0.411*** (0.0194)	1.764*** (0.0778)	0.415*** (0.0194)	1.156*** (0.0551)	0.415*** (0.0194)
AngloSaxon			1.413*** (0.181)	0.348*** (0.0935)	2.100*** (0.124)	0.348*** (0.0935)
Germanic			1.153*** (0.139)	0.319*** (0.0510)	0.629*** (0.100)	0.319*** (0.0510)
LatinAmerican			3.190*** (0.201)	1.277*** (0.0951)	2.554*** (0.145)	1.277*** (0.0951)
LatinEuropean			0.368*** (0.115)	0.210*** (0.0407)	0.0719 (0.0833)	0.210*** (0.0407)
mills lambda	4.726*** (0.355)		3.933*** (0.285)		0.553*** (0.193)	
Constant	-40.84*** (1.601)	-7.157*** (0.143)	-38.20*** (1.337)	-7.404*** (0.148)	-23.16*** (0.881)	-7.404*** (0.148)
Observations	45,421	45,421	45,421	45,421	45,421	45,421
Censored obs	16,379		16,379		16,379	
Uncensored obs	29,042		29,042		29,042	
exporter fixed effects	Yes		Yes		Yes	
importer fixed effects	Yes		Yes		Yes	
time fixed effects	Yes		Yes		Yes	

Note: to avoid dropping zero trade flows lnexport_adj was calculated by adding 1 USD to 0 trade values.

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: own calculation based on Word Bank (2014a, 2014b), CEPII (2013), De Sousa (2014), La Porta et al. (1999), Filippaios and Rama (2011) and WTO (2013) databases

Table 4: Results of Heckman estimations.

On the whole, models above validate the expected relationship between wine trade and common cultural, historical and geographical link with the trading partners. Results also confirm the positive role of free trade and regional trade agreements. In addition, the estimations suggest that Anglo-Saxon, Latin European, Latin American and Germanic countries have significant common trade relations that reduce wine trade costs. None of our hypotheses could be rejected.

Conclusion

In recent decades, global wine trade has resulted in increased wine consumption in North America and Asia. Currently, almost every second litre of wine is consumed in a third country, implying extra trade cost for countries.

The paper analysed the effects of cultural and geographical proximity on wine trade by applying a panel gravity model for global wine traders for the period of 2000-2012. It also investigated the role of language clusters in global wine trade costs.

The estimated models confirmed the standard gravity hypotheses in wine trade in line with the gravity literature (Dascal et al., 2002; Bacchetta et al., 2012; Head and Mayer, 2013; Lombardi et al., 2016).

Results suggest that the exporter and importer country's GDP, common official language and colonial history and religion based variables are positively related to wine export. It highlights the importance of country size and cultural similarity in wine export (Pinilla and Serrano, 2008; Dascal et al., 2002).

Results also suggest that costs of wine export could

be lower if trading partners have common cultural relations because they know better each other's business culture and practise (Bacchetta et al., 2012; Pinilla and Serrano, 2008).

Estimations also explored a positive role of free trade agreements, i.e. lower trade barriers stimulate wine trade by reducing trade costs (Bacchetta et al., 2012; Bianco et al., 2013).

Regarding language clusters, Anglo-Saxon, Germanic and Latin American countries export wines predominantly to each other's market. The additional effects of language clusters suggest that trade effect lowering trade costs are the highest in Latin American language clusters.

In sum, our empirical evidence proves that common historical, cultural and linguistic background has a significant role in wine trade and culturally similar country groups can benefit from the most significant trade advantage.

However, note that models applied have several limitations and restrictions as usual. Wine trade data are measured at the macro level and models assumed that wine products across countries were homogenous. Further research is needed in order to take into consideration other cultural, historical and geographical factors influencing wine trade.

Acknowledgements

This research was supported by the National Research, Development and Innovation Office Project No. K_119669 'Competitiveness of Agriculture in International Trade: A Global Perspective'. We are grateful for Imre Ferto on making useful comments and suggestions on earlier versions of the paper.

Corresponding authors:

Jeremiás Máté Balogh, PhD, assistant professor

Corvinus University of Budapest, Room 222, Fővám tér 8., H-1093 Budapest, Hungary

Phone: +36 30 318-6332, E-mail: jeremias.balogh@uni-corvinus.hu

ORCID:0000-0001-9081-0071

References

- [1] Aizenman, J. and Brooks, E. (2008) "Globalization and taste convergence: the cases of wine and beer", *Review of International Economics*, Vol. 16, No. 2, pp. 217-233. ISSN 1467-9396. DOI 10.1111/j.1467-9396.2007.00659.x.
- [2] Anderson, J. E. and van Wincoop, E. (2003) "Gravity with gravitas: a solution to the border puzzle", *American Economic Review*, Vol. 93, pp. 170-92. ISSN 0002-8282. DOI 10.1257/00028280321455214.

- [3] Anderson, J. E. (1979) "A theoretical foundation for the gravity equation", *American Economic Review*, Vol. 69, pp. 106-116. ISSN 0002-8282.
- [4] Bacchetta, M., Beverelli, C., Cadot, O., Fugazza, M., Grether, J-M., Helble, M., Nicita, A. and Piermartini R. (2012) "*A practical guide to trade policy analysis*", World Trade Organisation and United Nation, June 2012, Switzerland, 106 p. [Online] Available: https://www.wto.org/english/res_e/publications_e/wto_unctad12_e.pdf [Accessed: 26 Oct. 2014].
- [5] Baier, S. L. and Bergstrand, J. H. (2009) "Bonus vetus OLS: a simple method for approximating international trade-cost effects using the gravity equation", *Journal of International Economics*, Vol. 77, No. 1, pp. 77-85. ISSN 0022-1996. DOI 10.1016/j.jinteco.2008.10.004.
- [6] Bergstrand, J. H. (1985) "The gravity equation in international trade: some microeconomic foundations and empirical evidence", *The Review of Economics and Statistics*, Vol. 67, No. 3, pp. 474-81. E-ISSN 15309142, ISSN 00346535. DOI 10.2307/1925976.
- [7] Bergstrand, J. H. (1989) "The generalized gravity equation, monopolistic competition and the factor-proportions theory in international trade", *The Review of Economics and Statistics*, Vol. 71, No. 1, pp. 143-53. E-ISSN 15309142, ISSN 00346535. DOI 10.2307/1928061.
- [8] Cembalo, L., Caracciolo, F. and Pomarici, E. (2014) "Drinking cheaply: the demand for basic wine in Italy", *Australian Journal of Agricultural and Resource Economics*, Vol. 58, No. 3, pp. 374-391. ISSN 1467-8489. DOI 10.1111/1467-8489.12059.
- [9] CEPII (2013) "GeoDist and Language database", Centre de recherche français dans le domaine de l'économie internationale. [Online]. Available: <http://www.cepii.fr> [Accessed: 10 Sep. 2014].
- [10] Chaney, T. (2008) "Distorted gravity: the intensive and extensive margins of international trade", *American Economic Review*, Vol. 98, pp. 1707-1721. ISSN 0002-8282. DOI 10.1257/aer.98.4.1707.
- [11] Dal Bianco, A., Boatto, V. L., Caracciolo, F. and Santeramo, F. G. (2015) "Tariffs and non-tariff frictions in the world wine trade", *European Review of Agricultural Economics*, Vol. 49, No. 1, pp. 31-57. E-ISSN 1464-3618, ISSN 0165-1587. DOI 10.1093/erae/jbv008.
- [12] Dal Bianco, A., Boatto, V., Estrella-Orregob, J. and Gennari, A. (2013) "Is gravity pushing Argentinean wine exports? A gravity model applied to Argentinean wine", *VDQS XX Enometrics Conference*, Talca - Chile, September 2013. [Online]. Available: http://www.wineecoreports.com/Working_Papers/Abstract/WP_2013/DAL-BIANCO_ESTRELLA-ORREGO_BOATTO_GENNARI.pdf [Accessed: 5 May 2015].
- [13] Dascal, D., Mattas, K. and Tzouvelekas, V. (2002) "An Analysis of EU Wine Trade: A Gravity Model Approach International", *Advances in Economic Research*, Vol. 8, No. 2, pp. 135-147. E-ISSN 1573-966X, ISSN 1083-0898. DOI 10.1007/bf02295344.
- [14] De Blasi, G., Seccia, A., Carlucci, D. and Santeramo, F. (2007) "Analysis of Italian High Quality Wine Exports using the Gravity Model Approach", *Contributed Paper prepared for presentation at the 105th EAAE Seminar Bologna*, Italy, March 8-10, 2007. [Online]. Available: <http://ageconsearch.umn.edu/bitstream/7901/1/cp070026.pdf> [Accessed: 22 Jan. 2016].
- [15] De Sousa, J. (2014) "International Economics Data and Programs Regional Trade Agreements". [Online]. Available: <http://jdesousa.univ.free.fr/data.htm#RegionalTradeAgreements> [Accessed: 10 Jan. 2016].
- [16] Eaton, J. and Kortum, S. (2002) "Technology, Geography, and Trade", *Econometrica*, Vol. 70, No. 5, pp. 1741-1779. E-ISSN 1468-0262. DOI 10.1111/1468-0262.00352.
- [17] Filippaios, F. and Rama, R. (2011) "Cultural Distance and Internationalization: The World's Largest Food and Drink Multinationals", *Agribusiness*, Vol. 27, No. 4, pp. 399-419. ISSN 0742-4477. DOI 10.1002/agr.20283.
- [18] Head, K. and Mayer, T. (2013) "Gravity Equations: Workhorse, Toolkit, and Cookbook", CEPII Working Paper (Centre d'études prospectives et d'informations internationales), No. 2013-27. DOI 10.1016/b978-0-444-54314-1.00003-3.

- [19] Heckman, J. (1979) "Sample selection bias as a specification error", *Econometrica*, Vol. 47, No. 1, pp.153-161. E-ISSN 1468-0262. DOI 10.2307/1912352.
- [20] Helpman, E., Melitz, M. and Rubinstein, Y. (2008) "Estimating Trade Flows: Trading Partners and Trading Volumes", *Quarterly Journal of Economics*, Vol. 123, No. 2, pp. 441-487. E-ISSN 1531-4650, ISSN 0033-5533. DOI 10.1162/qjec.2008.123.2.441.
- [21] Kang, H. and Fratianni M. (2006) "International Trade, OECD Membership, and Religion", *Open Economies Review*, Vol. 17, No. 4, pp. 493-508. E-ISSN 1573-708X, ISSN 0923-7992. DOI 10.1007/s11079-006-0361-y.
- [22] Labys, W. C. and Cohen, B. C. (2004) "Trends or Cycles in Global Wine Export Shares", Division of Resource Management Working Paper RESMWP-04-03, *Oenometrics XI conference VDQS-AEA*, Dijon France, May 20-22. [Online]. Available: http://www.ibrarian.net/navon/paper/TRENDS_OR_CYCLES_IN_GLOBAL_WINE_EXPORT_SHARES.pdf?paperid=8089296 [Accessed: 10 Oct. 2015].
- [23] La Porta, R., Lopez-de-Silanes, F., Shleifer A. and Vishny R. (1999) "The Quality of Government", *Journal of Law, Economics and Organization*, Vol. 15, p. 222-279. E-ISSN 1465-7341, ISSN 8756-6222. DOI 10.3386/w6727.
- [24] Linders, G. M. and de Groot, H. L. (2006) "Estimation of the gravity equation in the presence of zero flows", Tinbergen Institute, Discussion Paper 2006-072/3. DOI 10.2139/ssrn.924160.
- [25] Lombardi, P., Dal Bianco A., Freda, R., Caracciolo, F. and Cembalo, L. (2016) "Development and trade competitiveness of the European wine sector: a gravity analysis of intra-EU flows", *Wine Economics and Policy*, Vol. 5, No. 1, pp. 50-59. ISSN 2212-9774. DOI 10.1016/j.wep.2015.12.002.
- [26] Stanley, M. (2013) "*The Global Wine Industry*". October 22, 2013. [Online]. Available <http://blogs.reuters.com/counterparties/files/2013/10/Global-Wine-Shortage.pdf> [Accessed: 22 Dec., 2015]
- [27] Morrison, A. and Rabellotti, R. (2014) "Gradual catch up and enduring leadership in the global wine industry", American Association of Wine Economists, Working paper No. 148. [Online]. Available: http://www.wine-economics.org/dt_catalog/aawe-working-paper-no-148-business/
- [28] Pinilla, V. and Serrano, R. (2008) "The Agricultural and Food Trade in the First Globalization: Spanish Table Wine Exports 1871 to 1935-A Case Study", *Journal of Wine Economics*, Vol. 3, No. 2, pp. 132-148. E-ISSN 1931-437X, ISSN 1931-4361. DOI 10.1017/s1931436100001176.
- [29] Ronen, S. and Shenkar, O. (1985) "Clustering Countries on Attitudinal Dimensions: A Review and Synthesis", *Academy of Management Review*, Vol.10, No. 3, pp. 435-454. E-ISSN 1930-3807, ISSN 0363-7425. DOI 10.2307/258126.
- [30] Santos, S. J. and Tenreyro, S. (2006) "The log of gravity", *The Review of Economics and Statistics* Vol. 88, pp. 641-58. E-ISSN 15309142, ISSN 00346535. DOI 10.1162/rest.88.4.641.
- [31] Tinbergen, J. (1962) "An Analysis of World Trade Flows" in "*Shaping the World Economy*", Twentieth Century Fund, New York.
- [32] Triandis, H. C. (1994) "*Culture and Social Behavior*", Mass McGraw Hill Custom Publishing, Boston, ISBN 0073052604.
- [33] World Bank (2014a) "World Integrated Trade Solution" (WITS), Commodity Trade Database. [Online]. Available: <http://wits.worldbank.org> [Accessed: 15 May 2014].
- [34] World Bank (2014b) "World Development Indicators" (WDI) database. [Online]. Available: <http://data.worldbank.org/data-catalog/world-development-indicators> [Accessed: 10 May 2014].
- [35] WTO (2013) "World Trade Organisation Members and observers", [Online]. Available <http://www.wto.org>, [Accessed: 20 Sep. 2014].

Appendix

Anglo-Saxon

Australia, Canada, Hawaii (USA), Island of Man, Ireland, Netherlands Antilles, Netherlands, New Zealand, South Africa, United Kingdom, United States of America

Arabic

Algeria, Bahrain, Brunei, Egypt, Iran, Jordan, Kuwait, Lebanon, Saudi Arabia, Syria, United Arab Emirates

Far East

Bangladesh, Cambodia, China, Fiji, Guam, Hong Kong, Indonesia, Macao, Madagascar, Malawi, Malaysia, Mali, Marianas Islands, Nepal, New Caledonia, New Guinea, Papua N. Guinea, Philippines, Seychelles, Singapore, Solomon Islands, South Korea, Sri Lanka, Surinam, Tahiti, Taiwan, Thailand, Vietnam

Germanic

Austria, Belarus, Bosnia, Czech Republic, Croatia, Estonia, Germany, Hungary, Latvia, Lichtenstein, Lithuania, Luxembourg, Poland, Slovakia, Switzerland, Ukraine

Independent

Israel, India, Japan, Russia

Latin American

Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Equator, Guatemala, Guyana, Honduras, Virgin Island, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Santa Lucia, Salvador, Trinidad & Tobago, Uruguay, Venezuela, Bahamas, Barbados, Bermuda, Cayman Islands.

Latin European

Albania, Belgium, Bulgaria, Cyprus, France, FYROM (Former Yugoslav Republic of Macedonia), Greece, Italy, Malta, Moldova, Monaco, Portugal, Romania, Serbia, Slovenia, Spain

Near East/Africa

Angola, Armenia, Belize, Botswana, Burundi, Cameroon, Congo, Ethiopia, Gabon, Ghana, Guinea, Ivory Coast, Kazakhstan, Kenya, Lesotho, Liberia, Morocco, Maurice, Mauritania, Mozambique, Namibia, Niger, Nigeria, Uganda, Uzbekistan, Pakistan, Reunion, Rwanda, Senegal, Sierra Leone, Soudan, Swaziland, Tanzania, Chad, Tunisia, Turkey, Yemen, Zaire, Zambia, Zimbabwe

Nordic

Denmark, Finland, Greenland, Iceland, Norway, Sweden

Source: Ronen and Shenkar (1985) in Filippaios and Rama (2011)

Appendix 1: Language classification.

Wine exporter countries	Frequency		Frequency
Argentina	145	Italy	195
Australia	171	Lebanon	92
Austria	137	Malta	37
Argentina	145	Moldova	79
Bulgaria	112	New Zealand	123
Canada	81	Portugal	178
Chile	163	Romania	91
China	81	Russia	51
Croatia	71	Slovak Republic	56
Cyprus	70	Slovenia	76
Czech Republic	101	South Africa	189
France	203	Spain	187
Georgia	76	Switzerland	144
Germany	190	Turkey	77
Greece	115	United Kingdom	183
Hungary	103	United States	157

List of export destinations

Afghanistan, Albania, Algeria, Andorra, Angola, Anguilla, Antigua, and, Barbuda, Argentina, Armenia, Aruba, Australia, Austria, Azerbaijan, Bahamas, The Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bermuda, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, British, Virgin Islands, Brunei, Bulgaria, Burkina, Faso, Burundi, Cambodia, Cameroon, Canada, Cape, Verde, Cayman, Islands, Central, African, Republic, Chad, Chile, China, Christmas Island, Cocos (Keeling) Islands, Colombia, Comoros, Congo Dem. Rep., Congo Rep., Cook Islands, Costa, Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Djibouti, Dominica, Dominican Republic, East Timor, Ecuador, Egypt Arab Rep., El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia(excludes Eritrea), Faeroe Islands, Falkland Island, Fiji, Finland, Sudan, France, French Polynesia, Gabon, Gambia, Georgia, Germany, Ghana, Gibraltar, Greece, Greenland, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, China, Hungary, Iceland, India, Indonesia, Iran, Islamic Rep., Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Korea, Dem. Rep., Korea, Rep., Kuwait, Kyrgyz Republic, Lao PDR, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macao, Macedonia FYR, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia, Fed. States, Moldova, Mongolia, Montserrat, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Netherlands, Netherlands Antilles, New Caledonia, New Zealand, Nicaragua, Niger, Nigeria, Niue, Norfolk Island, Northern Mariana Islands, Norway, Oman, Pakistan, Palau, Panama, Papua, New Guinea, Paraguay, Peru, Philippines, Pitcairn, Poland, Portugal, Qatar, Romania, Russian Federation, Rwanda, Saint Helena, Saint Pierre and Miquelon, Samoa, San Marino, Sao Tome and Principe, Saudi, Arabia, Senegal, Seychelles, Sierra, Leone, Singapore, Slovak Republic, Slovenia, Solomon Islands, Somalia, South Africa, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, Vincent and the Grenadines, Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Togo, Tokelau, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Turks and Caicos Isl., Tuvalu, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, Wallis and Futuna Islands, Yemen, Zambia, Zimbabwe

Source: own composition based on sample data

Appendix 2: Pattern of database.

Czech Foreign Wine Trade – Comparative Advantages Distribution in Relation to the European Union

Jan Borák, Tomáš Vacek

Department of Economics, Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

Abstract

The Czech agrarian foreign trade recorded significant changes since the Czech Republic joined the EU in 2004. This fact influenced also domestic and foreign wine trade of the Czech Republic. This article identifies the main changes in the product structure, and it specifies the level of Czech wine export comparative advantages' distribution in relation to European Union member states. The analysis takes into account not only the trade value (in USD) but also the trade volume (in tonnes) of particular commodities. Commodity structure (HS system is applied at a six-digit level for the more detailed analyses of trade) is analysed especially in relation to the unit price value and in relation to the comparative advantages' or disadvantages' distribution. The main analysis of the comparative advantages' distribution is based on Balassa index, Lafay index and the trade balance index. The results obtained from the individual analysis are presented by the modified "product mapping method". The territorial structure of the Czech agrarian trade is heavily focused on the trade with the European Union member states. The Czech Republic has comparative advantages in wine trade with the European Union in the following sub-aggregations: Wine of fresh grapes to 2 litres (HS 220421) and Grape must (HS 220430). Main destinations for Czech wine export are following: Slovakia, Poland and Germany.

Keywords

Comparative advantages, Czech Republic, EU, export/import, international trade, wine.

Borák, J. and Vacek, T. (2018) "Czech Foreign Wine Trade – Comparative Advantages Distribution in Relation to the European Union", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 31-43. ISSN 1804-1930. DOI 10.7160/aol.2018.100303.

Introduction

Wine is produced in about sixty countries, but in most of them the produced quantity is small, even negligible. In their marketing, the traditional wine-producing countries highlight the advantages of long-term tradition of grapevine growing in particular regions (Rocchi and Stefani, 2002). Twelve most important producers produce approximately 230 million hectolitres wine, which represents 80-90% of global volume. Wine-growing regions of high quality were rather connected with their location at principal trade routes than with the natural character of soil and climatic conditions. The quality of wine also used to be associated with the social state of the vineyard's owner (Dion, 1952). The supply must focus on the quality of infrastructure, abilities and inputs of the "host" - producing country (Kuemmerle, 1999; Woodward and Rolfe, 1993). For these reasons, the vintners worldwide use different

policies whose task is to prod into a better performance of international trade in wine-sector, especially in the field of entering into international relations. The goal is to share successful procedures (Fleury and Fleury, 2003; Ring and Van de Ven, 1994). Even though, according to Jeníček (2002), the development in information and transport technologies has reduced transport costs for goods, it is in terms of its economy better for the Czech Republic to aim at the European wine market. This is caused by still high transaction costs the exporters would have to incur to be able to penetrate one of the mentioned non-European markets, which Dal Bianco et al. (2014) understands as an obstacle in international trade in wine-sector. Even Dal Bianco adds that there is a descending tendency in customs and quota limitations, this is mostly compensated by stricter technical obstacles. It is also possible to focus on Euro-Asian countries, which are quite heterogeneous, when taking into consideration agricultural variables, and which

have not undergone economic transition, which, according to Benešová et al. (2016), offers a great potential for possible future cooperation.

The share of Europe as a whole in the global production is decreasing. In 2016, the world trade in wine-sector, which is understood as the total export of all countries, reached the volume of 104.1 million hectolitres, which is almost two-fold increase during the last 20 years (1996 - volume of 54.5 million hectolitres), and the value of 32.44 billion USD, which is almost three-fold increase during the last 20 years (1996 - value 11.6 billion USD). Looking at the territorial structure of the Czech trade in wine-sector, high dependence on the trade with European Union member states is obvious. In 1996, Czech vintners' trade with the European Union reached the rate of 93%, in 2016 the volume of trade reached 86%. In the course of the monitored period from 1996 to 2016, the share of European Union countries never decreased below 83%.

In 2004, the accession of the Czech Republic to the European Union brought a lot of changes on the market in general. According to Lombardi et al. (2016), although the globalization significantly influences even this branch, the EU was influenced less negatively than other markets. Over the last few years, the consumption of wine at various population segments, that are interested in nature, motivation and own choice of wine, has been growing (Ritchie, 2007). Among alcoholic beverages, wine is one of the most popular kinds with consumers in the Czech Republic. The average annual consumption of wine grew from 15.8 litres in 1996 to 16.8 litres per capita in 2005 (Pyšný et al., 2007), and to nearly 19.8 litres per capita in 2012 (Srovátka et al. 2014), which is more or less identical with 2016. The reason is that the quality of wine has significantly increased over the last years, mainly due to new production technologies. According to Peterová (2013), it can be in principle said that viniculture is one of the few commodities where the origin is paid. Although in the Czech Republic qualifications of wine pursuant to the German system, i.e. quality or sugar content in grapes, are more better known at the moment, according to Tomšík and Prokeš (2011) is advantageous to continue in establishing wine-grower's associations, so-called VOC, i.e. qualification of wine as to its origin (Romance system).

The negative balance of Czech foreign trade in wine-sector exceeded 173 million USD for the first time in 2011. Wine for 201.36 million

USD was imported to the Czech Republic, and the export amounted to 28.23 million USD. In the last years, import and export have been slightly rising, in any case significantly higher amount of wine is imported to the Czech Republic from abroad than that which is exported. In 2016, the genitive balance amounted to 158 million USD. Because the negative balance of the foreign trade in wine-sector has already exceeded 163 million USD, there is a certain space here for increasing the domestic production, as the inquiry from the Czech consumers is here. As Tomšík and Sedlo (2013) add, the Czech Republic is among countries dependent on the import of wine, whereby one third of the consumed volume of wine comes from the domestic production, and two thirds are imported. For this reason, it is necessary to pay careful attention to the trade in wine-sector and to focus on Czech Republic's comparative advantages in relation to the global market (especially EU market) in wine trade. According to Tomšík and Sedlo (2013), from the perspective of winegrowers, it would be even very suitable to organize and check imports based on the domestic production, as the volume of imported wine is influenced by the domestic production, while the volume of export is not, and it is gradually increasing.

Materials and methods

This article aims to identify changes on the market with wine, which occurred in the course of the analysed period from the year 1996 to the year 2016. The monitored period includes several years before and after the Czech Republic joined the EU (in 2004). In addition to individual changes, other particular factors are specified, which are responsible for these changes. The territorial structure is analysed in relation to EU countries. The structure of commodity (we use the HS system which divides the trade in wine-sector into four basic aggregations) is analysed especially in relation to the development and distribution of added value. The mentioned system is applied because of the simple interpretation of results and because of data availability.

The commodity structure on wine market is given by a 6-digit numeric code that divides the wine market into 4 commodity groups:

- | | |
|-----------|---|
| HS 220410 | Sparkling wine of fresh grapes |
| HS 220421 | Wine of fresh grapes, incl. fortified wines, and grape must whose fermentation has been |

arrested by the addition of alcohol, in containers of ≤ 2 l (excl. sparkling wine)

HS 220429 Wine of fresh grapes, incl. fortified wines, and grape must whose fermentation has been arrested by the addition of alcohol, in containers of > 2 l (excl. sparkling wine)

HS 220430 Other grape must

The article also specifies the distribution of comparative advantages in relation to the EU single market. To reach the above-mentioned aim, the essay applies basis analysis of the distribution of comparative advantages (Balassa Index, Lafay Index and the index of trade balance). Results from particular analyses are interpreted using “product maps”, which identify the process of formation of the Czech foreign wine trade and its commodity structures. Figures for particular analyses were drawn upon UN COMTRADE. Cash-flows are mentioned in USD and volumes are mentioned in tonnes.

For the analysis of comparative advantages within the global market or within partial markets the RCA Index will be used as a tool, which also was used in the case of Smutka and Burianová (2013). This index expresses the relative rate of comparative advantage at particular groups of goods, and its value is interpreted as an export ratio of a certain group of goods to the total export in relation to a certain group of countries. The degree of export strategy can be define according to the following formula (1):

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

where X_{ij} stands for the export of the corresponding group of goods from a given country, X_{it} stands for the total export of goods from a given country, X_{nj} symbolises the export of a certain group of goods in relation to a certain group of countries, and X_{nt} corresponds to the total export of goods from a certain group of countries.

If the value of Balassa Index is higher than 1, the comparative advantage is proven. If, in contrast, this index shows values less than 1, it can be said that a comparative advantage was not proven in the case of a given country. Furthermore, it must be noted that Balassa Index has not upper limit, but the bottom limit is equal to 0 (Balassa, 1965).

The comparative advantages shall be analysed

at a bilateral level, as Smutka et al. (2014) analysed in his article about current global state of sugar. For the analysis of comparative advantages within the global market, the LFI index will be used as a tool, which also was used by Smutka et al. (2016). This index provides information about the existence of comparative advantages at a bilateral level, i.e. only within two entities, doing trade between each other, where x_{ij} and m_{ij} stand for export and import of the product “ j ” from a country or a group of countries “ i ” in relation to the rest of the world (2).

If the LFI value is positive, the comparative advantage exists; the higher the values of this index is, the higher is the degree of specialization in the given country. In contrary, a negative value of the LFI index means missing specialization, i.e. comparative advantages. Lafay Index allows the position of each particular product to be analysed within the structure of international trade at each particular analysed country or a group of countries (Zaghiny, 2003).

$$LFI_j^i = \left(\frac{x_j^i - m_j^i}{x_j^i + m_j^i} - \frac{\sum_{j=1}^N (x_j^i - m_j^i)}{\sum_{j=1}^N (x_j^i + m_j^i)} \right) \frac{x_j^i + m_j^i}{\sum_{j=1}^N (x_j^i + m_j^i)} * 100 \quad (2)$$

Index of the foreign-trade balance (TBI) is used for the analysis of whether the county is specialized in export (as a pure exporter), or import (as a netto importer) for a certain group of products. TBI is formulated, as follows (3):

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

where TBI_{ij} indicates the index of country’s balance of trade even for the product “ j ”; x_{ij} and m_{ij} represent export and import of a group of products according to country “ i ” (Lafay, 1992). This index was also used by Smutka et al. (2018).

The country is in a particular group of products indicated as a “pure importer”, if the TBI value is negative, and as a “pure exporter”, if the TBI value is positive. (Widodo, 2009)

The further part of analysis submitted in this document was implemented by means of an analytic tool called “product maps”. This tool allows the user to evaluate premier exported production from two different perspectives, i.e. domestic balance of trade and international competitiveness (Widodo, 2009).

This tool is a matrix for the division of a set

Lafay index	LFI>0	Group B: Comparative Advantage Net-importer (LFI>0 and TBI<0)	Group A: Comparative Advantage Net-exporter (LFI>0 and TBI>0)
	LFI<0	Group D: Comparative disadvantage Net-importer (LFI<0 and TBI<0)	Group C: Comparative disadvantage Net-exporter (LFI<0 and TBI>0)
Czech Agrarian Foreign Trade Commodity Structure		TBI<0	TBI>0
		Trade Balance Index	

Source: Smutka et al. (2017)

Figure 1: Product maps LFI vs TBI.

of exported products into 4 groups according to two chosen coefficients using the original RSCA index, which was replaced by the LFI index that is supplemented by the TBI index, see Figure 1 (Smutka et al., 2017).

The original approach does not take into account the real intensity; it takes into consideration only the influence of import, and the original “product map” is slightly corrected. The LFI index is used here to receive more detailed figures about the real rate of comparative advantage.

Results and discussion

When looking at the summary of chosen aggregations (Table 1) it is clear that the Czech Republic recognized a long-term negative balance of trade in aggregations relating to wine. This is largely, according to Kraus et al. (2005), caused by unfavourable conditions of Czech vintners, such as limited area of vineyards as compared to important Western producers, or climatic conditions in temperate zone. On the other hand, the dynamic growth of export value must be assessed positively, as it increased 21-times (as compared to the import, which increased only 6.6-times). This development led to the increase in the coverage of import by export up to more than 13%. However, this is a tendency that has decreased recently for the reason of the reduction in total production in favour of the production with higher added value. This allows Czech producers to expand to demanding wine markets, and to focus on premium brands with higher quality.

Looking at the territorial structure of the Czech trade in wine-sector, high dependence on the trade with European Union member states is obvious (EU28). In 1996, Czech vintners' trade with European Union reached the rate of 93%, in 2016 the volume of trade reached 86%. In the course of the monitored period from 1996

to 2016, the share of European Union countries never decreased below 83%. Neighbouring countries - Slovakia, Poland and Germany - are the most important trade partners in terms of export value. To Slovakia, 57% of the total Czech wine export was transported in 2016. The states with the most important share in import to the Czech Republic include Italy, Spain, Slovakia and Hungary. In 2016, Italian producers imported to the Czech Republic about 28% of the total import, Spain with its share of nearly 26% was on the second place, then Hungary with 12.5%, and Slovakia with nearly 7% on the fourth place.

In 2016, the import consisted from 59% of white wine, 72% of which was imported in barrels. As to red wine, the relation between bottled wine and wine in barrels is almost balanced. We have to evaluate positively the development of the Czech Republic export unit prices which exceed the import unit prices in the course of the entire monitored period. Important was the significant deceleration in import prices between 2004 and 2016.

Export reached its historical maximum in 2013, when the total export reached 335 thousand hectolitres wine. After 2013, a sharp drop started, which was caused mainly by the change in the strategy of Czech vintners. They began to try to prefer the production of high-quality grapes of which they could produce wine of higher quality. The difficulty of this approach consists in higher demands on producers, and, of course, in lower yields per hectare. The average rate of increase in the value of Czech export was 17.53% between 1996 and 2016.

The total Czech import in the course of the monitored period was growing, and so was the export. The average growth rate reached the value of 10.45%. As in the case of export, the decrease occurred after 2013. The reason for this decrease was a monetary intervention commenced

	EU 28 (all 4 aggregations)					
	Export	Export unit price / tonne	Import	Import unit price / tonne	Balance	Coverage of import by export
1996	1 045 522	1 213.80	26 000 243	794.31	-24 954 721	4.02%
2004	4 499 227	1 699.51	77 496 184	1 345.93	-72 996 957	5.81%
2016	22 491 906	2 128.82	171 945 595	1 689.19	-149 453 689	13.08%
Basis index 2004/1996	4.30	1.40	2.98	1.69	2.93	N/A
Basis index 2016/2004	5.00	1.25	2.22	1.26	2.05	N/A

Source: UN Comtrade, own calculations (2018)

Table 1: Overview table export/import for all 4 aggregations (USD).

in November 2013 by the Czech National Bank. At the end of the year 2013, American dollar was right below 20.00 CZK/USD, but during the year 2015 it reached the level of 25.50 CZK/USD. This weakening of the Czech crown led to the increase of prices of imported goods, which touched also the wine-sector.

Especially, the commodity aggregations HS 220421 and HS 220429 have an essential impact on the total balance. The total balance is significantly negative in both cases, but we have to emphasize the existence of much more dynamic growth of exports in comparison to imports. The negative balance is mainly caused by the export of large volumes from wine superpowers, such as Italy and Spain. If we concentrate on unit prices, we can find out that Czech vintners succeed in exporting their products for higher prices, than those of imported goods from the European Union to the Czech Republic. This fact is supported by the dynamically growing export unit prices, which e.g. between the years 1996 and 2016 rose approx. 1.3-times.

The following part of the paper is focused on individual analysed aggregations trade performance analysis.

Trade with sparkling wine showed a dynamic growth in the course of the total monitored period (Table 2). Especially France and Italy participated in import flows, as they exported sparkling wine with the total value of 14 million USD (in 2016) to the Czech Republic. Czech exporters established themselves with that commodity mainly on two markets. The first one can be defined as the market with neighbouring countries, i.e. with Germany, Austria, Slovakia and Poland. The other important destination for exporters includes the Benelux countries, especially Belgium and the Netherlands. Noteworthy is also the fact that between 2004 and 2016, the tendency of more quickly increasing imports as compared to exports occurred,

which was negatively manifested on the degree of the coverage of import by export, i.e. decrease by 2.38%.

In the case of trade with commodity aggregation HS 220421, it is necessary to mention the dynamics in export growth, which regularly exceed import in the course of the monitored period (Table 3). This tendency was caused, until 2013, mainly by the increasing volume of grown grapevine, and the Czech export was thus supported mainly by the volume. After 2013, the producers revised their strategy and started the production of quality wines, which also means a challenge in the form of lower yields per hectare. To a certain extent, this change manifested itself in the territorial structure. After 2000, it was Slovakia and Hungary that became the main export partners. In 2016, the positions of both states were different - while Slovakia remained the most important export market, the position of Hungary weakened. For the Czech Republic, the dynamically evolving Polish market became very important, and only then the markets in Germany and Rumania. The position of Hungary was even behind these countries in 2016. In the case of import of the aggregation "Wine in containers smaller than 2 litres", the most important positions were occupied by wine superpowers France and Italy. Around the year 2000, the position of Hungarian importers was very strong as well, however, they were losing their positions in the course of the entire monitored period, being replaced by product from Germany and Spain.

Table 4 shows us the basic overview about the development of trade with the European Union in the branch of aggregation "Wine in containers bigger than 2 litres", which we could divide into three development stages. The decreasing share of exports was running throughout the monitored period until 2006; it was caused mainly by the decrease in exports to Finland

	EU 28 (HS 220410)					
	Export	Export unit price / tonne	Import	Import unit price / tonne	Balance	Coverage of import by export
1996	234 109	1 974.99	2 067 220	1 117.06	-1 833 111	11.32%
2004	717 707	2 727.58	5 099 384	2 911.86	-4 381 677	14.07%
2016	2 394 693	4 364.72	20 490 103	3 582.37	-18 095 410	11.69%
Basis index 2004/1996	3.07	1.38	2.47	2.61	2.39	N/A
Basis index 2016/2004	3.34	1.60	4.02	1.23	4.13	N/A

Source: UN Comtrade, own calculations (2018)

Table 2: Overview table export/import for HS 220410 (USD).

	EU 28 (HS 220421)					
	Export	Export unit price / tonne	Import	Import unit price / tonne	Balance	Coverage of import by export
1996	656 935	1 102.98	8 588 670	830.12	-7 931 735	7.65%
2004	3 654 734	1 609.18	38 211 870	1 164.55	-34 557 136	9.56%
2016	18 275 010	2 169.99	100 666 192	1 818.06	-82 391 182	18.15%
Basis index 2004/1996	5.56	1.46	4.45	1.40	4.36	N/A
Basis index 2016/2004	5.00	1.35	2.63	1.56	2.38	N/A

Source: UN Comtrade, own calculations (2018)

Table 3: Overview table export/import for HS 220421 (USD).

	EU 28 (HS 220429)					
	Export	Export unit price / tonne	Import	Import unit price / tonne	Balance	Coverage of import by export
1996	153 815	563.42	15 344 353	435.75	-15 190 538	1.00%
2004	126 786	761.78	34 112 256	486.69	-33 985 470	0.37%
2016	1 650 939	1 105.15	49 751 979	567.84	-48 101 040	3.32%
Basis index 2004/1996	0.82	1.35	2.22	1.12	2.24	N/A
Basis index 2016/2004	13.02	1.45	1.46	1.17	1.42	N/A

Source: UN Comtrade, own calculations (2018)

Table 4: Overview table export/import for HS 220429 (USD).

and Slovakia. The follow-up stage of development lasted from the year 2007 until the year 2013; it was marked by the increase in export volumes by more than 5.4-times. Slovakia was the major destination for Czech exports. The third stage featured a rapid fall in the produced quantity which also brought a drop in the total value of export. This fact was caused by the change in vintners' priorities, and the transition to the production of quality wines, which are mostly traded in the bottled (low-volume) form. In the field of export, a decrease in total imports was recorded, which was caused by the change in consumers' preferences in favour of bottled wines of higher quality. Producers from Italy and Spain were the major importers.

Trade with "Grape must" played a minor role only in the course of the monitored period, which was rather of a regional nature in the case of Czech exports. Slovakia and Poland were the major destinations of exporters. The commodity aggregation HS 220430 was imported mainly from Hungary, Italy and Spain. Grape must is a semi-product which is processed and converted into finished wine. For this reason, this item is, as compared to other wine aggregation, so small because the producers prefer trading with the final product which has a higher added value. When comparing unit prices, the export unit prices are higher. In contrast to the previous three aggregations, the difference is only minimum.

Analysis of comparative advantages

For a better understanding of Czech wine's position within the Czech Republic's international trade with the European Union, the paper provides an overview of Czech wine exports' comparative advantages analysis by done by Balassa Index. First, the presence of comparative advantages of wines in relation to the entire agrarian trade was researched. This analysis assessed "Grape must" to be the best aggregation, as it as the only one showed a long-term growing tendency. This fact was cause by the growing value of export to Slovakia, including the quantity and the financial volume. Another factor, which influenced the resulting coefficient, was the dynamics of increase in wine aggregation export. In the course of the monitored period, the total value of wine export increased 21.5-times, in contrast to the total agrarian export which rose just 8.2-times. Furthermore, the export of agrarian aggregations of the European Union grew more dynamically than in case of wine aggregations. This development resulted in the improvement of Balassa index's values. For Czech vintners, the dynamic increase in aggregations HS 220421 and HS 220429 is very promising. Results of "Grape must" must be treated with caution as a strong increase occurred after 2012.

The presence of comparative advantages was not proven in the case of particular wine aggregations in relation to the entire aggregation HS 22 (beverages and liquids). This fact is caused

by the minor position of wine export within the entire aggregation. In 2016, the share of wine in the total volume of exports to the European Union reached only 0.11% (only 0.07% in 2002). The above- mentioned aggregation was under dominating influence of foreign trade with beer and soft drinks. This result included another aspect - higher share of wine from the European Union member states (especially from important producers, such as France, Italy, Spain and Portugal) in the total export of the commodity aggregation HS 22. The average year-to-year change at particular aggregations amounted to 7.48% (HS 220410), 11.83% (HS 220421) and 13.49% (HS 220429).

As resulting from particular commodity aggregations in relation to the entire wine-sector segment (Table 5) the Czech foreign trade reaches comparative advantages in the long term in the case of wine, both in containers smaller than 2 litres and those bigger than 2 litres (with an exception in 2016). Until 2002, comparative advantages were proven, in relation to the European Union, in the case of aggregation HS 220410. However, it suffered an important decrease in exported quantity, which, alongside the increase in export by important European producers, led to the dynamic fall of this index. The relation between the aggregation "Wine in containers smaller than 2 litres" and the aggregation "Wine in containers bigger than 2 litres" is another interesting result. Since 2010, we can observe a decrease in the Balassa Index value in the case of wine above 2 litres, and a gradual

EU28 Balassa (4 chosen commodities)				
	HS-220410	HS-220421	HS-220429	HS-220430
1996	1.25504	0.94019	1.05247	0.04698
1998	2.42242	0.47157	1.68784	0.00000
2000	1.19378	0.77326	2.14711	0.00474
2002	2.16956	0.77288	0.39017	0.00000
2004	0.75946	1.20897	0.25015	0.00000
2006	0.84801	1.17300	0.19588	0.00000
2008	0.35064	0.88919	3.38652	0.00033
2010	0.20760	0.83716	3.84587	0.00292
2012	0.17397	1.04457	2.30151	0.02303
2014	0.29473	1.12075	1.64472	0.77862
2016	0.42700	1.29426	0.61743	1.90762
Basis index 2004/1996	0.61	1.29	0.24	N/A
Basis index 2016/2004	0.56	1.07	2.47	N/A
Average year-to-year change	-10.22%	3.25%	-5.19%	N/A

Source: UN Comtrade, own calculations (2018)

Table 5: Comparison between CZ and EU28 for aggregations HS 220410/21/29/30.

increase in wine with a volume below 2 litres. This tendency is caused by the change Czech producers' behaviour. They are preferring to switch from the production of large volumes of wine, with which they are not able to compete with countries, such as France, which produced 43.5 million hectolitres wine in 2016, or France, which produced even 50.9 million hectolitres wine, to the production of smaller volumes with higher quality. Such products are able to penetrate on demanding markets of important Western producers. Furthermore, the increasing tendency at the commodity aggregation HS 220430 was noticed, which began in 2008. This tendency was caused by dynamically growing exports mainly to Slovakia, where the Czech Republic exported for 18 thousand USD in 2011 (for 147 thousand USD in 2016). Observing the rate of growth in the case of particular aggregations, the position of the aggregation "Wine in containers smaller than 2 litres" seems to become stronger, which is in accordance with the tendency to produce wines of higher quality.

Resulting values of the LFI index confirmed Czech producers' and exporters' transition to the production of wine with higher added value, see Table No. 6, which is connected mainly with commodity aggregation HS 220421. Countries for this analysis were selected on the basis of two keys - an important European producer

(Italy, France, Spain, Portugal and Germany) or an important trading partner for the Czech Republic (Austria, Poland, Slovakia and Hungary). In the case of the Czech Republic, comparative advantages were proven by the aggregation "Wine above 2 litres" for most researched countries, except for Austria, Poland and Germany. In the case of Austria and Germany, the situation was caused by a very low volume of export as compared to the volume of import. Only 16 hectolitres of this aggregation were exported to Austria (3 395 hectolitres were imported) and 1 913 hectolitres to Germany (74 723 hectolitres were imported). The comparative advantage could not be proven for Poland, which was largely caused by the fact that the Czech Republic's export to its northern neighbour was diversified into all four commodity aggregations in contrast to Poland, which imported only aggregation HS 220421 to the Czech Republic.

Tables 7 and 8 present the development of product maps in the course of the monitored period. From the perspective of the Czech Republic, it would be optimal to have all aggregations in Sector A (presence of comparative advantages and positive balance of trade). This situation, however, occurred only in the case of the aggregation Grape must and only in the years 1996 and 2000. Unfortunately, for the Czech export, this concerns only an item with minimum influence on the total balance

LFI < 0			LFI > 0		
Country	Aggregation	Value of LFI 2016	Country	Aggregation	Value of LFI 2016
France	HS-220410	-0.00400	France	HS-220421	0.00460
France	HS-220429	-0.00060	Austria	HS-220410	17.06463
Austria	HS-220421	-13.81659	Spain	HS-220410	0.00001
Austria	HS-220429	-3.24804	Spain	HS-220421	0.66291
Spain	HS-220429	-0.66118	Poland	HS-220410	0.02074
Spain	HS-220430	-0.00174	Poland	HS-220429	0.01315
Poland	HS-220421	-0.03456	Poland	HS-220430	0.00067
Italy	HS-220410	-0.05695	Italy	HS-220421	0.00055
Italy	HS-220429	-0.13543	Slovakia	HS-220410	0.90947
Italy	HS-220430	-0.00151	Slovakia	HS-220421	21.34862
Slovakia	HS-220429	-22.94458	Slovakia	HS-220430	0.68649
Germany	HS-220421	-3.18303	Germany	HS-220410	1.31793
Germany	HS-220430	-0.00191	Germany	HS-220429	1.86701
Hungary	HS-220429	-3.59718	Hungary	HS-220410	0.26377
Hungary	HS-220430	-0.31108	Hungary	HS-220421	3.64449
Portugal	HS-220410	-0.00002	Portugal	HS-220421	0.00051
Portugal	HS-220429	-0.00049			

Source: UN Comtrade, own calculations (2018)

Table 6: Comparison between CZ and selected countries for aggregations HS 220410/21/29/30.

B - 1996	Export	Share in export	Import	Share in import	A - 1996	Export	Share in export	Import	Share in import
HS-220410	234 109	22.39%	2 067 220	7.95%	HS-220430	663	0.06%	0	0.00%
HS-220421	656 935	62.83%	8 588 670	33.03%					
Total	891 044	85.22%	10 655 890	40.98%	Total	663	0.06%	0	0.00%
D - 1996	Export	Share in export	Import	Share in import	C - 1996	Export	Share in export	Import	Share in import
HS-220429	153 815	14.71%	15 344 353	59.02%					
Total	153 815	14.71%	15 344 353	59.02%	Total				

Source: UN Comtrade, own calculations (2018)

Table 7: Relation between LFI and TBI, year 1996, in relation CZ x EU (USD).

B - 2016	Export	Share in export	Import	Share in import	A - 2016	Export	Share in export	Import	Share in import
HS-220421	18 275 010	81.25%	100 666 192	58.55%					
HS-220430	171 264	0.76%	1 037 321	0.60%					
Total	18 446 274	82.01%	101 703 513	59.15%	Total				
D - 2016	Export	Share in export	Import	Share in import	C - 2016	Export	Share in export	Import	Share in import
HS-220410	2 394 693	10.65%	20 490 103	11.92%					
HS-220429	1 650 939	7.34%	49 751 979	28.93%					
Total	4 045 632	17.99%	70 242 082	40.85%	Total				

Source: UN Comtrade, own calculations (2018)

Table 8: Relation LFI and TBI, year 2016, in relation CZ x EU (USD).

of foreign trade. Otherwise, wine aggregations are present only in Sectors B and D, for which the existence of negative balance of trade is a common denominator. Czech exporters do not have many possibilities to response to this situation, as they have only limited opportunities of production due to small area of vineyards in comparison to countries, such as Spain (the most important area of vineyards in the European Union, 975 thousand hectares, only 171.7 thousand hectares in the Czech Republic).

Wine below 2 litres is the major export commodity aggregation over the entire monitored period. In 1996, its share in the entire export was 62.83% (and 81.25 % in the year 2016). This aggregation is exported to Slovakia, Poland and Germany, and the export proportion to Romania has increase in the last years. From the point of view of important Western wine producers, Czech exporters succeeded to penetrate especially Spanish and Italian markets. The above-mentioned aggregation dominates even the import volumes alongside Wine above 2 litres. During the monitored years, the ratio between these items fully reversed. While in 1996, the import ratio between Wine above 2 litres and Wine below 2 litres was nearly 2:1, over selected years this ratio exactly reversed. This tendency occurred thanks to consumers' preferences. Czech consumers began to show higher interest in higher-quality sorts of wines, which are associated mainly with bottled wine.

Even though the Czech Republic was not able

to show positive balance of trade with the European Union, it succeeded in creating comparative advantages. From the year 1996 and the year 2008, the commodity aggregation "Sparkling wine" showed a comparative advantage. From the perspective of particular countries, the Czech Republic showed a comparative advantage in relation to e.g. Germany. Over time, the influence of this item decreased due to the dynamically growing turnover in the case of items HS 220421 a HS 220429. From the general point of view, it was Sector B that showed the most important share in the monitored years and whose share in the export was approximately 85% in the year 1996, and 82% in the year 2016.

As found out from the analysis of unit prices, the Czech Republic in its trade with the European Union exports for higher average unit prices, than those for which it imports. This situation has resulted from the comparison with EU 15 countries and EU 13 countries. Higher unit prices could be observed in the trade with traditional EU countries, which was caused by the higher standard of living of the inhabitants in these countries. The analysis of unit prices for particular countries against confirmed a stronger position of export unit prices in comparison to unit prices of imports. However, some exceptions were found, for example in the case of trade with Spain with commodity aggregation HS 220410. Very high unit prices were detected in the case of trade with the aggregation "Sparkling wine" with France and Italy. This situation

	unit prices HS 220410 (USD/kg)		unit prices HS 220421 (USD/kg)		unit prices HS 220429 (USD/kg)		unit prices HS 220430 (USD/kg)	
	Export	Import	Export	Import	Export	Import	Export	Import
EU 28	4.3647	3.5824	2.1700	1.8181	1.1051	0.5678	0.8754	0.7885
EU 15	4.8084	3.6204	3.4580	2.0869	1.9529	0.5201	N/A	1.3236
EU 13	3.8562	2.0787	2.1252	1.0020	1.0259	0.7006	0.8754	0.7121
Austria	33.2192	3.0687	6.0654	3.0768	4.3604	0.8057	N/A	N/A
Germany	4.9160	1.6136	3.4498	2.0138	1.9395	0.8642	N/A	2.5797
Poland	3.5266	N/A	2.7022	0.3981	2.5789	N/A	3.6052	N/A
Slovakia	4.0967	2.2438	1.8504	0.6223	0.8714	0.6935	0.8144	N/A
Hungary	3.9058	2.1756	2.2019	1.2316	0.8532	0.6867	2.9511	0.7121
France	13.1429	9.7185	3.6495	3.2410	N/A	1.8164	N/A	N/A
Italy	11.9524	2.8322	1.3850	2.4561	N/A	0.4784	N/A	1.3485
Portugal	N/A	4.8532	11.8571	3.5708	N/A	4.4134	N/A	N/A
Spain	1.7477	1.9028	5.4457	0.9383	N/A	0.5229	N/A	1.1903

Source: UN Comtrade, own calculations (2018)

Table 9: Comparison between the Czech Republic and selected groups/countries in unit prices.

confirmed an anticipation that only Czech wines of the highest quality could be able to penetrate on the demanding Western markets. Unfortunately, for Czech exporters, the export was only minimum, because only 42 litres of wine was exported to France, and only 21 litres to Italy.

Conclusion

The Czech Republic has been recorded long-term negative balance of trade in wine aggregations HS 220410 / 21 / 29 / 30. On the other hand, the dynamic growth of export value must be assessed positively, as it increased 21-times, while import value increased only 6.6-times. Looking at the territorial structure of the Czech trade in wine-sector, high dependence on the trade with the European Union member states is obvious. The most important trade partners in term of export are the neighbouring countries – Slovakia (57%), Poland and Germany. In 2016, Italian share in total wine imports reached about 28%, then Spain 26%, Hungary 12.5% and Slovakia 7%. The average inter-annual growth rate (1996 – 2016) of wine exports value reached 17.53% in the case of all four monitored aggregations together. After the year 2013, a strong export value fall was recorded. It was caused mainly by the change in Czech vintners' strategy. They started to produce high quality grapes. There are two results of new applied strategy. The first one is related to the significant volume reduction of produced wine. The second one is related to the growth of local consumption (because of better quality and increasing local demand). Speaking about import value development - during the analysed time period - the average inter-annual

growth rate of wine imports reached 10.45%. As in the case of export, the import value reduction was recorded after the year 2013. The reason was monetary intervention started by the Czech National Bank in November 2013. Aggregations HS 220421 and HS 220429 are typical because of their significant negative trade balance performance. The negative trade balance is caused mainly by the import of large volumes from wine superpowers, such as Italy and Spain. Looking at unit prices in detail, we can find out that Czech vintners succeed in exporting product of higher quality for higher prices.

The trade with “Sparkling wine” showed dynamic growth in the course of the entire monitored period. France and Italy that imported sparkling wine with the total value of 14 million USD (in the year 2016) especially participated in import flows. Czech exporters succeeded mainly in two regions (Benelux and neighbouring countries surrounding the Czech Republic). In the case of trade with “Wines below 2 litres”, it is important to mention the dynamic in the growth of export value, which regularly exceeded import value performance in the course of the monitored period. This tendency existed until 2013 and the Czech export was supported by the volume growth. After 2013, the above strategy was revised. In 2016, Slovakia was the most important export market, followed by the dynamically evolving Polish market. In the case of import of this aggregation, the most important positions were occupied by France and Italy. The aggregation “Wine above 2 litres” could be divided into three development stages. The share of exports was decreasing

over the monitored period until 2006, which was caused especially by the decrease in exports to Finland and Slovakia. The sub-sequent development stage followed between the years 2007 and 2013, whereby the export volumes increased more than 5.4-times and Slovakia was absolutely dominating. The third stage features a rapid drop in produced volume, which also brought about a fall in the total export value, which was caused by the transition to the production of high quality wines, which are merchandised mainly in bottles. The producers from Italy and Spain were the major importers. The trade with “Grape must” played only a minor role in the course of the monitored period. Exporters focussed on Slovakia and Poland, grape must was imported mainly from Hungary, Italy and Spain. Grape must is a semi-product, and the producers prefer trading with finished product, which are typical because of higher added value.

As resulting from particular commodity aggregations in relation to the wine-sector, the Czech foreign trade has reached comparative advantages in the long term in the case of wine, both in containers smaller than 2 litres and those bigger than 2 litres (with an exception in 2016). Until 2002, comparative advantages were shown, in relation to the European Union, even by aggregation HS 220410. Since 2010, we can observe a decrease in the Balassa Index value in the case of wine above 2 litres, and a gradual increase in wine with a volume below 2 litres. This tendency is caused by the changes in the Czech producers’ strategy. They try to switch

from the production of large volumes of wine to the production of smaller volume, but with higher quality and also higher unit value.

Comparative advantages and positive balance of trade could be observed solely in the case of the aggregation “Grape must” only in the years 1996 and 2000. “Wine below 2 litres” is the main commodity aggregation over the entire monitored period. In 1996, its share in the total export was 62.83% (and 81.25% in 2016). This aggregation is exported mainly to Slovakia, Poland and Germany. During the last years, the share of export in Romania has increased. From the perspective of important Western wine producers, Czech exporters penetrated mainly Spanish and Italian markets. The above-mentioned aggregation dominates also the import volumes, alongside the “Wine above 2 litres”. Over the monitored years, the ratio between these items fully reversed. While in the years 1996 the import ration between “Wine above 2 litres” and “Wine below 2 litres” was nearly 2:1, during the selected years - the ratio exactly reversed. This tendency occurred as a consequence of consumers preferences. Czech consumers began to prefer high-quality sorts of wines, which are associated mainly with bottled wine.

Acknowledgments

This article is prepared for the Internal Grant Agency project of FEM CULS Prague (20171024) – Analysis of the commodity structure of the Czech agrarian foreign trade.

Corresponding authors:

Ing. Jan Borák

Department of Economics, Faculty of Economics and Management

Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Prague – Suchbátka, Czech Republic

E-mail: borak@czu.cz

References

- [1] Balassa, B. (1965) "Trade liberalization and "revealed" comparative advantage", *The Manchester School of Economics and Social Studies*, No. 33, Vol. 2, pp. 99-123. ISSN 1049-0078. DOI 10.1111/j.1467-9957.1965.tb00050.x.
- [2] Benešová, I., Novotná, Z., Šánová, P. and Laputková, A. (2016) "Economic Comparison of Agricultural Sector of Eurasian Countries – Is There Any Potential for Development Through Economic Cooperation?", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 2, pp. 19-31. ISSN 1804-1930. DOI 10.7160/aol.2016.080202.
- [3] Dal Bianco, A., Boatto, V., Caracciolo, F. and Santeramo, F. G. (2014) "Tariffs and non-tariff frictions in the world wine trade", In: MPRA Paper No. 61813, University Library of Munich, Germany. [Online]. Available: https://mpra.ub.uni-muenchen.de/61813/1/MPRA_paper_61813.pdf [Accessed: April 24, 2018].

- [4] Dion, R. (1952) "Querelles des anciens et des modernes sur le facteurs de qualité du vin", *Annales De Géographie*, Vol. 61, No. 328, pp. 417-431. [Online]. Available: <http://www.jstor.org/stable/23442544> [Accessed: April 22, 2018].
- [5] Fleury, A. and Fleury, M. T. (2003) "Competitive strategies and core competencies: Perspective for the internationalization of industry in Brazil", *Integrated Manufacturing Systems*, Vol. 14, No. 1, pp. 16-25. DOI 10.1108/09576060310453317.
- [6] Jeníček, V. (2002) "*Globalizace světového hospodářství*" (In Czech), 1st ed., Prague, C. H. Beck. Beckovy ekonomické učebnice. ISBN 80-717-9787-1.
- [7] Kraus, V., Foffová, Z. and Vurm, B. (2005) "*Nová encyklopedie českého a moravského vína. 1. díl*" (In Czech), Prague: Praga Mystica. ISBN 80-867-6700-0.
- [8] Kuemmerle, W. (1999) "The drivers of foreign direct investment into research and development: An empirical investigation", *Journal of International Business Studies*, Vol. 30, No. 1, pp. 1-24. E-ISSN 1478-6990, ISSN 0047-2506. DOI 10.1057/palgrave.jibs.8490058.
- [9] Lafay, G. (1992) "The measurement of revealed comparative advantages", In: Dagenais, M. G. and Muet, P. A. (eds.) "*International Trade Modeling*", London, Chapman & Hill, pp. 209-234. ISBN 0412450003.
- [10] Lombardi, P., Dal Bianco, A., Freda, R., Caracciolo F. and Cembalo, L. (2016) "Development and trade competitiveness of the European wine sector: A gravity analysis of intra-EU flows", *Wine Economics and Policy*. Vol. 5, No. 1, pp. 50–59. ISSN 2212-9774. DOI 10.1016/j.wep.2015.12.002.
- [11] Peterová, J. (2013) "*Ekonomika výroby a zpracování zemědělských produktů*" (In Czech), 4th ed., Prague, CULS Faculty of Economics and Management. ISBN 978-80-213-2053-6.
- [12] Pyšný, T., Pošvář, Z. and Gurská, S. (2007) "Analysis of selected demand factors of wine market of the Czech Republic", *Agricultural Economics*, Vol. 53, No. 7, pp. 304-311. ISSN 0139-570X. DOI 10.17221/1151-AGRICECON.
- [13] Ring, P. S. and Van de Ven, A. (1994) "Developmental processes of cooperative interorganizational relationship", *Academy of Management Review*, Vol. 19, No. 1, pp. 90-118. ISSN 03637425. DOI 10.2307/258836.
- [14] Ritchie, C. (2007) "Beyond drinking: The role of wine in the life of the UK consumer", *International Journal of Consumer Studies*, Vol. 31, No. 5, pp. 534-540. E-ISSN 1470-6431. DOI 10.1111/j.1470-6431.2007.00610.x.
- [15] Rocchi, B. and Stefani, G. (2001) "Aspetti tecnologici, organizzativi e istituzionali nei processi di sviluppo rurale: alcune riflessioni", In: Basile, E. and Romano, D. (Eds.) "*Sviluppo rurale. Società, territorio, impresa*", Milan: Franco Angeli. pp. 332–352. ISBN 88-464-7961-0.
- [16] Smutka, L. and Burianová, J. (2013) "The competitiveness of Czech agrarian trade within the context of the global crisis", *Agricultural Economics*, Vol. 59, No. 4, pp. 183-193. ISSN 0139-570X. DOI 10.17221/103/2012-AGRICECON.
- [17] Smutka, L., Maitah, M. and Svatoš, M. (2017) "Changes in the Czech agrarian foreign trade competitiveness – different groups of partners' specifics", *Agricultural Economics*, Vol. 64. ISSN 0139-570X. DOI 10.17221/399/2016-AGRICECON.
- [18] Smutka, L., Svatoš, M., Tomšík, K. and Sergienko, O. I. (2016) "Foreign trade in agricultural products in the Czech Republic", *Agricultural Economics*, Vol. 62, No. 1, pp 9-25. ISSN 0139-570X. DOI 10.17221/18/2015-AGRICECON.
- [19] Smutka, L., Pawlak, K., Kotyza, K. and Svatoš, M. (2018) "Polish Sugar Industry Development", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 1, pp. 71-90. ISSN 1804-1930. DOI 10.7160/aol.2018.100107.
- [20] Smutka, L., Pulkrábek, J. and Benešová, I. (2014) "Current state of world sugar market", *Listy Cukrovarnické a Reparské*, Vol. 130, No. 2, pp. 70-76. E-ISSN 1805-9708, ISSN 1210-3306.

- [21] Syrovátka, P., Chládková, H. and Žufan, P. (2014) "Wine consumption in the Czech Republic and the prices of alcohol", *Agricultural Economics*, Vol. 60, No. 2, pp. 89–98. DOI 10.17221/114/2013-AGRICECON.
- [22] Tomšík, P. and Prokeš, A. (2011) „New strategic alliances of wine producers in the Czech Republic.“ *Agricultural Economics*. Vol. 54, No. 12, pp. 573-579. ISSN 0139-570X. DOI 10.17221/183/2011-AGRICECON.
- [23] Tomšík, P. and Sedlo, J. (2013) "Management of wine production with regard to its implementation into the wine markets of the Czech Republic", *Agricultural Economics*, Vol. 59, No. 5, pp. 202-210. ISSN 0139-570X. DOI 10.17221/125/2012-AGRICECON.
- [24] Widodo, T. (2009) "Comparative Advantage: Theory, Empirical Measures And Case Studies", *Review of Economic and Business Studies*, Vol. 2, No. 2, pp 57-82. ISSN 1843-763X.
- [25] Woodward, D. and Rolfe, R. (1993) "The location of export oriented foreign direct investment in the Caribbean basin“, *Journal of International Business Studies*, Vol. 24, No.1, pp. 121. E-ISSN 1478-6990, ISSN 0047-2506.
- [26] Zaghini, A. (2003) "Trade advantages and specialization dynamics in acceding countries“, Working Paper No. 249, European Central Bank, Frankfurt am Main: 4-15, ISSN 1725-2806.

Evaluation of Satellite Imagery to Increase Crop Yield in Irrigated Agriculture

Michael Hoffmann¹, Yaryna Butenko¹, Seydou Traore²

¹ Institute of Water Problems and Land Reclamation, Kiev, Ukraine

² Department of Biological & Agricultural Engineering, Texas A&M University

Abstract

The main aim of this study was to work out a satellite-imagery based approach that can be used to improve agricultural crop growing on a bigger-scale and on field level. Instead of working on small experimental fields, various vast farms have been selected, which were ready to cooperate for this study. Especially for the dry south of Ukraine, vegetation and soil indices provide useful information to improve crop development and productivity. However, many index variants produce similar results or unclear structures; therefore, their information content is restricted under practical conditions. The results analysis shows that a few indices are sufficient to regularly monitor irrigated fields. Talks with farmers revealed that advice is mainly needed to secure crop growth, leading to the decision to firstly select the indices NDVI and/or EVI. To detect failures in an early stage, we additionally used DIRT, NDRE, LAI, NMDI and OSAVI. NMDI could also be used to monitor irrigation activities. This article provides examples illuminating the implemented methodology.

Keywords

Remote sensing (RS), NDVI, vegetation index, irregular crop growth, satellite imagery, irrigation

Hoffmann, M., Butenko, Y. and Traore, S. (2018) "Evaluation of Satellite Imagery to Increase Crop Yield in Irrigated Agriculture", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 45-55. ISSN 1804-1930. DOI 10.7160/aol.2018.100304.

Introduction

Satellite imagery is increasingly used to optimize agricultural production (De Solan et al., 2012). Since the launch of the first Landsat satellite in 1972, agricultural monitoring has been implemented and improved worldwide (USGS, 2017). The aim of those activities was related to providing information on global or countrywide crop production, agricultural water use (irrigation), state statistic services and so far. On a smaller scale, satellite imagery was used for consulting of private farmers. Benedetti and Rossini (1993) selected NDVI and a regression model to predict best crop yield while other authors preferred PVI in combination with a Neural Network model for crop yield forecast (Panda et al., 2010).

The focus of this paper was not only on monitoring of crop growth but also the determination and optimization of some influential factors on field level while providing an overview on big agricultural areas. In our investigation area, located in south Ukraine, the number of fields and maximal

distances between them (up to 156 km straight line) were too big for regular field monitoring. This is however important as climatic conditions (Weather Online, 2017; FAO, 2017) require the application of irrigation (Frenken and Gillet, 2012; Bastiaanssen et al., 2000) and appropriate investments in its infrastructure and energy consumption (Duran et al., 2014). Facing a big number of different crops, as well as various types of available satellite imagery and modeling software, it becomes challenging to think of the best management approach while taking into account farmers requirements (De Solan et al., 2012). The data flow has to be quick and frequent enough to support precision agriculture and, as far as possible, irrigation management. We therefore used three different satellites facing the disadvantage that the singular bands' radiation spectra and resolutions are not identical (Congedo 2016), but fortunately results of index calculation differ only slightly (Mandanici and Bitelli, 2016). Because of the big distances between the fields, the images covered only smaller parts of the study area at different times. In addition, soil and weather

conditions were often different, even if fields were not far from each other, like a few hundred meters.

The objective of this work was to assess various vegetation indices, besides the commonly used Normalized Difference Vegetation Index (NDVI), to clarify reasons of reduced or uneven growth as can be caused for example by weeds, and, if possible, to take countermeasures. It was preferable to provide such information visually and/or enable calculation and assessment of boundary conditions that might be necessary to be changed to optimize crop growth. Results must be applicable in spite of strong differences between the most important crop types in terms of sowing date, growth forms, growth speed and state before harvest. We therefore put efforts on answering those questions as far as possible and provide advices for future improvements, determine irrigation need and, eventually, expected crop yield.

Taking into account all these circumstances, the challenge was to get as much as possible information out of the combined use of satellite imagery even under unfavorable preconditions, to detect and overcome the shortcomings and to use it for applied agricultural purposes. Last, not least, consulting costs-performance ratio had to be attractive for farmers with respect to the overall agricultural profitability.

Materials and methods

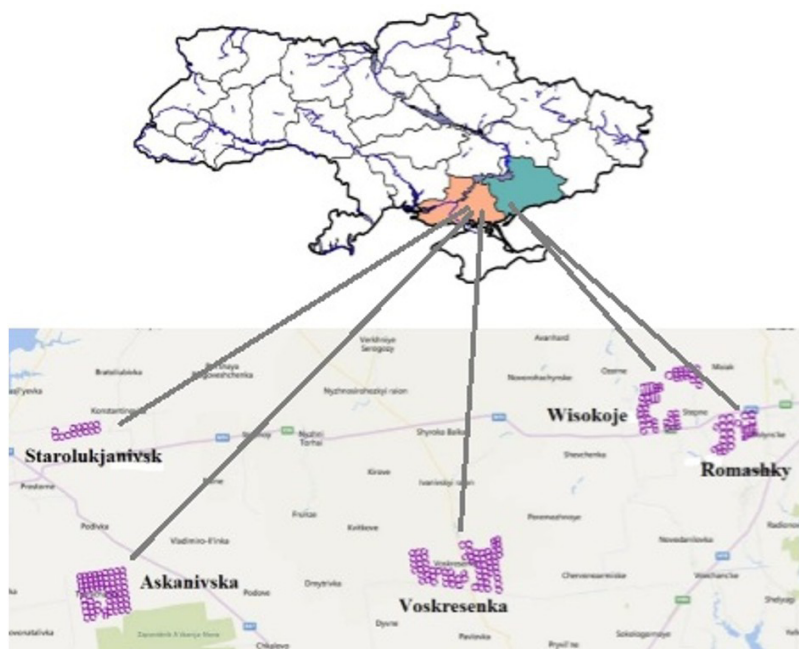
Study area and investigation period

In this study, the research team closely cooperated with individual growers and technical staff of large farms. Five farms were chosen for the study with more than 240 fields and a size per field of 50-100 ha in the region of Kherson and Zaporizhia Oblast (province) in south Ukraine (Figure 1). They are largely flat, only a few fields are uneven showing heights differences (depressions) of up to 4 m. The climate is rather dry with precipitations of 300-450 mm per year and often-violent thunderstorms in summer (FAO, 2017).

Imagery conversion and evaluations were performed occasionally in 2013, monthly in 2016 and 2017 during the winter months and as often as possible, about three to five times per month, during the vegetation period.

Data sources

In order to reduce costs, only free of charge satellite imagery was used. The selected satellites were Landsat 8 OLI/TIRS (further abbreviated Ls8), in a few cases Landsat7 ETM+ (Ls7) and the European satellite Sentinel 2a (S2a). The sensors, carried by these satellites, are described in (NASA and USGS, 2017; ESA, 2017;



Source: own processing

Figure 1. Location of farms in south Ukraine; distance Askanivska – Romashky straight line about 150km.

Wang et al., 2017). The images are composed of series of bands covering defined sections of the visible and infra-red electromagnetic spectrum of solar radiation; they are available with sufficient resolution (Ls8: 30 and 100m per pixel; S2a: 10, 20 and 60m) depending on the layer (band number). Further details about selection and download are available on several websites (USGS, 2017). For selection and download, the open source software (QGIS v. 2.18.15) together with the plugin “Semi-automatic Classification Plugin” (SCP, version 5.3.10) (Congedo, 2017) was used. For technical reasons since May 2017, Ls8 images could only be downloaded from the *Earthexplorer* website (USGS websites, 2017). Since September 2017, *Landsat Surface Reflectance High Level Data Products* were additionally available on demand including a selection of seven spectral indices and temperature; (for details see *ESPA*, 2017). To detect topographical unevenness Google Earth Pro, version 7.3.0.3832 was used first, and besides, results of the Shuttle Radar Topographic Mission (SRTM) (CGIAR-CSI, 2017) to prepare a digital elevation model (DEM) and calculate possible ditch courses using the modeling software AVSWATx (Arnold et al. 1998).

Data pre-processing

In addition to the SCP, a second QGIS plugin, “RS&GIS-17”, version 0.4 (Barane and Dwarakish, 2017) was used for data processing. Both plugins support various file types of satellite bands, clipping to smaller areas and their conversion from DN files to radiance and top of atmosphere reflectance being required to calculate spectral indices, albedo and temperature. For atmospheric correction, SCP uses the *Dark Object Subtraction 1* (DOS 1) method (Chavez, 1996). When clouds and/or their shadows were visible, they have been masked with the QGIS plugin Cloud Masking (Corredor-Llano, 2017) and excluded from statistical raster calculation. Fields, covered by clouds and/or cloud shadows by more than about half, have been completely removed from the analysis. RS&GIS-17 can use compressed Landsat files as provided for download and provides the possibility to account for clouds and cirrus. Results obtained when using the two plugins and the high level data products differ only slightly but it is not necessary to consider them in practice when comparing results, as other impacts can play a much bigger role. (For more detailed comparative studies, see Mandanici and Bitelli, 2016; Congedo, 2016). In addition, ENVI, software version 5.4, was occasionally used

for in-depth analysis of scatter plots.

For our study, NDVI has always been calculated first as main index for comparison of crop fields. Thereafter, a broader spectrum of indices was selected to test their usefulness with respect to quite different crop types and growth problems, and to enhance interpretation of results:

- Difference Index with Red Threshold (DIRT)
- Enhanced Vegetation Index (EVI)
- Leaf Area Index (LAI)
- Normalized Multi-band Drought Index (NMDI)
- Normalized Difference Red Edge Index (NDRE)
- Optimized Soil Adjusted Vegetation Index (OSAVI)

These indices are not further described here because a big number of related publications is already available. Indices, selected for in-depth studies, and used calculation methods are listed in the Table 1. Results are visualized as colored raster, but for further assessments and comparisons, statistical parameters for each singular field and culture were additionally calculated. In many cases, the various pixel values are not evenly and not normally distributed within singular fields and accordingly non-parametric statistics had to be applied. For our work, the 50-percentile (median) has been calculated (using QGIS *zonal statistics*) and the *Spearman rank correlation coefficient* to determine the relation between various indices. The interrelation between indices was visualized as scatterplots using the QGIS plugin *Raster_Best_Fit_Scatterplot* (Brom, 2015), *ENVI* v.5.4 and the MS windows program *Statistica* 8.

Results and discussion

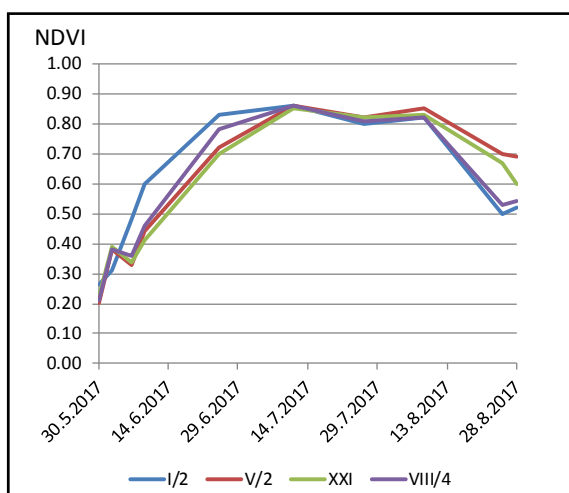
Visualization of irregular crop growth

The prevalent vegetation index NDVI was regularly determined using Ls8, Ls7 and S2a imagery. For the diagram (Figure 2), four obviously well growing maize fields, located in the Askanivska complex, were selected; unusable image sections (fields) with clouds or cloud shadows were masked out and only typical time series curves were obtained.

Index	Formula	Reference
DIRT	$\text{np. sign}(\beta - \text{band4}) * (\text{band5} - \text{band4}) / (\text{band5} + \text{band4}) \quad \{\beta=0.12\}$ {bands provided by Landsat 8 OLI/TIRS}	Langner et al., 2016
EVI	$\text{band3} * (\text{band5} - \text{band4}) / (\text{band5} + \text{C1} * \text{band4} - \text{C2} * \text{band2} + \text{L})$ {C1=6.0 ; C2=7.5 ; L=1} {bands provided by Landsat 8 OLI/TIRS}	Matsushita et al., 2007
LAI	$3.618 * \text{EVI} - 0.118$	Goswami et al., 2015
NDVI	$(\text{band5} - \text{band4}) / (\text{band5} + \text{band4})$ {bands provided by Landsat 8 OLI/TIRS}	Meera Gandhi et al., 2015
NMDI	$\text{band8A} - (\text{band11} - \text{band12}) / \text{band8A} + (\text{band11} - \text{band12})$ {bands provided by Sentinel 2a }	Wang and Qu, 2007
NDRE	$(\text{band8} - \text{band6}) / (\text{band8} + \text{band6})$ {bands provided by Sentinel 2a }	Tilling et al., 2007
OSAVI	$1.16 * (\text{band5} - \text{band4}) / (\text{band5} + \text{band4} + 0.16)$ {bands provided by Landsat 8 OLI/TIRS}	Rondeaux et al., 1996

Source: own processing

Table 1. List of used indices and band calculation formulas; abbreviations: B – blue, G – green, R – red, NIR – near-infrared.



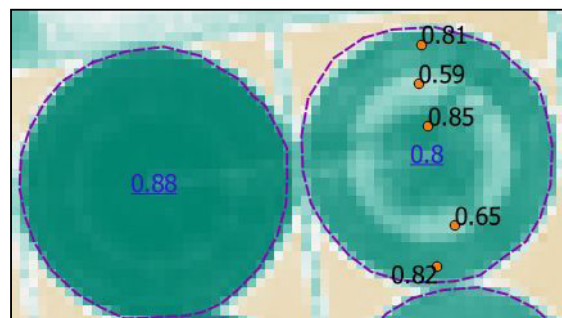
Source: own processing

Figure 2: Result of NDVI monitoring (50-percentiles) of four maize fields, days of irrigation excluded.

As monitoring showed, NDVI pixels are not evenly distributed over the farm fields because of man-made influences and also natural irregularities. This implies technical and irrigation management problems on the one hand and variability of soil quality, weather conditions, topography etc. on the other. The detection of problems on the huge farm areas using satellite imagery is quick and favorable and can have an advantage for better crop yields as shown in figures 3-5, illustrated herein as typical examples.

In figure 3, we found that irregular growth was due to a lack of optimal operation of a Fregat sprinkler machine (Fregat, 2018) on soy fields in the Wisokoje complex. As can be seen, the water distribution was partly defective or at least inadequate. To assess these irregularities, singular pixel values have been identified for further analysis. The sprinkler

machine was controlled and had to be repaired.



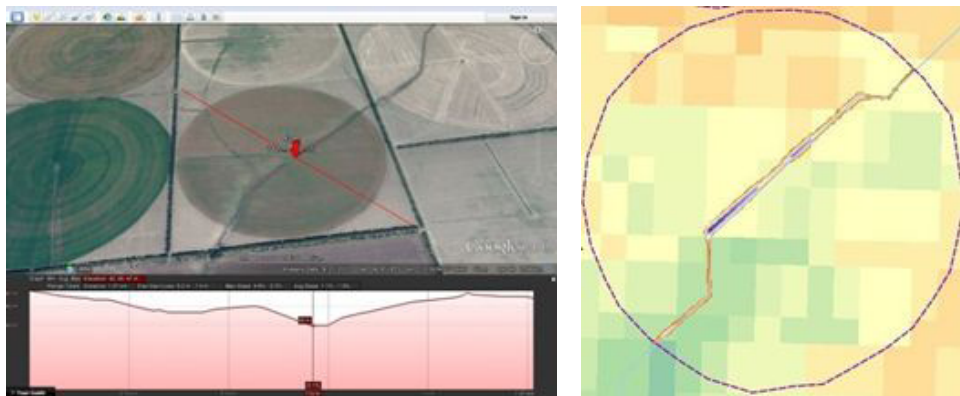
Source: own processing

Figure 3: Soy fields with indication of the 50-percentil of NDVI in blue, (Ls8 imagery from August 9, 2016); a) regular crop growth, b): irregular growth; figures indicate singular NDVI pixel values.

Figure 4 shows growth differences caused by topographical unevenness on a field of the Wiskoje complex, (a) shown with Google Earth Pro, and (b), by using a DEM based on SRTM data. According to Fournier (1967), cited in Roose, (1996) rain can cause erosion even on gentle slopes (like 2%). Moreover, soil characteristics are changed and crop growth altered. In our study (also Wiskoje, in 2017), we found ditches with bank slopes up to 4%; they drain neighboring fields and can change their productivity. The yields (weights) of soybean grains on two fields neighboring such a ditch were 6% resp. 11% higher than on the two higher adjacent fields.

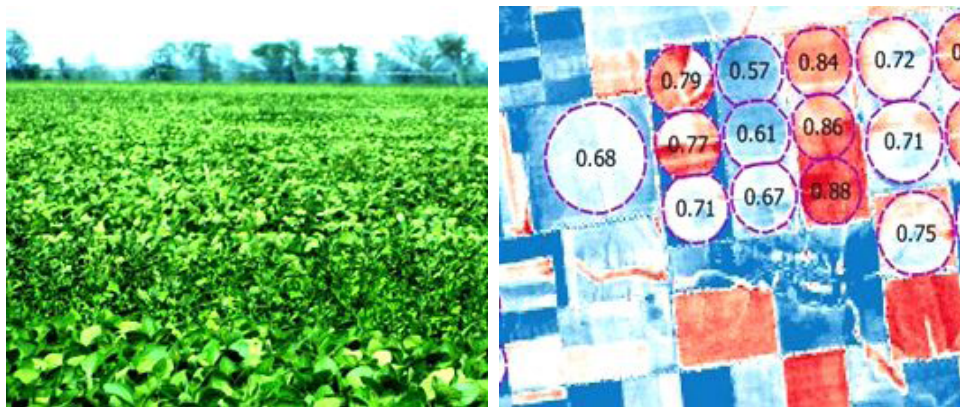
Another, more frequent problem is the growth of weeds or other irregularities as visible on Figure 5. For this purpose, Langner et al. (2016) have proposed to calculate DIRT that should indicate the dispersion of weed on mulched fields.

Besides, the various types of crop growth



Source: own processing

Figure 4: Irregular crop growth caused by erosion in the field; a): visualization of an overgrown water ditch, (top view and cross-section by Google Earth); b): DEM (pixel size 90m) of the same field and ditch course.



Source: own processing

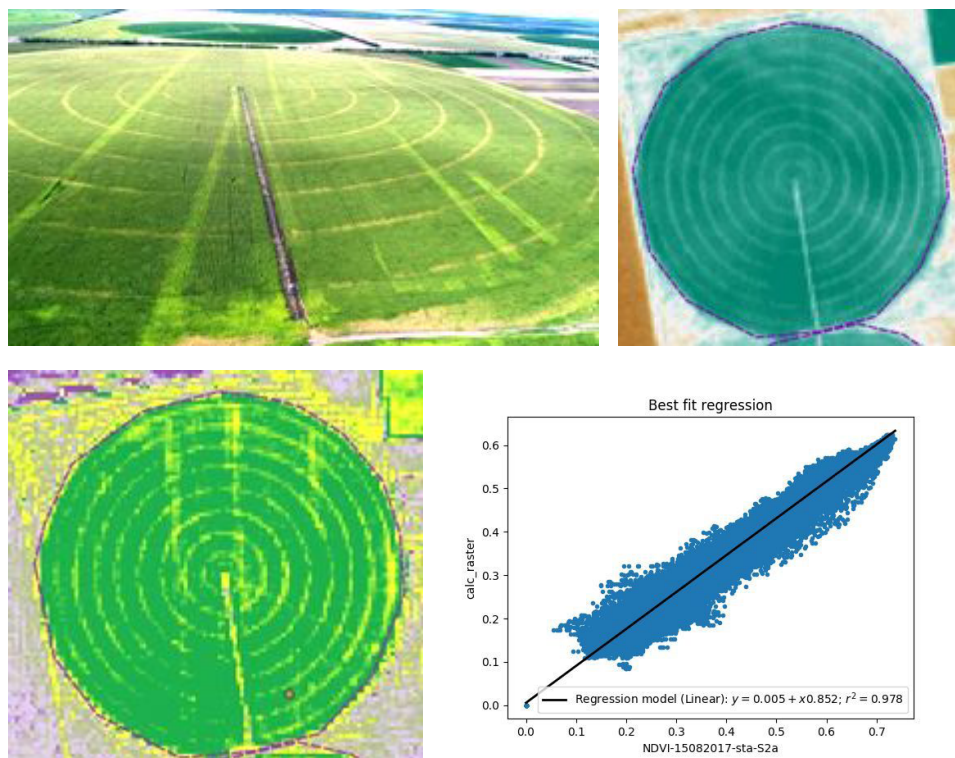
Figure 5: Unidentified irregularities as shown by a photo (a) and by DIRT (b), Ls8 imagery, June 9, 2017; Wisokoje.

and crop-similar weeds can cause uncertainties. Therefore, the results are considered only as hint on a noticeable deviation from vegetative growth standard (less clearly shown by NDVI). However, in modern agriculture weed is mostly suppressed by herbicides. For regular monitoring and reliable interpretation DIRT maps require additional experts' surveying on-site.

Another reason for growth irregularities appears when chemicals are distributed unevenly on the field. Figure 6a shows green-yellow stripes across a maize field; they appeared on the Starolukianivka complex in August 2017. Figure 6b and 6c show S2a images, used for NDVI and NDRE calculation, one day earlier.

As can be seen, the NDRE raster (Figure 6c) is significantly more suitable than the NDVI raster (Figure 6b) to detect these anomalies in spite of the fact that the scatterplot (Figure 6d) shows a good correlation between the two indices.

The reasons for the yellow stripes can be manifold and require analyses that are more detailed. A first field visit did not give any hints on parasite effects. In comparison with unaffected plants, affected ones showed brightening and growth impairment. In many cases, a deficit of certain plant nutrients because of uneven distribution of azote or other fertilizers can cause yellowing and growth reduction, as more precisely documented in special manuals as for example in the "Corn Diagnostic Guide" (Iowa State University, 2017). The so far shown imagery demonstrates that various typical agricultural shortcomings can be detected providing the opportunity for taking countermeasures.



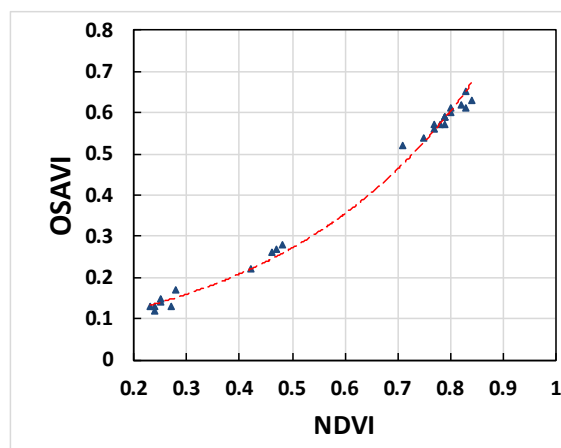
Source: own processing (a) Photography taken from helicopter (on August 15, 2017, Starolukjanivka), b) NDVI), c) NDRE, yellow color showing growth reduction, d) NDRE(y)-NDVI(x) scatterplot (print screen)

Figure 6. a) Growth disturbance as seen from helicopter, b) and c) NDVI raster and NDRE raster of the same field one day earlier, (d) NDRE – NDVI scatterplot, (based on b) and c)).

Rough assessments of soil moisture and crop yield

The following evaluations have provided additional insights being relevant for agricultural consulting. At the beginning of the vegetation period, uncovered soil and vegetation are mixed and NDVI allows only a semi-quantitative assessment. Later in the year, depending on the crop type, NDVI reaches a saturation plateau (at values > 0.6) and can lead to an underestimation of biomass and possible yield (Gu et al., 2013). Various different alternative indices have been described in the literature to overcome this disadvantage: a. o. ENDVI (Sentek Systems, 2015), OSAVI (Rondeaux et al., 1996), PVI (Bannari et al., 1995), SAVI (Huete, 1988), RDVI (Roujean and Breon, 1995); but the suitability of those indices depends very much on the crop type, growth state, soil cover degree and other parameters that can change from field to field. We therefore also tested and finally preferred the OSAVI and determined NDVI, ($n=15$ in 2016, $n=11$ in 2017,) in parallel as shown in figure 7. In the range of OSAVI medians between 0.6 and 0.7, crop growth assessment must take into account an underestimate of NDVI

by about 0.2 for a mixture of different fields (Wisokoje complex between May 25 and August 12, 2017).



Source: own processing

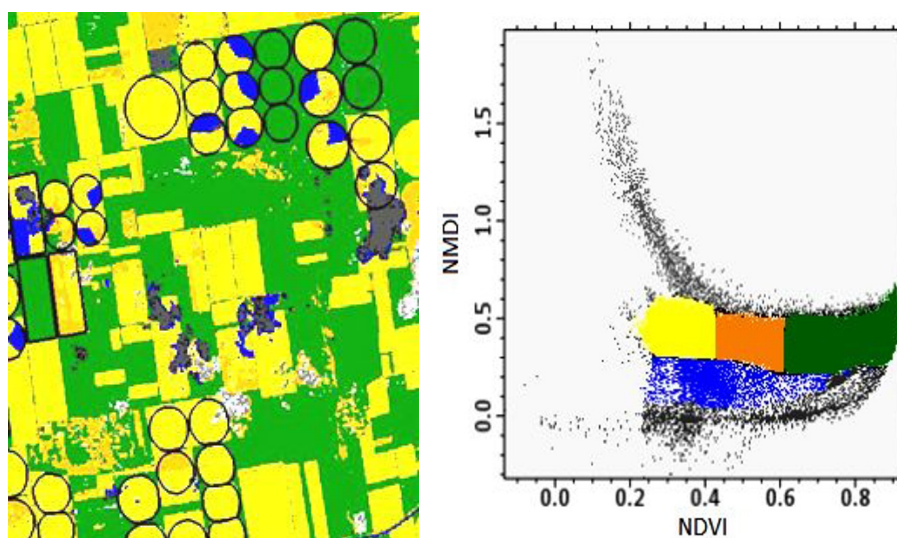
Figure 7. Relation between 50-percentiles of OSAVI and NDVI for various crop fields.

As crop growth is strongly dependent on soil moisture we also made attempts to assess this impact calculating moisture indices such as MI (Dupigny-Giroux and Lewis, 1999), NMI (Pandolfo

et al., 2017), NDMI (IDB, 2017), SMI (Hogg et al., 2013; Potić et al., 2017), MSI (IDB, 2017) and WDI (Sánchez et al., 2016). However, in case of dense crop growth, the result is, above all, related to moisture contained in the leaf internal structures. Soil moisture in the root zone or at least on the soil surface is not or not sufficiently indicated e.g. to support decision making for irrigation management; instead, special sensors can better determine it in situ. As replacement solution, the NMDI was additionally tested. It shows notably dry condition **for vegetation** when pixel values are < 0.6 and notably dry condition of **bare soils** with pixels > 0.75 , while intermediate pixel values appear to be less meaningful (Wang and QU, 2007). Figure 8a shows a NMDI map as of May 24, 2017, located in the Wisokoje complex at the beginning of the irrigation period. The dark blue triangles show the start of sprinkler

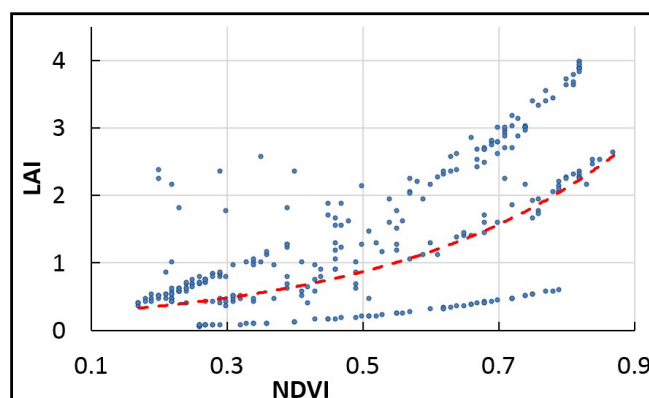
irrigation. Strong droughts are not usual at this time of the year, and during the vegetation period, droughts are combatted in time by applying irrigation. Figure 8b shows the relation of NDVI and NMDI in the form of a scatterplot where dark blue pixels are related to the blue pixels in the NMDI raster. Following, one can resume that NMDI, under certain conditions (as mentioned earlier), can indicate strong drought, but can also be useful to supervise the irrigation progress.

Besides soil moisture, farmers are especially interested in expected harvest of different cultures e.g. in terms of biomass. RS imagery can only provide vegetation indices like NDVI or EVI that correlate with the “Leaf Area Index” (LAI) (Wang et al., 2005). As shown in Figure 9, this relation is strongly influenced by the growth form of different crop cultures.



Source: own processing

Figure 8. a) Example of a NMDI raster; green -winter wheat, yellow and brown -soy and partly weed at different early growth stages b) NMDI-NDVI scatterplot; grey and black colors show cloud and cloud shadow pixels, blue irrigated sectors as visible in a).



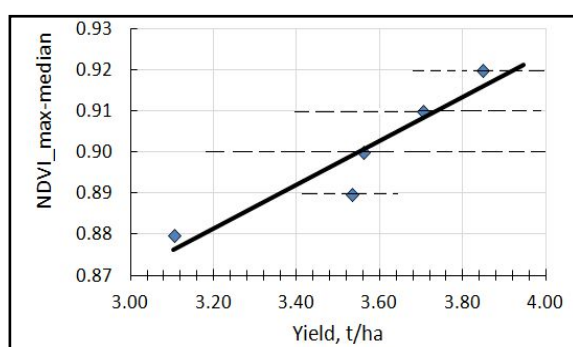
Source: own processing

Figure 9. LAI-NDVI regression (50-percentiles of different crops, near Wisokoje), Sept. 9, 2013.

According to Goswami et al. (2015), the magnitude of biomass can then be assessed by the formula

$$\text{Biomass} = 38.6 \cdot \text{LAI} - 21.2$$

Based on these results, the question was posed if merely NDVI can provide a rough hint on the expected harvest of singular crops as was reported earlier by Benedetti and Rossini (1993). As an example, we selected the weight of soybean grains (not the total plant biomass) that the Wisokoje farm harvested in 2017 from 34 different fields. The NDVI medians were analyzed at the time of maximal crop growth (July 2017), then averaged and compared with the soybean weights. The average grain yield (in tons/ha) showed up to correlate well with the maximal NDVI median averages ($r^2 = 0.88$; $p = 0.05$; $n = 34$). These first results, as shown in figure 10, show this rough relationship but the investigation needs to be continued to get more specific input data for various cultures and evaluations in the future.



Source: own processing

Figure 9. LAI-NDVI regression (50-percentils of different crops, near Wisokoje), Sept. 9, 2013.

Conclusion

The work described here is mainly practice oriented, thought to help making daily fieldwork more efficient and increase agricultural productivity in cooperation with big farms. As to our knowledge, such an approach was not reported before

in Ukraine. The challenge was to include vast field complexes being under different growth conditions. When firstly monitoring NDVI, irregular or unclear structures became quite often visible. Possible reasons could be limited by mapping several other vegetation indices and thus, improved crop growth could be achieved. For this purpose, vegetation index medians were calculated to assess crop growth more accurately for each singular field and to ease comparisons between fields. In case of uneven or insufficient crop growth, further indices were used, e. g. to reduce the influence of uncovered soil on the map (OSAVI), puddles or excess moisture (NMDI). Terrain unevenness, leading to water accumulation and humidity, were simply shown by a DEM and slope calculations (Google Earth). Further disturbances appeared when fertilizers were distributed unevenly. Thereupon, crop growth was impaired, best visible on a NDRE raster.

Farmers' request on potential crop yields was answered approximately and, for the time being, only for expected soybean yields. Our results have shown that a rough estimation of the grain weights is possible when taking into account the mean NDVI-medians at the time of maximal crop growth. During the vegetation period, satellite imagery was not used to calculate the evaporation balance as needed for irrigation planning; instead, we created a new irrigation model ("GIS-Poliv", 2018), but this will be validated only in further research and was therefore not reported here.

Acknowledgments

The authors want to thank the United State Department of Agriculture, Borlaug International Agricultural Science and Technology Fellowship Program and Texas A&M University for providing funds for personnel training and purchasing of software used for the work in this article. For consultation and technical supports, we are grateful to all our colleagues of the division Sustainable development and use of reclaimed territories, especially to the head of division Dr. Olga Zhovtonog.

Corrsponding authors

Dr. rer. nat. Michael Hoffmann

Institute of Water Problems and Land Reclamation

Vasylkivska Street 37, 03022 Kiev, Ukraine

Phone: +380989558916, E-mail: Mi-Hoffmann@gmx.net

References

- [1] Arnold, J. G., Srinivasan, R., Muttiah, R. S. and Williams, J. R. (1998) "Large area hydrologic modelling and assessment, part I: model development", *Journal of American Water Resources Association*, Vol. 34, pp. 73–89. E-ISSN 1752-1688. DOI 10.1111/j.1752-1688.1998.tb05961.x.
- [2] Bannari, A., Morin, D., Bonn, F., and Huete, A. (1995) "A review of vegetation indices", *Remote Sensing Reviews*, Vol. 13, No. 1, pp. 95-120. DOI 10.1080/02757259509532298.
- [3] Barane, P. and Dwarakish, G. S. (2017) "*Bridging the gap between potential and actual use of satellite data*", Plugin Repository [Online]. Available: https://github.com/PrathamGitHub/NITK_RS-GIS_17/blob/master/Information.pdf [Accessed: 23 Feb. 2018]
- [4] Bastiaanssen, W.G.M., Molden, D.J. and Makin, I.W. (2000) "Remote sensing for irrigated agriculture: Examples from research and possible applications", *Agricultural Water Management*, Vol. 46, No. 2, pp.137-155. ISSN 0378-3774. DOI 10.1016/S0378-3774(00)00080-9.
- [5] Benedetti, R. and Rossini, P. (1993) "On the use of NDVI profiles as a tool for agricultural statistics: The case study of wheat yield estimate and forecast in Emilia Romagna", *Remote Sensing of Environment*, Vol. 45, No. 3, pp. 311-326. ISSN 0034-4257. DOI 10.1016/0034-4257(93)90113-C.
- [6] Brom, J. (2015) "*Raster Best Fit Scatterplot for QGIS*" [Online]. Available: <http://www.jbrom.smoothcollie.eu/> [Accessed: 23 Feb. 2018].
- [7] CGIAR-CSI (The CGIAR Consortium for Spatial Information) (2017) [Online]. Available: <http://srtm.csi.cgiar.org/> [Accessed: 23 Feb. 2018].
- [8] Chavez, P. S. (1996) "Image-based atmospheric corrections - revisited and improved", *Photogrammetric Engineering and Remote Sensing*, Vol. 62, No. 9, pp. 1025-1036.
- [9] Congedo, L. (2016) "*Semi-Automatic Classification Plugin Documentation*". pp.198. [Online]. Available: https://www.researchgate.net/publication/307593091_Semi-Automatic_Classification_Plugin_Documentation_Release_6011. [Accessed: 23 Feb. 2018]. DOI 10.13140/RG.2.2.29474.02242/1.
- [10] Congedo, L. (2017) "*Landsat 8 Surface Reflectance: a Comparison of DOS1 Correction and USGS High Level Data Products*". [Online]. Available: <https://fromgistors.blogspot.com/2015/01/landsat-8-surface-reflectance.html?spref=yml> [Accessed: 23 Feb. 2018].
- [11] Corredor-Llano, X. C. (2017) "*Cloud masking*", [Online]. Available: <http://plugins.qgis.org/plugins/CloudMasking/> [Accessed: 23 Feb. 2018].
- [12] De Solan, B., Lesergent, A.D., Gouache, D. and Baret, F. (2012) "*Current use and potential of satellite imagery for crop production management*" [Online]. Available: www.google.com.ua/l?ursa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjG1NXM367XAhVPPFAKHsVBz0QFggxMAA&url=http%3A%2F%2Fec.europa.eu%2FdocsRoom%2Fdocuments%2F432%2Fattachments%2F1%2Ftranslations%2Fen%2Frenditions%2Fnative&usg=AOvVaw3QmcBqsid0qerTe-Hfiqs2 [Accessed: 23 Feb. 2018].
- [13] Hogg, E. H., Barr, A. G. and Black, T. A. (2013) "A simple soil moisture index for representing multi-year drought impacts on aspen productivity in the western Canadian interior", *Agricultural and Forest Meteorology*, Vol. 178–179, No. 15, pp. 173-182, ISSN 0168-1923. DOI 10.1016/j.agrformet.2013.04.025.
- [14] Huete, A. R. (1988) "A soil-adjusted vegetation index (SAVI)", *Remote Sensing of Environment*, Vol. 25, No. 3, pp. 259-309. DOI: 10.1016/0034-4257(88)90106-X.
- [15] IDB (Index Data Base) (2017) "*Simple Ratio 1600/820 Moisture Stress Index (MSI)*", [Online]. Available: <https://www.indexdatabase.de/db/i.php> [Accessed: 23 Feb. 2018].
- [16] Iowa State University (2017) "*Corn Diagnostic Guide*", [Online]. Available: <https://www.aganytime.com/dekalb/tools/Documents/CornDiagnosticGuide.pdf> [Accessed: 23 Feb. 2018].

- [17] Langner, H., Böttger, H. and Schmidt, H. (2016) "Difference Index with Red Threshold", ResearchGate 09, [Online]. Available: <https://www.researchgate.net/search.Search.html?type=publication&query=Difference%20Index%20with%20Red%20Threshold> [Accessed: 23 Feb. 2018].
- [18] Mandanici, E. and Bitelli, G. (2016) "Preliminary Comparison of Imagery for a Combined Use", *Remote Sensing*, Vol. 8, pp. 1014; [Online]. Available: www.mdpi.com/journal/remotesensing [Accessed: 23 Feb. 2018]. ISSN 2072-4292. DOI 10.3390/rs8121014.
- [19] Matsushita, B., Yang, W., Chen, J., Onda, Y. and Qiu, G. (2007) "Sensitivity of the Enhanced Vegetation Index (EVI) and Normalized Difference Vegetation Index (NDVI) to topographic effects: a case study in high-density Cypress forest", *Sensors (Basel)*, Vol. 5, No. 7, pp. 2636–2651. ISSN 1424-8220. DOI 10.3390/s7112636.
- [20] Meera Gandhi, G., Parthiban, S., Thummalu, N. and Christy, A. (2015) "NDVI: Vegetation change detection using remote sensing and GIS – A case study of Vellore District", *Procedia Computer Science*, Vol. 57, pp.1199 – 1210. ISSN 1877-0509. DOI 10.1016/j.procs.2015.07.415.
- [21] NASA and USGS (2017) "Landsat". [Online]. Available: <http://eoedu.belspo.be/en/satellites/landsat.htm> [Accessed: 23 Feb. 2018]
- [22] Panda, S., Ames, D. and Panigrahi, S. (2010) "Application of Vegetation Indices for Agricultural Crop Yield Prediction Using Neural Network Techniques", *Remote Sensing*, Vol. 2, pp. 673-696. ISSN 2072-4292. DOI 10.3390/rs2030673.
- [23] Pandolfo, A., Antunes, P. and Gong, X. (2017) "Using Landsat TM data for soil moisture mapping" [Online]. Available: https://mafiadoc.com/vegetation-mapping-with_59cceed81723ddd52081b506.html [Accessed: 23 Feb. 2018].
- [24] Potić, I., Bugarski, M. and Matić-Varenica, J. (2017) "Soil Moisture Determination using Remote Sensing data for the property protection and increase of agriculture production", Paper presented at the "Worldbank conference on land and poverty", The World Bank, Washington DC, March 20-24, 2017.
- [25] Rondeaux, G., Steven, M. D. and Baret, F. (1996) "Optimization of Soil-Adjusted Vegetation Indices", *Remote Sensing of Environment*, Vol. 55, No. 2, pp. 95-107. ISSN 0034-4257. DOI 10.1016/0034-4257(95)00186-7.
- [26] Roujean, J.-L. and Breon, F.-M. (1995) "Estimating PAR absorbed by vegetation from bidirectional reflectance measurements", *Remote Sensing of Environment*, Vol. 51, No. 3, pp. 375–384. ISSN 0034-4257. DOI 10.1016/0034-4257(94)00114-3.
- [27] Sánchez, N., González-Zamora, A., Piles, M. and Martínez-Fernández, J. (2016) "A new soil moisture agricultural drought index (SMADI) integrating MODIS and SMOS products: a case of study over the Iberian Peninsula", *Remote Sensing*, Vol. 8, No. 4, ISSN 2072-4292. DOI 10.3390/rs8040287.
- [28] Sentek Systems website (2015) "Comparisons-between-NDVI", [Online]. Available: <http://www.senteksystems.com/2015/11/25/> [Accessed: 23 Feb. 2018]
- [29] Tilling, A. K., O'Leary, G. J., Ferwerda, J. G., Jones, S. D., Fitzgerald, G. J., Rodriguez, D. and Belford, R. (2007) "Remote Sensing of nitrogen and water stress in wheat", *Field Crops Research*, 2007, Vol. 104, No. 1-3, pp. 77-85. ISSN 0378-4290. DOI 10.1016/j.fcr.2007.03.023.
- [30] USGS (2017) "Landsat and Agriculture - Case Studies on the Uses and Benefits of Landsat Imagery in Agricultural Monitoring and Production" [Online]. Available: <https://pubs.usgs.gov/of/2017/1034/ofr20171034.pdf> [Accessed: 23 May. 2018].
- [31] USGS (2017) "Landsat Provides Near Real-Time Global Agricultural Analysis" [Online]. Available: <https://landsat.usgs.gov/landsat-global-agricultural-analysis> [Accessed: 23 May. 2018].
- [32] USGS websites (2017) [Online]. Available: <https://landsat.usgs.gov> and <http://earthexplorer.usgs.gov/> [Accessed: 23 Feb. 2018]

- [33] Wang, L. and Qu, L.L. (2007) “NMDI: A normalized multi-band drought index for monitoring soil and vegetation moisture with satellite remote sensing”, *Geophysical Research Letters*, Vol. 34, No. 20, E-ISSN 1944-8007. DOI 10.1029/2007GL031021.
- [34] Wang, Q., Adikua, S., Tenhunena, J. and Granierb, A. (2005) “On the relationship of NDVI with Leaf Area Index in a deciduous forest site”, *Remote Sensing of Environment*, Vol. 94, No. 2, pp. 244-255. ISSN 0034-4257. DOI 10.1016/j.rse.2004.10.006.
- [35] Wang, Q., Blackburn, G. A., Onojeghuo, A. O., Dash, J., Zhou, L., Zhang, Y. and Atkinson, P. M. (2017) “Fusion of Landsat 8 OLI and Sentinel-2 MSI Data”, *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 55, issue 7. ISSN 0196-2892. DOI 10.1109/TGRS.2017.2683444.
- [36] Weather Online [Online]. Available: <https://www.weatheronline.co.uk/reports/climate/Ukraine.htm> [Accessed: 23 Feb. 2018]

Drivers for Smart Servitization in Manufacturing Companies

Lucie Kaňovská¹, Eva Tomášková²

¹ Faculty of Business and Management, Brno University of Technology, Brno, Czech Republic

² Faculty of Law, Masaryk University, Brno, Czech Republic

Abstract

Wireless communication technologies associated with the Internet of things (IoT) have started to be used also in manufacturing. Developing data-driven services by IoT also known as “smart services” in manufacturing business has become one of the current trends. Sensors enable IoT systems to provide intelligent and smart services during the shift towards smart production. Smart technologies have begun to be used also in agriculture by means of agricultural and farming applications. The aim of the paper is to determine why manufacturing companies have started to provide smart services with their products. A literature review presents the background of smart services in manufacturing companies as well in agriculture. For the empirical part, a qualitative multi-case study was conducted among seven Czech electrotechnical manufacturers and one Czech agricultural tractor manufacturer. All case companies have already begun with their smart service development. The findings indicate that manufactures usually decide by themselves to start with smart servitization, but the main categories of smart servitization drivers are connected to competitive advantage. The study is unique in highlighting the problems of smart services in SMEs in the Czech Republic, where the industrial sector is still dominant in comparison to other European countries.

Keywords

Smart servitization, smart services, electrotechnical and agricultural manufacturers, smart (precision) agriculture (farming), Czech Republic.

Kaňovská, L. and Tomášková, E. (2018) “Drivers for Smart Servitization in Manufacturing Companies”, *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 57-68. ISSN 1804-1930. DOI 10.7160/aol.2018.100305.

Introduction

Many manufacturers deliver not only tangible products to their customers, but also provide services accompanying their products. Industrial companies are offering product-related services throughout the product lifecycle due to the increasing input costs and competition (Herterich et al., 2015). Such service-oriented practise is described as “servitization”, a practise becoming inevitable among manufacturers which no longer offer tangible products without accompanying services customized to suit the customer needs (Baines et al., 2009). The first beginning of servitization in manufacturing could be seen in 1800s, when International Harvester used services to help bringing their new reaping equipment to farmers located in the American Midwest (Baines and Lightfoot, 2013).

Some manufactures use data-driven services by the Internet of Things (IoT), also known as “smart services”. Smart services are important

for both manufacturing companies as service providers as well as for their customers. Service can improve value creation and profitability for both the business and customers. The beginning of smart service provision is not easy, especially in SMEs (small and medium-sized enterprises) where many enterprises struggle with lack of money, insufficient digital technologies or unskilled employees. Large companies may assume very complicated and challenging tasks. The agricultural manufacturers also implement the IoT related technologies to be able to deliver services which can track crop environments to optimize crop yields and develop sustainable outcomes (Cedeño et al., 2018).

Most of agriculture is directly driven by weather, consequently “holy grail” of smart or precision agriculture is accurate, automated and continuous weather forecast (Bögel, 2017). However, an increasing number of manufacturers are beginning to add smart services to their offers. Their motivations to start with smart service

provision could be based on competition, demand and economic motives. Motivations to servitize vary according to product complexity, although cost savings and improved service quality appear important demand-based motivations for all manufacturers (Raddats et al., 2016).

Some researchers have already studied service transformation in manufacturing companies, but there are not many analyses that focus on the impact of ICT on industrial services. To fill the void, the paper presents the investigation into why manufacturing companies have started to provide smart services to their products. A qualitative multi-case study was conducted among seven Czech electrotechnical SMEs and one Czech manufacturer of tractors. All case companies have already started with smart service development. The findings show that manufactures usually decide by themselves to start with smart servitization, but the main categories of smart servitization drivers are connected to competitive advantage.

Theoretical background

Companies in manufacturing industries, including production of agricultural equipment (such as tractors, harvesters, trailers), encounter various challenges. In particular, competition in terms of cost and technology leadership has increased with the commodization of products (Lim et al., 2015). Thus, numerous companies have adopted a service-led competitive strategy to distinguish themselves from competitors. Literature calls this trend “servitization” (Baines et al., 2009). Manufacturing industry participants are more concerned in offering customized services such as maintenance, repair, training, overhauling, and technical supporting, commonly known as “servitization in manufacturing” (Lightfoot et al., 2013).

Smart Servitization

It is widely agreed that technology is behind the rapid progress of today’s service driven economy. Smart servitization or “smartization” is considered a new level of interconnected intelligence including automatic processes and data transformation extending the scope of product related services companies can offer. Some consider ICT essential to an increasing number of services and argue that the rise of services and the information revolution are inseparable (Rust et al., 2014). The area of smart servitization has not been properly researched yet as the scarce research projects focused on one specific digital technology at a time excluding

the influence of all relevant technologies. According to Grubic and Jennions (2017), more thorough investigation and systematization of the existing knowledge is necessary.

The technological advancement including cloud manufacturing, IoT, online analytics and additive manufacturing resulted into an interconnected world. The rapid ICT development allowed businesses to apply innovative strategies and unique business models to better satisfy their customers.

Some manufactures develop data-driven services by the Internet of Things (IoT), also known as “smart services”. The term “Internet of Things” (IoT) means a “global network infrastructure where physical and virtual objects are discovered and integrated seamlessly” (Kiritzis, 2011). The “IoT” is growing faster than the “internet of people” because billions of cars, production tools, household devices, sensors, etc. All will be connected to the network in the near future. Furthermore, connectivity and data will get cheap and globally accessible (Bögel, 2017).

Smart services are defined as services tailored to specific customer needs with the help of data and intelligent processing (Hermann et al., 2016). Therefore, it is essential to understand the customers and their surroundings, to have smart data and platforms to integrate and process the data and to change the business models and company mindset (Marquardt, 2017). IT technologies help to gain quality and timely information for the success of both large and small companies. Šilerova et al. (2017) mention that it would be worthwhile for the IT department to monitor the impact of the usage of information system on the business results as well as the competitiveness of the company, goodwill, social situation in the company, cooperation with the suppliers, and the customers. Knowledge in the field of information and communication technologies has become an essential condition for the success of managers in all areas of economic activity (Hallová, 2017). Smart services are often seen as one of the enablers of servitization (e.g. Neu and Brown, 2005; Oliva and Kallenberg, 2003). According to Allmendinger and Lombreglia (2005): “Soon, it will not be enough for a company to offer services; it will have to provide ‘smart services’”.

The terminology related to smart services has not been unified yet. There are many definitions of smart services such as ‘teleservice’ (Borgmeier, 2002), ‘tele-maintenance’ (Garcia et al., 2004), ‘telematics’ (Chatterjee et al., 2001), ‘e-service’

(Rowley, 2006), ‘e-maintenance’ (Levrat et al., 2008) or some variations using the term ‘remote’, such as ‘RRDM (Remote Repair, Diagnostics and Maintenance)’. However, the term ‘smart service’ has been prevailing (Klein, 2017). Klein (2017, p. 8) describes smart services as “Smart services are technologically-mediated services actively delivered by the provider through accessing a remote asset and exchanging data through built-in control and/or feedback devices.” Beverungen et al. (2017) define smart service as “the application of specialized competences, through deeds, processes, and performances that are enabled by smart products”.

The farming industry is not an exemption of the smart servitization era nowadays. The agriculture industry is changing towards the IoT. This could be called as “Precision” or “Smart” farming”. The current crop environment is tracked by “Smart Devices” and all the productive units interacting with it. For agri-food businesses, it is a new trend, which offers multiple occasions for optimizing crop yield and providing sustainable products and services (Cedeño et al., 2018).

Smart services in agriculture

Agriculture is a sector in the early phase of its digital transition. Farmers and manufactures of agriculture machines, such as harvesters and tractors, should study how to build and manage smart systems, how to acquire and harness digital capabilities and how to collaborate and compete in the current environment (Bögel, 2017).

The term precision agriculture, together with GPS-guided tractors, also appeared in the early 1990s. Its fundamental principles were well known by farmers since the early days of agriculture (Brase, 2005). Precision agriculture developed at varying pace geographically (Zhang et al., 2002). France were the door openers in Europe, just like Argentina and Brazil in South America. Despite early efforts, the sector’s digital progress was slow. It takes time to assess and evaluate the short and long-term effects of this kind of innovation, but we can assume that it will follow the same trajectory as that of other industries, but apparently slower. Industry observers express the concern that adoption of agricultural software solutions is slow, penetration is much lower than predicted, digital systems’ capabilities are underutilized, many producers use them only to prepare simple tables, to-do-lists and working schedules (Bögel, 2017).

Cedeno et al. (2018) identified two customer needs addressed by smart services intending to optimize

tractor-implement operations. Following is the description of the needs identified. First, farmers need to implement integration with tractors - Smart services to address this need include product system (highly integrated tractor with implements for optimal operations, optimization of equipment operations (implement operation optimized based on historic operation data), remote diagnosis (diagnosis accomplished remotely through remote service centers), remote repairing (non-complex repairs made by remote service centers), predictive services (trigger service activities based on current component condition), and real-time simulations (simulation different tractors - implement operation for prototyping and testing purposes). Second, the work plan elaboration needs to be more efficient. Following smart services are at disposal to address this need: automatic work plan generator (generates work plans according to current progress and available resources), real-time project manager (tracks current progress, forecasts potential delivery times and resources consumption based on historic data).

For products such as farming machines, tractors, diggers, and hoisting machinery, there is a great potential for fuel economy when operating them with the IoT support. A FireFly Equipment turfgrass slab harvester, for example, is able to save up to 50% of its fuel because it may be operated almost all-day long. (National Instruments, 2018). The following examples of manufactures show the presence of smart service technologies in their products.

Valtra is a manufacturer and service provider in the Nordic countries and Valtra machines are sold in over 75 countries. Their System Valtra Connect transmits tractor data to smart phones and computers. Data are accessible to both customers and to customer service centers (Valtra, 2018).

Tractors and some other machines manufactured by John Deere are able to report, monitor, and control machine operations through telematics promises to revolutionize heavy machinery-based industries. The benefits could be seen in the efficient logistics, reduced maintenance, and cost control. Their products can provide a system that fits customer specific needs by using of Components that are designed and manufactured to withstand severe temperature, vibration, and sealing requirements (John Deere, 2018).

Products branded by New Holland provide New Holland’s PLM® solutions for their customers.

A comprehensive software package enables to manage all aspects of farm to enhance productivity and reduce soaring input costs. Telematics technology enables fleet managers to connect to their machines from the comfort of their office. Customers can send and receive real-time information that saves time and enhances productivity (New Holland, 2018).

Until the end of 2019, Lesprojekt sluzby, s.r.o. (Ltd.), based in the Czech Republic, will work together with ZETOR TRACTORS a. s. company on the "DataBio" EU project, which is an application of telemetry and precision farming to tractors (Zetor, 2018). FarmTelemetry (www.farmtelemetry.eu), the project of Lesprojekt služby, s.r.o., provides an innovative solution to support farmers in the management of their farming actions. Moreover, it reduces the energy consumption, improves carbon balance and maintains high level of outputs. This project empowers farmers and companies to choose the right decisions and timely optimize the level of farm inputs by using its competitive edge (Farmtelemetry, 2018).

According to Bögel (2017), great potential is arising from the use of high-technology in modern agriculture as drones and sensor can collect and submit real time data, process this data and design advanced models and make recommendations to farmers through mobile devices or through robots which allow for immediate implementation.

Motivations and drivers for smart servitization

Many authors discussed the motivations of manufacturers undertaking servitization. These motivations are based on Wise and Baumgartner (1999). Oliva and Kallenberg (2003) divided the motivations into three main categories: competitive motivations, demand-based motivations and economic motivations. Also, Baines et al. (2009) suggest a typology based on: strategic (competitive), marketing (demand-based) and financial (economic) motivations.

Table 1 shows motivations and drivers for servitization based on current literature as described by Raddats et al. (2016).

Analysis of the private data performed by Grubic et al. (2011) indicated those factors that are driving companies to develop and adopt diagnostic and prognostic technology. The main factors driving manufacturers to develop and adopt diagnostic and prognostic technology are following ones:

- improving product performance,
- improving availability,
- improving maintenance efficiency and effectiveness,
- and differentiating from competitors' products.

The above-mentioned factors can be related to manufacturer's competitive strategy rather than to the need for regulatory compliance

Driver	Source(s)	Explanation of driver	Motivation for servitization (Oliva and Kallenberg, 2003)
Product differentiation	Mathieu (2001)	Creates a stronger value proposition than products alone	Competitive
Cost savings	Araujo and Spring (2006),	Saving the customer money in terms of product ownership	Demand based
Improved service quality	Araujo and Spring (2006); Fischer et al. (2012)	Improvements in customer operational processes	
Risk reduction	Baines and Lightfoot (2014)	Sharing new technology introduction and operational performance risk	
New revenue stream	Mathieu (2001)	Services provide incremental revenue to product revenue	Economic
Stabilize revenue	Gebauer and Fleisch (2007); Slack (2005)	Services revenue less liable to fluctuate than product revenue	
Increased profitability	Oliva and Kallenberg (2003)	Higher profitability attributable to service activities	
New service business model	Kowalkowski (2014); Spring and Araujo (2009)	Manufacturers able to develop service offerings that replace product offerings	

Source: adjusted according to Raddats et al., 2016

Table 1: Motivations and drivers to servitize.

and safety. According to Grubic et al. (2011), about 70 percent of companies link higher and sustained revenues to adoption, 84 percent of companies consider servitization as a tool to strengthen relations with customers while allowing for a better recognition of their needs. By adopting this technology, manufacturers expect their customers to benefit from reduced total cost of ownership and increased availability. Consequently, it should lead to a reduction of risks and a better focus on key competencies. Grubic et al. (2011) also attribute the adoption and development of diagnostic and prognostic technology to the ever-rising rivalry on the market. Additionally, value propositions of equipment availability, risk reduction, and total cost of ownership are at the centre of attention. Therefore, diagnostic and prognostic technology can be considered an important enabler of servitization and no longer a cost of doing business.

Farmers want smart services to connect their tractors and implements to the Internet for a better understanding of agricultural operations and demand a personalized everyday working plan, which is based on data analysis from previous work shifts. For them is also essential to gather and analyse gained data. The important data in agriculture could be temperature, humidity and pressure of tractor environment and data related to clarify root causes and failure rates (Cedeño et al., 2018).

The aim of the paper is to determine why manufacturing companies have started to provide smart services with their products.

Materials and methods

There is a lack of knowledge about how smart services are used in praxis by manufacturing companies. As Wunderlich et al. (2015) recapitulate, *“Despite the accelerating development of these smart services, academic research is still in its infancy. We see the need to further explore the effect that smart service has on organizations, customers and the evolving service landscape”* (Wunderlich et al., 2015). In addition, the majority of existing research is based on case studies (e. g. Brax and Jonsson, 2009; Neu and Brown, 2005; Oliva and Kallenberg, 2003) and these case studies should be accompanied by quantitative, survey-based analysis across a sample of manufacturing companies (Gebauer and Kowalkowski, 2012; Neu and Brown, 2005). Hence, academics might focus their research as well on digital servitization in order to create a greater diversity, which will

lead to increased value (Paschou et al., 2017).

Compared to the other European countries, the industrial sector still domains the economy in the Czech Republic. To learn more about smart services in manufacturing in the Czech Republic, the empirical part of the research included qualitative case studies which were conducted in a form of semi-structured interviews. The whole research focused on unfolding how are smart services provided by manufacturers nowadays. The interviews targeted the following areas: type of smart products and smart services, the length and way of smart service provision, customer perception of smart services, *the reasons for starting with smart service provision*, the benefits gained from smart services, barriers connected to smart service provision, gathering and using the data gained from smart services, specifics of Czech industrial market, collaboration with other firms and “learnings” for other firms which want to start with smart services.

In comparison with a single case approach, the multi-case approach provides more possibilities for analysis by allowing comparison and contrast of the results to point out specifics of each case and some generalization. For the purpose of this paper, the part of the study focused on the main reasons for commencing with smart service provision among the case companies was used.

Context of the research

The aim was to select companies within the same industry but in different stages of smart service provision. Purposive sampling was used to choose the companies. Seven companies participating in the research were electrotechnical producers who operate in the same industry but supply a lot of products and services to their customers with different degrees of service orientation. The respondents recruited from directors or managers of the case companies.

All case companies have been implementing smart services to their offers at different levels and ranges, which provides valuable information about smart services in different contexts. Following are the main smart services provided by the case companies: remote monitoring, control and diagnostics, remote repairs, preventive and predictive maintenance. Three companies were selected from the members of the Electrotechnical Association of the Czech Republic (<https://www.electroindustry.cz/>). Four companies were detected from previous research

conducted among sixty electrotechnical SMEs in the Czech Republic, South Moravian Region (CZ-NACE 26 and CZ-NACE 27) in 2014. A part of the research conducted in 2014 focused on services in manufacturing) contributed to the current knowledge with insights into service offering of electrotechnical manufacturing companies. The research was important not only to learn about the current situation of service offering in electrotechnical companies but was also essential for discovering companies providing smart services to their customers.

For the purpose of this research, another case company was added. This eighth case company was a larger manufacturer of tractors and it was chosen to provide a perspective on the current situation in smart services in a different industry. Seven small and medium companies were chosen from electrotechnical companies to present huge variety of their products, services and evaluation of smart services. Further, one case company producing tractors and front loaders, was chosen for the research also. Due to a number of employees and the typical characteristics of products (tractors and other agriculture equipment, which are still needed in agriculture sector) participated in our qualitative research only one manufacturer from another industry. Farmers operate in unique and ever-changing context and conditions and thus their participation in innovation efforts is desirable. As Bögel (2017) informs, the EU launched the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) and supports the bottom-up approach to innovations. This program provides a common platform for farmers, researchers, business and other stakeholders and allows them to work closely together on finding solutions to joint problems and sharing the results.

Despite the fact that current literary sources have outlined generic motivations for servitization (Baines et al., 2009), not a great number of studies have yet focused on whether the motivations differ between various types of manufacturers. To give an example, Neu and Brown's (2005) study of servitisation within IT companies reveals the motivations relevant to this sector but do not attempt to generalise the motivations to other sectors. Similarly, Fischer et al. (2012) inform about generic motivations for the capital goods sector and describe motivations to servitize as a decision to "defend" the existing product business or "grow" into new services markets. This research therefore seeks to determine

possible drivers behind the beginning of smart servitization and present some categories of drivers from the current manufacturers' perspective. The details of all case companies mentioned in this paper are listed in Table 2.

Firm	Respondents	Number of employees	The length of smart service provision in years
A	Owner	15	1
B	Product Manager	50	1
C	Owner	10	2
D	Owner	4	2
E	Owner	25	2
F	Owner	148	2
G	Product Manager	170	More than 2
H	R&D Manager	680	2

Source: authors

Table 2. Case company description.

Data collection and analysis

The data were collected through in-depth interviews with owners or with top managers in the case companies. The interviews were conducted among the case companies from April 2017 to March 2018. The length of the interview ranged from 50 to 100 minutes. As they were performed on site, the interviewer was able to tour the company and get familiar with the company's environment. The informants were assured that no identifying information would be provided when the findings are presented. The majority of face-to-face interviews was recorded and transcribed. The themes were predefined, and the semi-structured interview contained open-ended questions.

The data analysis was performed followed an abductive analysis process, where the literature investigation laid the foundation for early interviews, which then used developing themes to track important issues as the interviews progressed and the understanding of smart services in the real-life setting increased (Dubois and Gadde, 2014). Open coding was used to organize the data and converting them to discrete thematic blocks. As qualitative case research is sensitive to researchers' subjective explanations, some peer consultations was necessary to decrease researcher bias and to increase the objectivity of the study. A rich set of direct interview quotations to demonstrate interpretations was added to support the transparency and conformability of the findings.

The study of literature laid the foundation for first interviews. Based on the data gathered

through these interviews, themes were identified and developed in a form of open-ended questions. As the interviews progressed, the understanding of smart service provision in the business environment. Data analysis was performed using open coding to organize the data and converting them to discrete thematic blocks. As qualitative case research is sensitive to researchers' subjective explanations, some peer consultations was needed to avoid researcher bias and to ensure greater objectivity of the study. Therefore, the authors include multiple citations to better illustrate the findings and to secure the transparency and conformability.

Results and discussion

The case studies aim to analyze the current situation of smart service provision in manufacturing companies. One section of the research study was focused on finding the drivers behind smart servitization in manufacturing companies. A research question was formulated: *Why have manufacturing companies started to provide smart services to their products?* To answer the RQ, following contextual questions were prepared: (a) Who has initiated the beginning of smart servitization in manufacturing companies? (b) What are the drivers of smart servitization in manufacturing companies? The findings are presented below along with some quotes which help to illustrate the findings.

(a) Who has initiated beginnings of smart servitization in manufacturing companies?

In six case companies, the main initiative to start with smart service provision arose from the company itself. One case company has started because of their customers and another one because of their competitors. The findings are placed in the Table 3.

Firm	A	B	C	D
Activity of...	customers	company	company	company
Firm	E	F	G	H
Activity of...	company	company	competitors	company

Source: authors

Table 3: Activity to start with smart service provision.

The findings, placed in the Table 3, show three "active" subjects and three types of motivations by Oliva and Kallenberg (2003). Therefore, it is possible to say that activity of customer is demand based motivation, activity of company could be economic motivation and activity of competitor is

competitive motivation.

(b) What are the drivers of smart servitization in manufacturing companies?

Many different drivers or reasons for starting with smart service provision were identified by the case companies during the interviews, including better flexibility, costs and time savings, better product reliability, higher sales and profits, an increase in customer satisfaction, etc. However, seven out of eight respondents mentioned a competitive advantage to be the driver as it could be also gained through the use of smart services. Three case companies mentioned that smart services are seen as one of the current market trends and must be incorporated to company activities. For the findings, see Table 4.

Firm	Drivers
A	Improve situation on the market, increase competitive advantage, better work with the data for product innovation
B	Better product diagnostics, create competitive advantage, better promotion of solution
C	Product differentiation such as current trend, improve competitive advantage against large companies, better flexibility
D	Essential part of our lives, better data using for monitoring, analyzing and diagnostics
E	Use big potential of the gained data, increase competitive advantage, time and costs savings for customers, better product reliability
F	Differentiating from competitor's products, increase profitability, better product reliability, increase of operation security
G	Differentiating from competitor's products, increase profitability, new revenue stream as a trend, better facilitating of maintenance, costs and time savings
H	Be part of current trend, improve competitive advantage, provide product differentiation, improve product innovation

Source: authors

Table 4. Drivers of smart servitization for manufacturers.

"We had to start with smart service provision. Smart services were a crucial condition for one tender in the past, where we wanted to participate. We had not provided them before, so we could not be involved."

"I perceive smart services a natural part of today's world. The data are very valuable and could change products so much. It is important to use the data. It is a necessity for our future."

"Essential part of our lives."

"Smart services are the competitive advantage of SMEs against large companies."

“Smart services were something new and unknown in the beginning. We saw their big potential.”

“Smart services definitely help us.”

“Smart services have many advantages also for our customers.”

The qualitative research has focused on the problems related to the reasons for starting with smart service provision. The research was conducted among eight manufacturing companies (seven electrotechnical companies and one manufacturer of tractors) in the Czech Republic, South Moravian Region. A research question (RQ) was formulated for the purpose of the research to find out why the companies have started to offer smart services to their products. The case studies investigated the situation in eight firms to receive an answer to the research question presented in this paper.

Theoretical Implications

Smart services based on smart products discussed in the paper are a very innovative topic, which is quite new in the research field and still open to further investigations. According to the research mentioned in this paper, six case companies (out of eight participating companies) have started with smart service provision based on their own decision. One case company has started with smart service provision because of their customers' demand and another one due to their competitors. An increasing number of physical items, tools, machinery and devices is now supplied with electronics, and enable computing and communication.

Many drivers for the onset of smart service provisions were identified by the case companies during the in-depth interviews in manufacturing companies. Nevertheless, seven out of eight respondents stressed the competitive advantage. In their opinions, the main driver behind beginning with smart service provision is to gain competitive

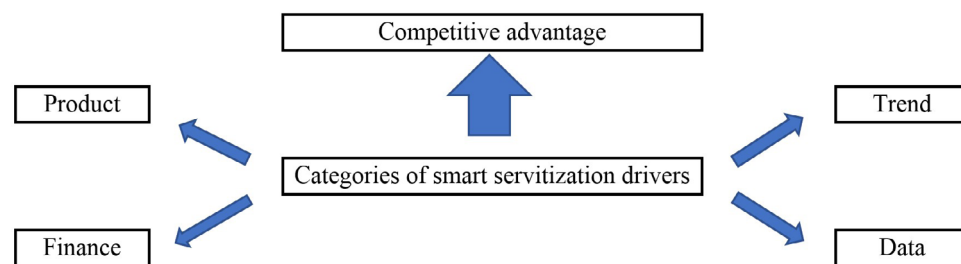
advantage. The paper determinate possible drivers of smart servitization and present some categories of drivers in the Figure 1. Categories of drivers were distributed to the main five areas, such as: competitive advantage, current trends, data, finance and product. The Figure 1 is based on the findings from the research in eight manufacturing companies. The figure provides a better insight into the problems of smart service provisions and their drivers of current manufacturers.

The arrows to one category of drivers (competitive advantage) is bolder than to another four arrows (trend, data, finance and product) because of their frequency in respondents' answers. In fact, all four categories make for competitive advantage.

As Fischer et al. (2013) mention, even manufacturers in high-technology sectors as well as those focused on product innovation are facing great difficulties and challenges when trying to differentiate their tangible products alone. This is a result of low-cost competitors' strategies who set very low prices of tangible products in order to gain market share. Economic motives could be essential considering the corporate focus change from product to services. Further, such change is perceived crucial for economic success.

Managerial Implications

The findings illustrate the reasons why to start with smart service provision in manufacturing companies. Three quarters of respondents decided to start with smart service provision upon their own decision and have already made first steps to implement smart services. The company is to decide whether or not to provide smart services. But first and foremost, the company needs to be clearly willing to offer them. The company may often be pushed by various circumstances, most frequently by their competitors and/or by the customers. Nevertheless, the company itself must openly incline towards this new possibility



Source: authors

Figure 1. Categories of smart servitization drivers for manufacturers.

and opportunity to exploit the potential of smart service provision. Following are the key benefits of remote monitoring technology for the manufacturers: improved performance and availability of their products, cost reduction, insight into customer needs and feedback for R&D (Grubic, 2011).

According to the findings presented in the paper, the initial idea to start with smart services is connected to gaining possible competitive advantage. However, also other drivers were mentioned and are also considered important. Usually a combination of more drivers led to smart service provision (see Table 3). The respondents pointed out at least three different drivers and not only one. This is an important conclusion as it allows a more complex perception of the problems of smart services. Manufacturers have to see the benefits of smart servitization.

Findings show that manufactures usually decide by themselves to start with smart servitization, but the main categories of smart servitization drivers are connected to competitive advantage. Findings mentioned by Grubic (2011) imply that industry has positive expectations about the potential of remote monitoring technology. Remote monitoring technology does not only support existing value propositions but also enables new business models and service innovations. Once the companies perceive the benefits, it is much easier for them to start with change towards smart servitization. Nevertheless, the rather limited number of cases considered in this study do not allow a consistent generalization of the findings. Therefore, it may be useful to prepare a quantitative research to find out in depth about the main reasons and to try to discover some relations in the answers of the respondents.

Despite the fact that there is a great number of companies using remote monitoring technology enabling them to advance their services, these have not been properly recorded and described in more detail to ascertain the common practice in the area of servitized strategies (Grubic, 2011). Smart services are the future of manufacturing according to the respondents. Today's manufacturers recognize smart services as a possible competitive advantage. However, smart services will be a necessity in the close future.

Conclusion

Digitalization managed to raise efficiency, productivity and profitability in many industries. The new technologies and tools will influence

directly and indirectly the development of manufacturing, including agriculture. Many stakeholders, large and small companies, research and development centers realize the opportunity and contribute to the digital development (Bögel, 2017). In the field of agriculture, precision agriculture put the industry on a new development trajectory, pushing ahead efficiency and productivity thresholds. Gains in yields will more depend on innovating in context, datafication of key factors, statistical analysis and decision-support algorithms (Bögel, 2017). The paper explores current situation in manufacturing companies which provide smart services to their clients, with the focus on the reasons why to start with smart service provision. To reach the research objective and answer the research questions, a qualitative multi-case study was conducted among eight Czech manufactures which have already started with smart service development.

The findings revealed that the manufactures usually decide by themselves to start with smart servitization, but the main categories of smart servitization drivers are connected to competitive advantage. This paper contributes to better understanding why today's manufacturing companies have started to provide smart services. Based on the case studies findings, the first implications for practice and theory were drawn. However, the study presented in this paper is still in the initial phase. The number of cases limitates a consistent generalization of achieved findings. The findings will be confirmed by further investigations.

The case studies methodology to analyze the "smart servitization" is overwhelmed, while very few theory building contributions were found (Paschou et al., 2017). While case studies may be very important in order to align academia and industry, it is necessary to stimulate more effort to develop and propose conceptual and theoretical works. A real digital servitization theory has still to come. That theory can also be built through well-designed surveys that have also the advantage of achieving a possible generalization of the results (Paschou et al., 2017). Although the study presented in this paper is still in the initial phase and a more in-depth research is needed before profound conclusions are made, first implications for practice and theory are drawn. However, the number of research cases is limited and does not allow a consistent generalization. As Paschou et al. (2017) notes that even though there is a great number of case studies analysing "smart servitization", a true smart servitization theory has not yet been designed. Moreover, not only is it important to align academia

and industry through multiple case studies, it is equally important to stimulate more effort to develop and propose conceptual and theoretical works. According to Paschou et al. (2017), this could be achieved through well – designed surveys which can result in a possible generalization of the findings.

The quantitative research of smart services is planned for the next year. The research will be conducted among manufacturers and focused on smart services. The aim will be to verify the findings from the qualitative research described in this paper.

Corresponding authors

Ing. Lucie Kaňovská, Ph.D.

Institute of Management, Faculty of Business and Management

Brno University of Technology, Kolejní 2906/4, 612 00 Brno, Czech Republic

E-mail: kanovska@fbm.vutbr.cz

References

- [1] Allmendinger, G. and Lombreglia, R. (2005) "Four strategies for the age of smart services", *Harvard business review*, Vol. 83, No. 10, pp. 131. ISSN 0017-8012.
- [2] Baines, T. S., Lightfoot, H. W., Benedettini, O., and Kay, J. M. (2009) "The servitization of manufacturing: A review of literature and reflection on future challenges", *Journal of manufacturing technology management*, Vol. 20, No. 5, pp. 547-567. ISSN 1741-038X. DOI 10.1108/17410380910960984.
- [3] Baines, T. and Lightfoot, H. W. (2013) "Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services", *International Journal of Operations & Production Management*, Vol. 34, No. 1, pp. 2-35. ISSN 0144-3577. DOI 10.1108/IJOPM-02-2012-0086.
- [4] Beverungen, D., Matzner, M. and Janiesch, C. (2017) "Information systems for smart services", *Information Systems and e-Business Management*, vol. 15, No. 4, pp. 781-787. E-ISSN 1617-9854, ISSN 1617-9846. DOI 10.1007/s10257-017-0365-8.
- [5] Bögel, G. (2017) "Competing in a smart world: the need for digital agriculture", In: *Management and Organization: Concepts, Tools and Applications*, pp. 11-28. [Online]. Available: http://real.mtak.hu/54836/1/12_Management_and_Organization-Pearson-2017j%C3%BAAn08-DOI_CrossRef-2017j%C3%BAAn13f.pdf. [Accessed: 20. May 2018]. DOI 10.18515/dBEM.M2017.n02.ch01.
- [6] Borgmeier, A. (2002) "Schlußbetrachtung", In: *Teleservice im Maschinen-und Anlagenbau*. Deutscher Universitätsverlag, pp. 209-217. DOI 10.1007/978-3-322-81064-9.
- [7] Brase, T. (2006) "Precision Agriculture", Delmar Cengage Learning, Independence, Kentucky.
- [8] Brax, S. A. and Jonsson, K. (2009) "Developing integrated solution offerings for remote diagnostics: A comparative case study of two manufacturers", *International Journal of Operations & Production Management*, Vol. 29, No. 5, pp. 539-560. ISSN 0144-3577. DOI 10.1108/01443570910953621.
- [9] Cedeño, J. M. V., Papinniemi, J., Hannola, L. and Donoghue, I. (2018) "Developing smart services by internet of things in manufacturing business", *LogForum*, Vol. 14, No. 1., E-ISSN 1734-459X, ISSN 1895-2038. DOI 10.12783/dtetr/icpr2017/17680.
- [10] Chatterjee, A., Greenberg, J., Jones, M., Kaas, H. W. and Wojcik, P. (2001) "Telematics: decision time for Detroit", *London Business School Review*, Vol. 12, No. 2, pp. 21-38. E-ISSN 2057-1615. DOI 10.1111/1467-8616.00172.
- [11] Dubois, A. and Gadde, L. E. (2014) "Systematic combining - A decade later", *Journal of Business Research*, Vol. 67, No. 6, pp. 1277-1284. ISSN 0148-2963. DOI 10.1016/j.jbusres.2013.03.036.
- [12] Farmtelemetry (2018) "Farmtelemetry Solution". [Online]. Available: <http://www.farmtelemetry.eu/> [Accessed: 20.4.2018].

- [13] Fischer, T., Gebauer, H. and Fleisch, R. (2012) "Service Business Development: Strategies for Value Creation in Manufacturing Firms", *Cambridge University Press*, Cambridge. DOI 10.1017/CBO9781139136730.
- [14] Garcia, E., Guyennet, H., Lapayre, J. C. and Zerhouni, N. (2004) "A new industrial cooperative tele-maintenance platform", *Computers & Industrial Engineering*, Vol. 46, No. 4, pp. 851-864. ISSN 0360-8352. DOI 10.1016/j.cie.2004.05.019.
- [15] Gebauer, H. and Kowalkowski, C. (2012) "Customer-focused and service-focused orientation in organizational structures", *Journal of Business & Industrial Marketing*, Vol. 27, No. 7, pp. 527-537. ISSN 0885-8624. DOI 10.1108/08858621211257293.
- [16] Grubic, T., Redding, L., Baines, T. and Julien, D. (2011) "The adoption and use of diagnostic and prognostic technology within UK-based manufacturers", *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, Vol. 225, No. 8, pp. 1457-1470. DOI 10.1177/0954405410395858.
- [17] Grubic, T. and Jennions, I. (2017) "Remote monitoring technology and servitised strategies-factors characterising the organisational application", *International Journal of Production Research*, Vol. 56, No. 6, pp. 2133-2149. E-ISSN 1366-588X, ISSN 0020-7543. DOI 10.1080/00207543.2017.1332791.
- [18] Hallová, M., Polakovič, P. and Slováková, I. (2017) "Current Trends in Training of Managers in the Field of Information and Communication Technologies and Identifying the Barriers to Education of Managers", *AGRIS On-line Papers in Economics and Informatics*, Vol. 9, No. 4, pp. 45-52. ISSN 1804-1930. DOI 10.7160/aol.2017.090405.
- [19] Hermann, M., Pentek, T. and Otto, B. (2016) "Design principles for industrie 4.0 scenarios", *System Sciences (HICSS), 49th Hawaii International Conference on. IEEE*. DOI 10.1109/HICSS.2016.488.
- [20] John Deere (2018) "Telematics" [Online]. Available: <https://www.deere.com/en/electronic-solutions/telematics/> [Accessed: 15.3.2018].
- [21] Kiritsis, D. (2011) "Closed-loop PLM for intelligent products in the era of the Internet of things", *Computer-Aided Design*, Vol. 43, No. 5, pp. 479-501. ISSN 0010-4485. DOI 10.1016/j.cad.2010.03.002.
- [22] Klein, M. M. (2017) "Design Rules for Smart Services: Overcoming Barriers with Rational Heuristics", Doctoral dissertation, Universität St. Gallen, Switzerland.
- [23] Levrat, E., Iung, B. and Marquez, C. A. (2008) "E-maintenance: review and conceptual framework", *Production Planning & Control*, Vol. 19, No. 4, pp. 408-429. E-ISSN 1366-5871, ISSN 0953-7287. DOI 10.1080/09537280802062571.
- [24] Lim, C. H., Kim, M. J., Heo, J. Y. and Kim, K. J. (2015) "Design of informatics-based services in manufacturing industries: case studies using large vehicle-related databases", *Journal of Intelligent Manufacturing*, Vol. 29, N. 3, pp. 497-508. E-ISSN 1572-8145, ISSN 0956-5515. DOI 10.1007/s10845-015-1123-8.
- [25] Lightfoot, H., Baines, T. and Smart, P. (2013) "The servitization of manufacturing: A systematic literature review of interdependent trends", *International Journal of Operations & Production Management*, Vol. 33, No. 11/12, pp. 1408-1434. ISSN 0144-3577. DOI 10.1108/IJOPM-07-2010-0196.
- [26] Marquardt, K. (2017) "Smart services—characteristics, challenges, opportunities and business models", In: *Proceedings of the International Conference on Business Excellence, De Gruyter Open*, pp. 789-801. ISSN 2558-9652. DOI 10.1515/picbe-2017-0084.
- [27] National Instruments (2018) "Learn how to implement the Industrial IoT at a one-day industry event" (seminar), Brno.
- [28] Neu, W. A. and Brown, S. W. (2005) "Forming successful business-to-business services in goods-dominant firms", *Journal of Service Research*, Vol. 8, No.1, pp. 3-17. E-ISSN 15527379, ISSN 10946705. DOI 10.1177/1094670505276619.

- [29] New Holland (2018) "Telemetry system". [Online]. Available: <http://www.agriexpo.online/prod/new-holland/product-169826-2253.html>. [Accessed: 25.3.2018].
- [30] Oliva, R. and Kallenberg, R. (2003) "Managing the transition from products to services", *International Journal Of Service Industry Management*, Vol. 14, No. 2, pp. 160-172. ISSN 0956-4233. DOI 10.1108/09564230310474138.
- [31] Paschou, T., Adrodegari, F., Perona, M. and Sacconi, N. (2017) "The digital servitization of manufacturing: a literature review and research agenda", 27th RESER Conference Bilbao [Online]. Available: https://www.researchgate.net/publication/319628925_The_digital_servitization_of_manufacturing_a_literature_review_and_research_agenda [Accessed: 20 April 2018].
- [32] Raddats, C., Baines, T., Burton, J., Story, V. M. and Zolkiewski, J. (2016) "Motivations for servitization: the impact of product complexity", *International Journal of Operations & Production Management*, Vol. 36, No. 5, pp. 572-591. ISSN 0144-3577. DOI 10.1108/IJOPM-09-2014-0447.
- [33] Rowly, J. (2006) "An analysis of the e-service literature: towards a research agenda", *Internet research*, Vol. 16, No.3, pp. 339-359. ISSN 1066-2243. DOI 10.1108/10662240610673736.
- [34] Rust, T. R. and Huang, M.-H. (2014) "The service revolution and the transformation of marketing science", *Marketing Science*, Vol. 33, No. 2, pp. 206-221. E-ISSN 1526-548X, ISSN 0732-2399. DOI 10.1287/mksc.2013.0836.
- [35] Šilerová, E., Hennyeyová, K., Michálek, R., Kánská, E., and Jarolínek, J. (2017) "Influence of the Correct Management of the IT Department on the Quality of Data and Information Processing", *AGRIS On-line Papers in Economics and Informatics*, Vol. 9, No. 4, pp. 91-98. ISSN 1804-1930. DOI 10.7160/aol.2017.090409.
- [36] Valtra (2018) " *Systém Valtra Connect*" (In Czech). [Online]. Available: http://www.valtra.cz/Syst-eacutem-Valtra-Connect_9935.aspx [Accessed: 20 April 2018].
- [37] Wunderlich, N. V., Heinonen, K., Ostrom, A. L., Patricio, L., Sousa, R., Voss, C. and Lemmink, J. G. (2015) "Futurizing" smart service: implications for service researchers and managers", *Journal of Services Marketing*, Vol. 29, No. 6/7, pp. 442-447. ISSN 0956-4233. DOI 10.1108/JSM-01-2015-0040.
- [38] Zetor (2018) " *Výzkumná činnost a granty*" (In Czech). [Online]. Available: <https://www.zetor.cz/vyzkumna-cinnost-a-granty> [Accessed: 26.2.2018].
- [39] Zhang, N., Wang, M. and Wang, N. (2002) "Precision agriculture - a worldwide overview", *Computers and electronics in agriculture*, Vol. 36, No. 2-3, pp. 113-132. ISSN 0168-1699. DOI 10.1016/S0168-1699(02)00096-0.

Novel Approach for Creation, Storage and Presentation of Online Information Content

Jan Masner, Jan Jarolímek, Eva Kánská

Department of Information Technologies, University of Life Sciences Prague, Czech Republic

Abstract

The paper provides an overview of a methodology for creation, storage and presentation of online information content (in World Wide Web environment). It is primarily intended to be utilized by open source content management systems and applications for publication of articles, news, papers etc. Open source software and, in particular, content management systems are broadly used in areas such as agriculture, rural development, public and non-profit sector. The methodology covers processes of content creation and updating in general, storage structure and presentation with consideration for sharing and exchanging possibilities. Authors can benefit from easier content creation process as well as consistent output visibility in real time. Structured and standardized storage structure can simplify development of modules, extensions or application libraries. Moreover, the process of CMS (or application) upgrade or transition to a different one which utilizes the methodology and its standards can be simplified and accelerated as well. Finally, the methodology can bring economic benefits by acceleration of CMS development and publication process.

Keywords

WWW, information content, CMS, HTML, WYSIWYG.

Masner, J., Jarolímek, J. and Kánská, E. (2018) "Novel Approach for Creation, Storage and Presentation of Online Information Content", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 69-77. ISSN 1804-1930. DOI 10.7160/aol.2018.100306.

Introduction

Use of the Internet and the World Wide Web (WWW) has rapidly spread over the population during past years. The last two decades have seen a significant departure from classical printed media such as newspapers or magazines. In order to stay relevant in light of these changes, many outlets switched to online publication or at least increased their online presence (Das et al., 2009).

Establishing and managing such websites and portals have become easier as of late. At the beginnings of WWW, websites were static and to publish anything meant to write each page using raw HTML. Throughout time, dynamic technologies such as JavaScript, PHP or ASP allowed websites to become more interactive. Due to the development of internet and web technologies, especially content management systems (CMS), even users without knowledge of desired technologies (HTML, CSS, JavaScript) can manage the online content nowadays (Brown, 2014). Creating online information content mostly means writing in form of articles (in general). Most of current open source CMSs use mainly

WYSIWYG editors (What You See Is What You Get). These editors strive to work like conventional desktop text editors such as Microsoft Word. Nevertheless, the output is not always as intended and seen in the editor. Some users claim that working with advanced positioning is still tricky (Masner et al., 2015). Output from these editors can potentially generate an inconsistent HTML code, which needs to be resolved programmatically (Spiesser and Kitchen, 2004). In addition, complex WYSIWYG editors can be a security thread (Javed and Schwenk, 2015).

Open source software and open source content management systems in particular are highly exploited in the field of online publication. In areas such as agricultural sector, rural development, government and local government and non-profit sector, the open source software is very popular. It is a logical way of saving expenses for own development.

Among the most important content management systems are WordPress, Joomla, and Drupal. For example, Drupal is used by US White House or Czech television. The current market share

according to WebsiteSetup (Mening, 2017) is shown in Figure 1. Other market share statistics show rather similar results.











Some CMSs, such as Drupal, are starting to provide more advanced way of content creation. The content can be composed from separate, simpler and more independent blocks using native fields and the Paragraphs module (Nikolic and Šilc, 2016; ANON, 2017; Czerniak, 2015). Other systems have a different approach or are not this far yet. For example, posts in WordPress can be composed from blocks, but their features are limited. Joomla offers this type of content composition by providing many extensions with various different features, mostly with narrow purposes.

Internet and WWW environment has also changed the way journalism is done nowadays (Dailey and Starbird, 2014). The interactivity, social media, open journalism and other opportunities are changing the journalists work (Villi and Noguera-Vivo, 2017; Fu, 2016; Grubenmann, 2016). Contemporary journalism is not a domain of newsrooms of major media outlets anymore and is significantly expanding to non-profit sphere (Paulino and Rodrigues Xavier, 2015).

Current information content should focus not only on the appearance of the result shown in a browser but also to be accessible for humans as well as for machines (Minin et al., 2015). As (Rudman and Bruwe, 2016) stated: “Web 3.0 entails an integrated Web experience where the machine will be able to understand and catalogue data in a manner similar to humans.” Content is also commonly viewed on variety of devices, especially smartphones and tablets (Šimek et al., 2014). Some media

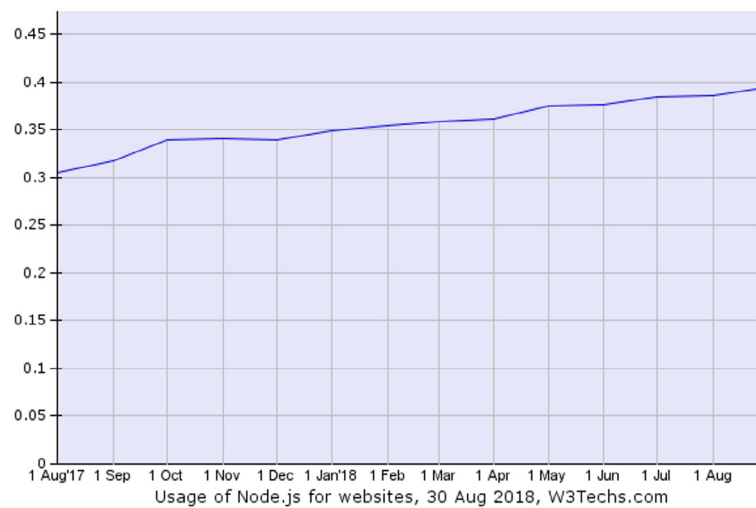
portals have their own application, which can provide added value in comparison to simple responsive website (Mendoza, 2014). The structuring of content also helps to display it more responsively. To sum up, the structured and semantic content is crucial for the modern WWW environment.

The main goal of the proposed methodology is to bring standardisation to creation, storage and presentation of the information content in WWW environment. As Sahay (2003) shows, the standardisation simplifies software development and enables utilisation of widely used libraries, modules and frameworks based on open source code. Using open source software components has therefore a positive influence on development speed (Merilinn and Matinlassi, 2006). Current trend in web development leans towards small applications modules, reusable components and microservices. For example, ecosystem around Node.js is based on NPM packages and reusable libraries. Node.js is currently the world’s fastest growing open source platform (Node.js Foundation, 2016). According to w3techs statistics (w3techs, 2018) the growth in the percentage of servers running Node.js is shown in Figure 2.

#	WEBSITES USING	MARKET SHARE %	ACTIVE SITES	# OF WEBSITES IN MILLION
1	 WordPress	59.9 %	26,701,222	239,139
2	 Joomla	6.6 %	2,009,717	13,480
3	 Drupal	4.6 %	964,820	23,330
4	 Magento	2.4 %	372,915	12,095
5	 Blogger	1.9 %	758,571	15,779
6	 Shopify	1.8 %	605,506	11,587
7	 Bitrix	1.5 %	200,210	3,925
8	 TYPO3	1.5 %	582,629	3,568
9	 Squarespace	1.5 %	1,390,307	9,799
10	 PrestaShop	1.3 %	262,342	2,099

Source: Mening, 2017

Figure 1: Use of content management systems across websites.



Source: W3Techs, 2018

Figure 2: Usage of Node.js for websites, August 2017

Materials and methods

First of all, we carried out a several Focus Groups sessions with editors and people authoring online information content. Focus Groups is an informal method firstly defined by Jacob Nielsen. Its goal is to determine user's needs and thoughts before the process of design and development of an application (Nielsen, 1997). The interviews conducted during the sessions consisted from the following core questions and some discussion around:

1. Could you describe the process of authoring an article?
2. Do you use MS Word or compose the article directly in your CMS?
3. Do you use any WYSIWYG in your CMS and how do you feel about it?
4. If so, is the output from the WYSIWYG editor always as it looks like while editing?
5. What is the structure of the content you commonly create?
6. How would you feel about composing an article from separate blocks?

We performed an analysis of the open source CMS market share and the applications itself. We analysed features available for content authoring and composing especially in terms of how the systems store data. We have also investigated options of transitioning between the systems or at least exporting the data to a machine-readable form such as XML(W3C, 2008) or JSON (ECMA, 2013) for subsequent usage.

One of the core ideas of the proposed methodology

is a standardisation of the storage format. Current most used CMSs are using PHP and MySQL database in background. But there is also a significant growth of applications written in JavaScript, running on Node.js and using NPM packaging system (Wittern et al., 2016). These applications usually utilise a NoSQL type of database. However, many of the frameworks used are database engine independent.

Therefore, rather than defining any strict relational model, the methodology uses a Domain model of UML Class diagram. The implementation then has to follow a set structure instead of specific database model.

The online information content can be defined as the part of website that is shown to the user and holds the main independent message of a page. Specifically, it is placed inside the <article> element. To form the model, we firstly analysed what is possible to store regarding the information content and HTML. The goal is to enable structuring of content as much as possible and to be machine readable and understandable. We focused on the HTML5 specification (W3C, 2017), its Content models and possibilities of atomization. Content model in the HTML5 specification says which elements can certain element contain (W3C, 2017).

To facilitate portability of the content, an exchange format based on the storage structure needs to be defined. In WWW environment, there are basically two formats used to store and exchange data – XML and JSON. As (Sandrih et al., 2017) stated, both formats are very commonly used and are exchangeable and inter-transformable.

Many authors point out that JSON format is faster in processing and less data-intensive, especially for use with mobile devices (Nurseitov et al., 2009; Jorstad et al., 2008; Lin et al., 2012). JSON is therefore appropriate exchange format to be used within web services and by server side APIs in communication with mobile applications.

The previous chapter is currently a work in progress. The exchange format is highly dependent on a storage model. So, the results in this area are under active development and will be published within further research.

Results and discussion

Creation and updating of the content

Results from Focus Groups sessions can produce confusing results as users can think of needs that they would actually not use given the opportunity (Nielsen, 1997). For that reason, we subjected them to a rigorous criticism. The most important and relevant results can be summarized as follows:

- Users mostly edit their content in MS Word and then insert it into the CMS. The main reason is that the CMS tool is not as user friendly and comfortable as the desktop text processor.
- Desktop text processors saves the data immediately and works offline. Current CMS are usually written in PHP and need to reload the whole page to save the edited content. Saving content in real-time like cloud office suits do would be the solution.
- Most users create the content mainly in WYSIWYG editors. The resulting output of more complicated parts usually slightly differs.
- Users rated positively the composition of content from separate blocks. They also highlighted the need of seeing the result as immediately as possible.
- There was a consensus that there are certain content types or certain parts of content written repeatedly. The good idea would be to implement some templates. On the other hand, the templates should not be too static.

Content storage

All the three major content management systems slowly adopt the way of content creation by composition from independent blocks. The most advanced is the Paragraphs module in Drupal. The module has most of the features mentioned above. However, it still lacks in the ability

of real-time saving and previewing of the content.

The structure used to store the content in various CMSs is usually very different and there are currently very few tools for exporting, importing or exchanging the content between systems. Therefore, if a developer decides to change the CMS, the export and import of current information content needs to be done on a database level. Typically, many web administrators start with a simple CMS and as the website grows, they end up needing a more complex one.

Regarding the specification, information content can be generally placed in the following elements:

- Headings (<h1> to <h6>)
- Paragraphs (<p>)
- Lists (, , <dl>)
- Tables (<table>)
- Embedded content (<audio>, <canvas>, <embed>, <iframe>, , <math>, <object>, <svg>, <video>)

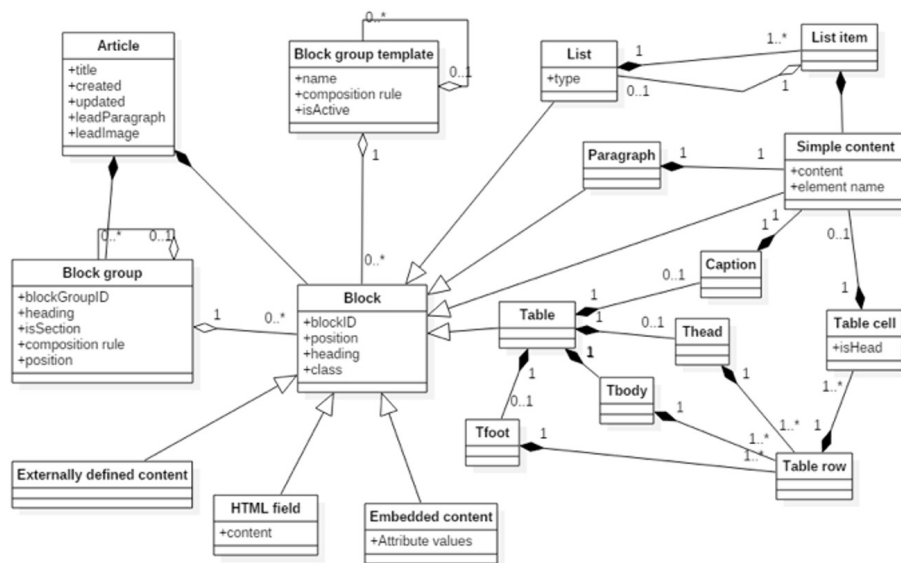
The specification for each element mentioned defines its Content model. By default, it is very generalised and open. For the purpose of the methodology, we have defined stricter Content model. It allows straightforward application of the storage model. The new rules are shown in Table 1. The table is made according to the current HTML5 specification (W3C, 2017). In order to provide valid output, limitations defined in the specification still have a higher priority.

Element	New Content model
h1, h2, ... h6	Elements defined in 4.5 Text-level semantics
p	Elements defined in 4.5 Text-level semantics
ul, ol	 elements exclusively
dl	<dt> and <dd> elements exclusively
li, dd, dt	Elements defined in 4.5 Text-level semantics
table	Table elements - <caption>, <thead>, <tbody>, <tfoot>, <tr>
td	Elements defined in 4.5 Text-level semantics
	Elements defined in embedded content category

Source: own processing

Table 1: Newly defined Content model.

To help in development of libraries and frameworks, there is a need to unify the form and structure of the content. Therefore, we proposed a model of the content structure. The model is shown in Figure 3 using the Domain model from UML Class diagram.



Source: own processing

Figure 3: Model for storage of the information content.

The descriptions of classes from the Figure 3 are as follows:

Article

Article is the main class and holds the main information about the content instance. It holds general information about the content such as title, dates, lead paragraphs, pictures etc. General metadata about the content instance can be linked here.

Block

Article consists of Blocks and Block groups. Block is a basic structure item of the Article. It contains an atomized content and forms the structure. Later on, it can be supplemented by metadata (e.g. Microdata).

Block group

Blocks can be put together into groups. The Block group class represents more complex part of content. It can be a pair of an image and a caption or anything which does not fit in a simple Block. Block group should have defined some rule for presentation. Basically, there should be at least a HTML template to assemble the Blocks within the group.

List, Paragraph, Table, Embedded content

These classes hold the atomized content in a machine-readable form. The form of the content is defined in Table 1.

Simple content

Simple content is a basic content which does not

make sense to continue to divide. It may contain elements from section 4.5 Text-level semantics of HTML5 specification exclusively. Optionally it can be contained in one element – element name attribute.

HTML field

Even though, all the information content should fit in the classes above, there still needs to be an option to insert general HTML. Some authors are advanced users and are familiar with HTML. Sometimes it is needed to insert a non-standard piece of code, e.g. widget supplemented by JavaScript code.

Externally defined content

In content management systems, a piece of content from a different source is often inserted. It is usually embedded photo gallery, poll, form or any other interactive form. In this case, the Block is only a link to an external entity. The final presentation is then provided by the CMS.

Conclusion

Nowadays, there is a significant departure from conventional printed media. More and more information is published online. Publishing on web is not exclusively a task for professionals in the area any more. Using content management systems, almost anyone is able to run a web site and publish articles. The information content in contemporary WWW environment is read and interpreted not only by humans, but by machines as well.

WYSIWYG editors are likely to be supplanted in the near future. To ease the authoring of the information content as well as enable its easier structuring, creation by composition from separate blocks presents itself as the logical next step.

Our proposed solution follows the trends in creation structured content. There is a need to utilize templates, but some WYSIWYG features are still necessary. However, they can be minimized to basic inline text editing features (Text-level semantics). Many users mentioned that it is important for them to see the result. In response, using modern technologies, the content can be saved and the result projected in real-time. We therefore proposed the two-pane editing layout, where user edits the content on one side and see the result on the second. The composition from blocks can also help responsiveness (at the input as well as at the output) and can produce consistent and semantic HTML.

The results of the suggested approach for editing content are highly dependent on its final implementation. The live preview of the result can be even omitted, especially for experienced users. However, the strict usage of predefined templates and well-designed Block groups are necessary.

Nowadays, the development of software is driven by open source libraries and frameworks. Standardisation helps the development in this area. In addition, there are issues in exporting and exchanging content. Therefore, we proposed the unified structure of the content for storage. We used a universal Domain model from UML Class diagram instead of any database model. Although the main content management systems use solely MySQL, there is a significant growth of NoSQL databases used with JavaScript applications. The result is shown in Figure 3.

Benefits and new opportunities

The structured composition of content can help authors produce superior content. The content can be more unified across the website as the content creation environment would lead the user to do so. The templates for repeating content types can do most of the work.

The structured form of content allows much more efficient transformation for the presentation. The content can be displayed in a different way on mobile devices and in desktop browsers. Moreover, the more stringent separation of content from appearance would help in any future redesign process. Additionally, more interactivity can be

employed.

In general, the structured approach can be used not only for websites publishing news. For example, scientific journals can provide the editing environment for authors. There can be available templates specifically adjusted for the desired journal and its format. There can be defined validation rules on input, so the author is forced to insert correct formats, appropriate sizes of images, etc. Finally, the process of online or desktop publishing can be more automated and managed by software.

Open source software and, in particular, content management systems are broadly used in areas such as agriculture, rural development, public and non-profit sector. The knowledge of ICT technologies is significantly on a lower level within those areas. The proposed methodology can significantly improve working with the online content and can help produce more consistent superior content. For farmers as content consumers, it can help easier access the desired content.

In conclusion, there are opportunities for economical savings in development as well as in administration of content management systems.

Further research

To help further research, we have developed a prototype application which implements all the findings and results we achieved. It will be used for more user testing such as Think aloud protocols.

There is still more work to be done, especially in the area of content storage. The model also needs improvements in the semantics area. It is crucial to find optimal way to attach metadata. There are various metadata formats used in connection with HTML5 including Microdata, RDFa, JSON-LD or Microformats.

Finally, the methodology will have to be consulted among the professional public in order to be accepted and implemented. The developers of popular content management systems would probably need to adjust it and propose their own improvements.

Final summary

In previous chapters, we introduced emerging methodology for creation, storage and presentation of online information content. The methodology can be divided into three main areas. Each deal with different aspects of the content life cycle.

In the paper, we dealt mainly with the first two areas. The description of them is as follows:

- Creation and updating of the content
 - Basic principles of the content creation
 - Set of rules and recommendations
- Content storage
 - The core of the methodology
 - Model of a standardised structure for storage
- Presentation, semantics and archiving
 - Presentation of the content
 - Exchanging, exporting, etc.

The proposed methodology could bring many new opportunities as well as improvements

for the current state of art. It is still a work in progress. It will need to engage interest groups in the research and development process. Even though, the whole methodology will not be implemented, empowering partial aspects can probably help in the desired field as well.

Acknowledgments

The results and knowledge included herein have been obtained owing to support from the following institutional grants. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 20181005 – “Processing of precision agriculture and IoT data in regards to big data in agriculture”.

Corresponding authors

Ing. Jan Masner, Ph.D.

Department of Information Technologies, Faculty of Economics and Management,

Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Prague - Suchbát, Czech Republic

Email:masner@pef.czu.cz

References

- [1] Brown, M. (2014) "Writing and Editing in the Browser", *The Journal of Electronic Publishing*, Vol. 17, No. 1. ISSN 1080-2711. DOI 10.3998/3336451.0017.111.
- [2] Czerniak, B. (2015) "Paragraphs are Drupal's answer for structured content". [Online]. Available: <https://www.commercialprogression.com/post/paragraphs-are-drupals-answer-structured-content> [Accessed: 20 April 2018].
- [3] Dailey, D. and Starbird, K. (2014) "Journalists as Crowdsourcerers: Responding to Crisis by Reporting with a Crowd", *Computer Supported Cooperative Work: CSCW: An International Journal*, Vol. 23, No. 4–6, pp. 445-481. ISSN 15737551. DOI 10.1007/s10606-014-9208-z.
- [4] Das, S., Goetz, M., Girard, L. and Clark, T. (2009) "Scientific publications on web 3.0". In: *ELPUB 2009 - Rethinking Electronic Publishing: Innovation in Communication Paradigms and Technologies - Proceedings of the 13th International Conference on Electronic Publishing*, pp. 107-129. [Online]. Available: <http://www.scopus.com/inward/record.url?eid=2-s2.0-84864867845&partnerID=40&md5=aaf22a5286a9eca030c3f6956c29f25b> [Accessed: 15 May 2018].
- [5] DRUPAL (2017) "Paragraphs", Druapl.org. [Online] [vid. 2017-01-01]. Available: <https://www.drupal.org/project/paragraphs> [Accessed: 1 Jan. 2017].
- [6] ECMA (2013) "The JSON Data Interchange Format", 1st Editio. Geneva: Ecma international. [Online]. Available at: <http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-404.pdf> [Accessed: 5 Jan 2018].
- [7] Fu, J. S. (2016) "Leveraging Social Network Analysis for Research on Journalism in the Information Age", *Journal of Communication*, Vol. 66, No. 2, pp. 299-313. ISSN 14602466. DOI 10.1111/jcom.12212.
- [8] Grubenmann, S. (2016) "Action research: Collaborative research for the improvement of digital journalism practice", *Digital Journalism*, Vol. 4, No. 1, No. 160-176. ISSN 2167-0811. DOI 10.1080/21670811.2015.1093274.

- [9] Javed, A. and Schwenk, J. (2015) "Systematically Breaking Online WYSIWYG Editors. Springer International Publishing, pp. 122-133. DOI 10.1007/978-3-319-15087-1_10.
- [10] Jorstad, I., Bakken, E. and Johansen, T. A. (2008) "Performance evaluation of JSON and XML for data exchange in mobile services", In: *WINSYS 2008: Proceedings Of The International Conference On Wireless Information Networks And Systems*, pp. 237-240. ISBN 978-989-8111-62-3.
- [11] Lin, B., Chen, Y., Chen X. and Yu, Y. (2012) "Comparison between JSON and XML in Applications Based on AJAX", In: *Proceedings - 2012 International Conference on Computer Science and Service System, CSSS 2012*, pp. 1174-1177. ISBN 9780769547190. DOI 10.1109/CSSS.2012.297.
- [12] Masner, J., Vaněk, J., Jarolímek, J. and Očenášek, V. (2015) "Markup Languages Support for Content Management of Agricultural Portals", In: *HAICTA 2015. Greece: CEUR-WS*, pp. 594-602. ISSN 1613-0073.
- [13] Mendoza, A. (2014) "Mobile App or Mobile Web: The Big Debate", In: *Mobile User Experience*, pp. 161-173. ISBN 9780124095144. DOI 10.1016/B978-0-12-409514-4.00008-8.
- [14] Mening, R. (2017) "Popular CMS by Market Share", WebsiteSetup [Online]. Available: <https://websitesetup.org/popular-cms/>. [Accessed: 15 Jan. 2017].
- [15] Merilinn, J. and Matinlassi, M. (2006) "State of the Art and Practice of OpenSource Component Integration", In: *32nd EUROMICRO Conference on Software Engineering and Advanced Applications (EUROMICRO'06)*, pp. 170-177. ISBN 0-7695-2594-6. DOI 10.1109/EUROMICRO.2006.61.
- [16] Minin, H. C., Alemán, J. J., Sacramento, C. and Trevisan, D. G. (2015) "A WYSIWYG editor to support accessible web content production", In: *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, pp. 221-230. ISBN 9783319206776. DOI 10.1007/978-3-319-20678-3_22.
- [17] Nielsen, J. (1997) "The Use and Misuse of Focus Groups". [Online] Available: <https://www.nngroup.com/articles/focus-groups/>. [Accessed: 1 Jan. 2016].
- [18] Nikolic, S. and Šilc, J. (2016) "Drupal 8 modules: Translation management tool and paragraphs", *Informatica (Slovenia)*, Vol. 40, No. 1, pp. 145-152. ISSN 03505596.
- [19] NODE.JS FOUNDATION (2016) "World's Fastest Growing Open Source Platform Pushes Out New Release". [Online]. Available: <https://nodejs.org/en/blog/announcements/v6-release/>. [Accessed: 20 Jan. 2017].
- [20] Nurseitov, N., Paulson, M., Randall Reynolds, R. and Izurieta, C. (2009) "Comparison of JSON and XML Data Interchange Formats: A Case Study". [Online]. Available: <http://www.cs.montana.edu/izurieta/pubs/caine2009.pdf> [Accessed: 13 Febr. 2017].
- [21] Paulino, F. O. and Rodrigues Xavier, A. C. (2015) "Nonprofit Journalism: Transition, Growth, Sustainability And Independence", *Revista Comunicacao Midiatica*, Bauru SP: Universidade Estadual Paulista Júlio de Mesquita Filho Faculdade de Arquitetura Artes e Comunicação Programa de Pós-Graduação em Comunicação, Vol. 10, No. 1, pp. 154-168. ISSN 2236-8000.
- [22] Rudman, R. and Bruwe, R. (2016) "Defining Web 3.0: opportunities and challenges", *The Electronic Library*, Vol. 34, No. 1, pp. 116-131. ISSN 02640473. DOI 10.1108/EL-08-2014-0140.
- [23] Sahay, S. (2003) "Global software alliances: the challenge of 'standardization'", *Scandinavian Journal of Information Systems*, Vol. 15, No. 1, pp. 3-19. E-ISSN 1901-0990.
- [24] Sandrih, B., Tosić, D. and Filipović, V. (2017) "Towards Efficient and Unified XML/JSON Conversion - A New Conversion", *IPSI BGD Transactions On Internet Research*, Vol. 13, No. 1. ISSN 1820-4503.
- [25] Šimek, P., Stočes, M. and Vaněk, J. (2014) "Mobile access to information in the agrarian sector", *AGRIS On-line Papers in Economics and Informatics*, Vol. 6, No. 2, pp. 89-96. ISSN 1804-1930.

- [26] Spiesser, J. and Kitchen, L. (2004) "Optimization of HTML automatically generated by WYSIWYG programs". In: *Thirteenth International World Wide Web Conference Proceedings, WWW2004* pp. 355-364. [Online]. Available at: <https://www.scopus.com/inward/record.uri?eid=2-s2.0-19944369446&partnerID=40&md5=476eaa75b8614f9482862279bb4062df> [Accessed: 20 May 2018].
- [27] Stočes, M., Šilerová, E., Vaněk, J., Jarolimek, J., Šimek, P. (2018) "Possibilities of using open data in sugar & sugar beet sector" , *Listy Cukrovarnické a Reparské*, Vol. 134, No. 3, pp. 117-121. E-ISSN 1805-9708, ISSN 1210-3306.
- [28] Villi, M. and Noguera-Vivo, J.-M. (2017) "Sharing media content in social media: The challenges and opportunities of user-distributed content (UDC)", *Journal Of Applied Journalism & Media Studies*, Vol. 6, No. 2, pp. 207-223. ISSN 2001-0818. DOI 10.1386/ajms.6.2.207_1.
- [29] W3C (2008) "*Extensible Markup Language (XML) 1.0*", W3C Recomm. [Online]. Available: <http://www.w3.org/TR/xml/> [Accessed: 15 April 2017].
- [30] W3C (2017) "*HTML5.2*". [Online]. Available: <https://www.w3.org/TR/2017/REC-html52-20171214/> [Accessed: 15 April 2017].
- [31] W3TECHS (2018) "*Usage Statistics and Market Share of Node.js for Websites*" [Online]. Available: <https://w3techs.com/technologies/details/ws-nodejs/all/all>. [Accessed: 30 August 2018].
- [32] W3TECHS (2018) "*Usage Statistics of HTTP/2 for Websites*". [Online]. Available: <https://w3techs.com/technologies/details/ce-http2/all/all> [Accessed: 20 Febr. 2018].
- [33] Wittern, E., Suter, P. and Rajagopalan, S. (2016) "A look at the dynamics of the JavaScript package ecosystem", *Proceedings of the 13th International Workshop on Mining Software Repositories - MSR '16*, Austin, Texas, pp. 351-361. DOI 10.1145/2901739.2901743.

Agrarian and Land Reforms in Rwanda: Situation and Perspectives

Mireille Mizero¹, Antoine Karangwa², Philippe Burny¹, Baudouin Michel¹, Philippe Lebailly¹

¹ Département d'Economie et du Développement Rural, Gembloux Agro-Bio Tech, Université de Liège, Belgium

² Department of Rural Development and Agricultural Economics, School of Agriculture and Food Sciences, University of Rwanda, Rwanda

Abstract

Rwanda is a landlocked country of Eastern Africa with 26,338 km². The total arable land in Rwanda is more or less than 1.8 million ha and Rwanda has the highest population density in Africa. A series of policy reforms and agrarian strategic plan have been elaborated to transform the economy now oriented towards subsistence agriculture into a knowledge-based service and market-oriented economy. The research question is who has the right to land ownership for its rational use? The purpose of this article is to contribute to land sharing prospects between agricultural operators and investors in Rwanda for the optimisation of land access in the rural areas. This work is the result of deep literature review related to the situation of land issue prevailing from pre-colonial period to the recent 2004 land policy reforms in Rwanda. Crucial challenges before the beginning of the effective agrarian evolution are widely discussed. Agrarian perspectives show that the foreignization of agrarian reforms put Rwandan peasants in uncomfortable position. The changes in land use and tenure in Rwanda have been stimulated by both outside influence and inside adversary forces. The real land reform policy consists in specialization and exploitation of large-scale farms subsequent to land consolidation of small plots registered by individuals whose property certificates are preserved. Meanwhile, the required registration of land holdings does not entitle the land to definitive appropriation but it only provides the rights of use if rational exploitation is guaranteed. Such a rational system may result in expropriation for the inefficient producers. This article emphasizes that in the case of Rwanda where population growth rate is high, the redistribution of land has its limits. The land consolidation should not be a rule either. Any agrarian reform must find a point of balance. This equilibrium consists in reducing the pressure on the property assets and promoting rural entrepreneurship. Agriculture program may improve and diversify the mode of land access and improved input acquisition to feed a growing population whereas non-agriculture population is gradually increasing. It has been found that farmers operating in co-operatives are more secure and have advantage for land access than individual farmers.

Keywords

Land access, agrarian perspectives, land reforms, foreignization, Rwanda.

Mizero, M., Karangwa, A., Burny, P., Michel, B. and Lebailly, P. (2018) "Agrarian and Land Reforms in Rwanda: Situation and Perspectives", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 79-92. ISSN 1804-1930. DOI 10.7160/aol.2018.100307.

Introduction

Rwanda is one of the landlocked countries of sub-Saharan Africa. It covers an area of 26,338 km². According to the results of the general population and housing census, held from 16th to 30th August 2002, the population density calculated on an occupied area of 25,314 km² was evaluated at an average of 322 inhabitants/km². There were 283 inhabitants/km² in 1991, date of the last census before the 1994 genocide (Ministry of Finance

and Economic Planning, National Census Commission, 2003). "The population density in 2012 was 415 inhabitants per square kilometres. Compared to neighbouring countries: Burundi (333), Uganda (173) or Kenya (73), Rwanda is the highest densely populated country in the region. It was only 183 persons per sq. km in 1978, and 321 in 2002 " (National Institute of Statistics of Rwanda (NISR), Ministry of Finance and Economic Planning, 2012). The population growth is almost 3% annually and income per capita increase to 4.67% in contrast with 2.65% in Sub-Saharan Africa between 2000

and 2010 (WDI; 2012 cited by Klasen and Reimers, 2014). A recent report by the International Monetary Fund (2016) has recognized that almost half of the Sub-Saharan African countries, including Rwanda, have experienced declining in their economy. The raw material commodity prices decreasing on the international market is the main cause (International Monetary Fund, 2016). The downward trends of the raw material prices on the international market are likely to extend over a long period, according to the cited International Monetary Fund report.

The International Monetary Fund assumes that constant economic growth in some Sub-Saharan countries, over the last decade, was due to both strong economic reforms, rigorous domestic policies and a favourable external environment. International Monetary Fund injunction is quite clear. It recommends to those countries with declining economies to make deep revision of their internal economic policies in this thorough terms "changement de cap" in order to deal with the deterioration of the external economic environment. The inclusion in a market-led economy and improvement of the business environment are on the agenda of reforms of legal frameworks and economic policies to avoid emergency adjustments according to the IMF (2016). It is clear that the Rwandan government is convinced that solutions to the socio-economic challenges the country is tackle cannot be solved only at the local level neither is the country viable on its own (Van Hoyweghen, 1999). Therefore, he cannot claim self-sufficiency without opening himself to the global market and carefully transform his economic model. However, according to Ansoms (2009), the risk of the marginalization of peasant is high with an agrarian reform policy that masks the social realities of rural Rwanda.

The agricultural sector is the priority in regard to his important role in Rwandan economy (Karangwa, 2008, Musabanganji et al., 2016). The current mode of organization of agriculture sector, which has been traditional for many decades, has low levels of productivity (Karangwa, 2008). However, the transformation of agricultural production systems and the demand-driven agriculture should improve the performance of farms (Republic of Rwanda, Minister of Natural Resources, 2006; Karangwa, 2008). The country has embarked on a strategy of intensification of strategic food crops: rice, maize, beans, potatoes and wheat as well as the traditional export crops such as tea, coffee, pyrethrum (Republic of Rwanda, Minister of Natural Resources, 2006). Rwanda is engaged

on the efficient use of land and water. Therefore, agriculture sector is moving from subsistence model to the market oriented one. Rwanda intends to reduce the dependence of the population on agriculture as the only source of income through the consolidation of other sectors, namely industry and services (Republic of Rwanda, Minister of Natural Resources, 2006). Thus, the government needs a new agriculture strategic plan and land reform framework to boost agriculture performance in a sustainable way (Musabanganji et al., 2016).

Indeed, the post-genocide government has committed to market-led agrarian and land systems opposed to State-led land reforms (Nkusi, 2000). The Strategic Plan for the Transformation of Agriculture in Rwanda (PSTA) is based on four pillars summarized as follows: The transition from a subsistence agricultural economy to a market-led economy, the intensification and gradual modernization of the agricultural sector, the redistribution of roles and responsibilities among all stakeholders in accordance to the new agricultural policy, State withdrawal from several sectors, decentralization and new working methods. The Minister of Agriculture and Livestock adopted the program approach (Republic of Rwanda, Ministry of Agriculture and Livestock, 2004).

The Republic of Rwanda and the Minister of Natural Resources (2006) are convinced that high density of the population is the main cause of land scarcity. According to the government of Rwanda, the critical situation of land insufficiency is worsening by the fact that most farmers practice mainly rain fed agriculture. Soil fertility has deteriorated as a result of the demographic pressure on land, while the use of organic and non-organic inputs remains very low. Other serious constraints are that many lands in Rwanda are at high risk of erosion due to the high land dominant topography. The government considers that the inadequate management of natural capital and the use of traditional technologies have led to soil degradation (Republic of Rwanda, Minister of Natural Resources, 2006).

Some concerns arise when policymakers intend to transfer responsibilities to other stakeholders and let the global market become the engine of local agrarian destiny. How is it possible to conciliate both human needs and land sharing in a pragmatic way of rational agrarian perspectives? Who has the right to own land for a rational use to compensate the gap of production of those who could not access to individual land property? The purpose of this article is to contribute to agricultural land sharing

prospects in Rwanda. The first and the 2nd section review the origin of agrarian reforms in general and the evolution of the pattern of land reform adopted in Rwanda. The methodology in detail is presented in the 2nd chapter. Main results are discussed in the 3rd chapter. The 4th and last chapter covers the major conclusion and agrarian perspectives in Rwanda.

1. Concept of agrarian reforms and individual property

According to Dufumier (2004), the general definition of agrarian reform consists in the State intervention of redistributing land accumulated by large landowners to landless peasants and small scale farmers. Agrarian reforms should normally result in an equal distribution of land. To be effective, agrarian reforms must be followed by a number of accompanying measures to make available other agricultural inputs such as water, livestock, a minimum of efficient equipment, credits, improved infrastructures and trustworthy services. Even that definition is very clear and correct politically as well as morally justified, it is not as easy as it seems to be when the big landholders are asked or imposed to share their farmland to the landless. Many examples can be assessed in Africa and elsewhere in the world. Without an exhaustive record, the case of South Africa post-Apartheid, the recent Zimbabwean and in Mozambique, land reforms has shown that it is not easy to proceed by expropriation of big farmers who have developed strong trajectories to safeguard their assets through political lobbies and stable socio-economic positions (Compagnon, 2003; Dufumier, 2004; Cousins, 2007; Fairbern, 2013).

The modern concept of agrarian reform would have been initiated by the agrarian transformation in the Scandinavian countries, probably in Denmark in the late 1700s (Herrera et al., 1997). Based on ideas emerging in European countries such as England, France and Germany, the Counts of Bernstorff and Reventlow, reformists, have instigated a program of consolidation of the fields holds by their peasants. They introduced new technologies and facilitated the sale of land to their peasants as well as their new status of ownership protection (Skovgaard, 1950 cited by Herrera et al., 1997). Securing landowner status is necessary but not sufficient. Indeed, in the agricultural sector, property is good in itself, but it is not enough. According to Lenoir (1984), when the farms areas are at least few hectares, the debt necessary for their equipment is not profitable, and the supervision

of the peasants by technicians is inefficient. The disorder in land management of these parcels leads to their impoverishment (Lenoir, 1984). Agricultural modernization is facilitated by large-scale production facilities applied on large farms, at least 50 ha where production techniques based on advances in science and technology are used to produce for export the surplus. Private property and land consolidation is central to this view of modern agriculture (Burger, 2001).

Article 3 of the 2005 Organic Land Law in Rwanda stipulates that land is the common property of all Rwandans but only the State has an eminent right to the agreement of occupation rights. The certificate of ownership gain by a small operator is nothing else than a right of occupation. Nkusi (2000) is clear when he precise that the registration of individual properties will facilitate transfer or acquisition procedures, especially because most Family farms are under the threshold of profitability. The absence of registration is a barrier of control over the exchange and transfer processes and the consolidation of farms according to the author (Nkusi, 2000).

Every recognized landowner obtains, outside the public and private domain of the State, an emphyteutic lease contract ranging from 3 to 99 years as envisaged by the articles 5, 24 and sections 2 and 3 of the cited Organic land law. According to the article 20 of the same Organic Land Law, it is forbidden to divide rural lands for agriculture and pasture with an area less than 1 ha. Those with an area inferior to 5 ha can only be divided after authorization by the local land commission. The means of rational exploitation of a consolidated land become more significant (Nkusi, 2000). Nkusi (2000) supports that land owner is not really the technical operator. He distinguishes land ownership and land use.

All marsh lands automatically belong to the State. They cannot be definitely transferred to individuals or acquired in private manner under the pretext of having occupied the marsh lands for long time (art. 29 of the Organic Law 08/2005, 14/07/2005 governing land tenure in Rwanda). In addition, the landowner is required to rationally and continuously exploit his property. Like this coercive version of agrarian reforms is based on expropriation with or without compensation of former large landowners. It has inspired many communist and its variant socialist countries (Herrera et al., 1997).

Indeed, the Russian revolution of 1917 and various socialist and populist regimes between the first and the Second World War converted the ideology of agrarian reform in the Western World, from a liberal economic process to a model of equity in rural areas led by the state to redistribute land (Herrera et al., 1997). The author noted that, in fact, it was the reason why a class of conservative landowners did not want to participate in land reform. Most land reforms in Latin America, Asia and the Near East have been derived from this coercive model. Therefore, from the foundation of FAO in 1945, agrarian reform was considered as one of the main tools for rural transformation and agricultural development (Herrera et al., 1997, pp. 53-54). The coercive forms of obligatory fragmentation of large estates into small holdings for distribution to landless peasants by the State intervention are currently discouraged. In so-called "modern" agriculture, the transformation of land into a marketable commodity like other agricultural goods and products is becoming the trust model supported by international institutions and financial partners lead by FAO (Herrera et al., 1997).

2. Evolution of land size in Rwanda

The total arable land in Rwanda has increasing in time and in space but the individual land size has decreased. The farmland size is in average equal to 0.23ha for the majority of agriculture operators and those who owned 10 ha of farmland are considered as large scale landholders (NISR, 2015) while in western countries, a large scale farmer can own several hundreds of ha. According to REMA (2009) the total arable land is about 1.4 million hectares which represented almost a half of the total surface area of the country. In the recent years, the cultivated area has exceeded 1.6 million ha and the recent seasonal agriculture survey revealed that the whole land covered by agriculture domain is equal to 1.8 million ha (NISR, 2015). The Republic of Rwanda precise that permanent pasture covers 0.47 million ha and someone can keep in mind that over 70 per cent of the country's total land surface is occupied by agricultural related activities (ROR 2008 cited in REMA, 2009). The topographic profile of Rwanda is dominated by hills and mountains. Then, the low land in Rwanda is limited to almost 165,000 ha of marshlands of which about 57 % (93,754 ha) have been cultivated. However, some 5,000 ha have been well managed and are ready to be cultivated (REMA, 2009). The Republic of Rwanda deplores the fact that a large part of the marshlands are exploited by peasants, whether or not they are

in co-operatives, without prior studies have been carried out (ROR, 2008 cited in REMA, 2009).

3. Criteria of rational use of the farm land

Article 63 of the land law in Rwanda stipulates that: The conservation or continued rational exploitation of land shall be assessed according to its use in accordance with the master plan for the allocation, development and use of land. Rational use is also validated if agriculture operators and investors have adopted particular crops and techniques designed by the competent authorities. Continuity of exploitation is evaluated in relation of the duration of non usage that cannot exceed 3 years (Article 64). This article states that shall be accepted as conserved and exploited rationally, the land carrying crops or buildings, those carrying forests so as not to pollute the environment, those prepared for receiving seeds, those whose crops have just been harvested and setting aside for a period not exceeding 3 years, those which have just been harvested, as well as those of the pastures on which individuals graze the authorized animals, either individually or collectively or in organization enjoying a legal personality. Article 65 completes it to clarify the 5 criteria for assessing land considered as not conserved or rationally used:

- That not protected against erosion.
- That intended for agriculture but which is not covered by plantations or cultivation on at least half of its area.
- Land dedicated to grazing but which is not actually and regularly occupied by livestock grazing or not covered with fodder crops at least on half of its area.
- Land intended for any kind of construction but whose construction has not been completed within the deadlines set by the law.
- That intended for non-profit use but activities have not started before a maximum period of three years.

In the following pages, we describe how land reforms in Rwanda were not only a product of inside enterprise. They have been influenced by outside ideologies joint with inside rival forces.

4. Rwandan agrarian reforms characteristics

Nkusi (2000), consultant of CCOAIB (Conseil de concertation des organisations d'appui aux initiatives de base) advocates that the transfer of the rights of appropriation is necessary to allow the extension of the agricultural holdings. Transfer land facilitation aim the increasing

of crop production must be in favour of the people who are fully responsible and masters of their rights and open to the economic objectives of the government. According to him, these paths allow to solve future land conflicts and prevent the country from experiencing social explosions like those in Zimbabwe. For the history of agrarian reform in Zimbabwe refer to the critical analysis did by Professor Daniel Compagnon at "Institut d'Etudes Politiques de Bordeaux". Although it intended to expropriate the big farmers, land reforms in Zimbabwe are controversial. Instead of benefiting the peasants, it has rather contributed to land grabbing by former rebels close to Mugabe's government (Compagnon, 2003). Zimbabwean agrarian reforms are close to those operated during the first Republic of Rwanda regarding the violence against and killings of the big farmers they have prompt.

The post-genocide Rwandan approach is a quiet and gentle dispossession of landowners unable to achieve the objectives set by the land tenure reforms. The strategy of redistribution is oriented towards the big investors to achieve the purpose of progress in land productivity. In this context, free consent in the purchase, lease or sale of exploitation rights are being facilitated by the authority (Nkusi, 2000). The pre-colonial land regime was based on agriculture and livestock integration. Nkusi (2000) depicted the "Ubukonde and Ibikingi" system as a dynamic and integrated system based on the customary rights. There were sporadic conflicts between agricultural and pastoral families for good grazing lands, transhumance areas and the control of quality sources of water. Land relations were based on the lack of restrictions of occupation of the territory. Agricultural and pastoral productions were linked with other professional trades such as handicraft. Maquet (1967) contested this description of land sharing harmony in traditional Rwanda. He has established a comparative model between the feudal patterns in the Middle Ages in Europe and the traditional Rwandan land system.

Nkusi (2000) estimate that ownership by the "Umukonde: large landowner" was not rational. Proprietor "Mukonde" easily had an area beyond 500 hectares with the possibility to establish several client families. Different armed groups have introduced a new form of political patronage on land in violation of the traditional land tenure. There were different customary land law in pre-colonial Rwanda related to pasture and culture rights (Maquet, 1967; André and Platteau, 1996; Nkusi, 2000). The more

significant were:

- "Ubukonde": right of ownership of the family leader who has slashed the forest.
- "Ubugererwa": right of exploitation temporarily transferred to persons or families settled by the head of the «Mukonde» family.
- "Inkundu" is the customary right of local politicians to manage unclaimed or abandoned properties.
- "Intora": customary right established by the local politician to appropriate a field or to take a part of the land from the landholding of each client family living in his district. This land, considered as the counterpart of the chief duty, was crop-free but cleared.
- "Gukeba or Kugaba": to establish people in a grazing land or on uncultivated land by the chief of the clan.
- "gikingi": grazing right recognized for herders' families and integrated into customary pastoral law.
- "Igisingati and Igikorera": customary law of free grazing on harvested agricultural areas.
- "Ubuhake": usufruct right on cow in exchange of security guaranteed by a powerful owner to his client who continues to provide other services to the patron (Maquet, 1967).

The extension of the territory by conquest wars was still valid as a strategy for farmland and pastures extension. Colonization stopped this expansionist approach of the territory and introduced a dualistic land tenure system. The Germans have not changed the customary law of traditional Rwanda. They recognized the king's sovereignty over the land. The land purchased by the Catholic and Protestant missions was based on the delivery of gifts, not monetary compensation (Nkusi, 2000). The supremacy of the written law to the customary law was introduced by the Belgians after the First World War. The 1926 reform organizes a cohesive territory and removes the rights of customary chiefs to dispose of land outside their districts. Colonization introduced the occupation certificate on land. But people should not be dispossessed of the land wherever they grow crops. Unused and vacant lands returned to the hands of the state. Verwimp (2011) revealed that the explosion of socio-political conflicts in 1959 showed the limits of the land tenure system in Rwanda. The violent dispossession of the pastoral peasants has taken an ethnic aspect. This crisis

also reversed the balance of political power after the independence in the 1960s. The land and livestock properties of the Tutsi refugees were redistributed to Hutu residents by the State dominated by Hutu leaders (Verwimp, 2011).

The "Ibikingi" pastoral system was abolished and the "Bagererwa": landless peasants obtained vacant land as individual properties. According to Nkusi (2000), the decree of 1960 aimed to protecting the interests of the settled people and guaranteeing them security of tenure. The 1976 decree-law practically expropriates the Rwandan population and attests the State as the owner of the land. The populations continued their occupation as usual and did not change their habits in matters of land acquisition or transfer. The State did not take any measures to harmonize agricultural land ownership based to the written law. The result of that reform is a binary system of land tenure. The first derived from the roman law of property (Maquet, 1967) is secure and inalienable and other customary rights become fragile (Nkusi, 2000). The new land tenure strategy after withdrawal the former occupants showed its limits during the post-independence period.

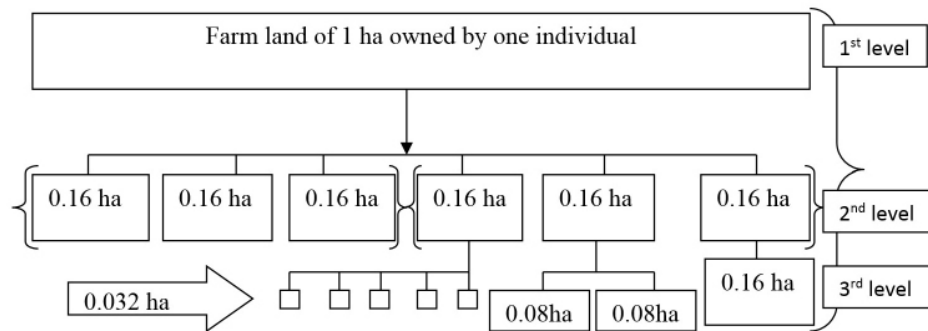
The 1970s and 1980s were characterized by a period of agricultural prosperity broken down by the demographic pressure (Amelot, 1997). During the 1990s, the pressure on agricultural space was a sad reality. The government was lacking arguments and durable solutions to deal with the tension generated by land scarcity challenge. Internal migrations became absolutely impossible for the extension of landholdings. The average family farm decreased from 2 ha in 1960 to 1.2 ha in the mid-1980s (Nkusi, 2000), represent 40% loss of the size of family farms in one generation. The justification for keeping Rwandan refugees in exile outlook by the former President Habyarimana was no longer a solution to the problem of land scarcity. Population growth eventually made unsustainable all attempts to manage the land. The land issue in Rwanda is endorsed by several authors to the "Malthusian trap" (André and Platteau, 1996). The 1990 war led by the 1959 refugees has challenged the political system unable to solve the old dispute related to land access and control. The new wave of refugees from 1996 after the genocide against Tutsi in 1994 created complicated situation about land sharing. There was another vicious cycle of dispossession and illegal appropriation. The new regime ruling after the historic genocide of 1994 manifest the beginning of a new era of land governance based on the principles of liberalization

of the land market. However, the process is overseen by the government.

Materials and methods

The methodology consists in a multidisciplinary approach. Bibliographic review of the relevant scientific literature was undertaken by using the following key words: Rwanda, land access, agrarian perspectives, land reforms, foreignization, and peasant. Reports from the national and international institutions have been consulted. Moreover, an analysis of the official discourses was done to capture the importance of the land issue in the public opinion. The methodological approach did not neglect the cultural aspects. Despite the generalization of the school system for education, Rwandan culture is both oral and written. The local language songs broadcast on radio, online videos are rich in information that few researchers are interested in socioeconomic studies. The history of the latest genocide in Rwanda has shown that radio is an important tool for mobilizing and relaying messages designed by the authorities to reach a larger audience. Even if advanced technologies in information and communication have been improved in Rwanda, the reading culture is not common. The expression of emotions or claims is usually conveyed by lyric songs. Through musical expression, there is a way to decode approvals or disapprovals of policies or practices, concerns and messages that the authors want to share with a wide audience as quick as possible. Videos posted on YouTube by opposition media were visualized.

In addition, the analysis of agrarian perspectives to follow up land policy change and agro-economic strategies of land sharing in Rwanda requires comprehensive tools that are sometimes need to be developed. Thus, the model below (Figure 1), allows to demonstrate the appreciation of agricultural land in relation with growing population. The model illustrate what is happen when people decide to keep their farm as common land property or to share and grouping their owned land or to share without pooling together their individual plots. Further on, the dispossession risk from smallholdings to constitute large farms as required by the 2004 agricultural land policy is closely examined. The constitutional hypothesis agree that land is a common good to all Rwandan, agricultural land belongs to the whole population in the country like the family land belongs to all its members. The later could share equally the farm



Source: Established by the author, modified from Ndayishimiye (2005)

Figure 1: Land sharing limits in the context of land scarcity.

without exclusion. Each landowner will sooner or later do the same for his children in the future. Even before the land sharing occurs, each member of the household is supposed to own his part of the land inheritance. The diagram above (Figure 1) shows for example a case in which a farm land of one ha belongs to 1 individual at time t and has been shared between fifteen descendants after 2 generations. Even if its members decide to concentrate their individual parcels it is not exceeding 1ha both. In the country or within families, agriculture and non-agriculture population interfere in land demand. Land access becomes complicated if everybody needs individual property. It was up to land owners to choose if they share or consolidate their holdings. But now, the land law in Rwanda is clear. A property of one ha cannot be fragmented. From one ha, six individuals possess $1/6$ ha each at the second level. It'll be $1/30$ ha each when 5 individuals are sharing 0.16 ha at the third level. When there are 2 stakeholders on the third level, they'll get $1/12$ ha each. If the owner to the second level has no descendant he'll keep his $1/6$ ha after free generations. At the opposite, if three individuals decide to concentrate their plots on the 2nd level they have a collective land of 0.48 ha. When all the 15 stakeholders from this family decide to pool their plots together, they have access to 1 ha. Otherwise, their marginal individual property equals to 0.06 ha. In this great fragmentation, some members of the family or some people in the country could search for other way of land access rather land ownership. Hereafter, their marginal individual property is under the minimum of cost-effectiveness.

Results and discussion

1. Analysis of the President Paul Kagame's speech on the land issue

Access to land is a high sensitive issue in Rwanda.

When he answered the questions of the local elected representatives during the meeting held in Kigali from 28th to 30th March 2018, His Excellency Paul Kagame, President of Rwanda said that the issue of access to land in Rwanda is a political question. Thus, it does not fall under the courts of justice. He told the audience that if that battle is to begin again, they are ready to fight. He insists that there is no way to continue to revisit this issue. Addressing this issue judicially would lead to complex question that lawyers and the Ministry of Justice cannot resolve. This debate must be closed, he ordered. He said that they must stop "Akajagari", means the disorder. He added that whoever wants to deal with this complicated question should first of all ask him the question of why the Rwanda Patriotic Front was founded. How did he came to power? This is not a question of the courts of justice, he concluded. He asked the assembly if they want to continue to revise everything.

Once the Minister of justice reply to the President of the Republic, he recognized that the land issue in Rwanda is a national concern. It concerns almost the entire country according to him. The issue was addressed during the Harusha peace negotiations between the former rebellion represented by current President Paul Kagame and the government of the former President of Rwanda Juvenal Habyarimana. In his response to the President's questions, he recognized that local administrative had debated this question, three days before. When, they held a retreat in Rubavu district, local representatives agreed to find out the way it should be closed. They have engaged to stop haunting the President's mind when he hears people claims every time in Nyaruguru, Rubavu, Karongyi, in the Eastern Region and so on. The Minister of justice remembered the audience that the issue of land sharing, the right to property and the land law reforms has been widely discussed, since Harusha. Long-time refugee has the right to be relocated but he must not recover his former property.

His Excellency Paul Kagame was direct and intransigent in his reaction to the response given by the Minister of Justice during the meeting. According to President Paul Kagame, the big question is that if they turned that issue into a concept of jurisprudence, they may open up a problem they'll never overcome. He added that it is no longer a question for debate, because it would take another 5 years, 10 years without verdict.

2. Analysis of the speech of the President of Alliance for Green Revolution in Africa

When the issue of access to land remains complex and unresolved in Rwanda, there is also the question of integration and access to the market of small and middle enterprises. Mrs Agnes Kalibata, Former Minister of Agriculture and Livestock in Rwanda, has becoming the President of AGRA (Alliance for Green Revolution in Africa). Lately, she has been awarded for the Honoris Causa Prize in March 2018 by the "Université de Liège". In her speech, she regretted that the requirements of major financial institutions were incompatible with the operational conditions of small and medium-sized agricultural enterprises.

"The harsh truth is, if an investor expects that their investment will only go to the 5 or 10 million Euros type of businesses, and then they are not really serious about investing in growing African agriculture markets. Such investments will have minimal impact at scale [...]. Additionally, agriculture SMEs face some of the greatest risk which they have no capacity to absorb. This includes the foreign exchange risk. As they deal in food crops that are traded in local currency, they cannot borrow in foreign currency. They are also exposed to political risks. In most African countries, governments, for example, impose export bans for political reasons. This is done without regard for private agri-businesses which suffer as they can no longer access regional markets" (Kalibata, 2018).

3. Foreigner investors and elites power in business

On Sunday, 22nd January 2018, 12 GMT, Radio Itahuka, a medium of Rwandan citizens based in Washington DC broadcasts on Short waves 19M 15420 KHz. Major Jean Marie Micombero and Robert Mukombozi, activists in the opposition living in Belgium were interviewed. The journalist Serges Ndayizeye asked them to comment the doing business framework in Rwanda. They said that the Rwandan economy much more benefits

to foreigners than to natives. Ansoms (2013) reported two cases of land grabbing in swampland by foreigner investors facilitated by local authorities in detriment of peasant's livelihoods. In the other hand, the case below reported in a video posted on YouTube by the Natural resources authority (2016) show a ceremony of land sharing in Rubavu district where large land owner has been expropriated in favour of small landholders.

4. Large Landholdings: counterbalanced land sharing

The land sharing ceremony was supervised by representatives of the Rwanda Natural Resources Authority (RNRA, 2016): "Ugusaranganya ubutaka: land sharing" in the North-Western Region of Rwanda, Rubavu District, Mudende Cell, Mirindi Sector. Matayo Ngirira, a large landowner has died but he was represented by his brother Michel Hategekimana. The later gave 22 ha of 50 ha of his land property. The land has been shared between 68 neighbouring families. Each of those 68 Rwandan families returned from Congo was given by the Rwanda natural resource authority an average small plot of 0.32ha with a certificate of ownership. The former owner apparently rejoices for the outcome of this land dispute after 22 years of the conflict.

The lesson learned is that the way land is shared looks like unfair but reasonable. Smallholders with empty hands get small plots of land. On the other hand, the big landowner without having to lose all of his property, he remains with the big part of the cake. By the way, it had been demonstrate that there is a strong inverse relationship of land size and the productivity in Rwanda (Ansoms et al., 2008; Ali and Deininger, 2015). One more consideration is that those who get exploitation rights have the obligation of results. But they cannot guarantee to fulfil what authorities asked them to achieve if they are not supported by a coherent institutional and financial framework. The land system design in Rwanda is a mixture of small private properties in majority for survival livelihoods owned by those called "agriculture operators" and large private holdings for investment opportunities owned by those called "large scale farmers". The later are "the person, institution or cooperatives growing crops on minimum 10ha or raising minimum 70 cattle, 350 goats or sheep, 140 pigs, 1,500 chicken or managing 50 bee hives" (Republic of Rwanda, National institute of statistics of Rwanda, 2016).

5. Low value of the labor force disadvantages access to land for peasant

Ansoms (2013) qualifies as "large-scale land deals" the phenomenon where family farmers in African countries are facing hard competition with big investors both foreigners and local elites facilitated by liberalization policies on agricultural and land markets. Family farming is now forced to engage in agro-business so as not to be out of the market, where imperfect competition often prevails. The diagnosis of the agriculture labor force value shows that it is mainly based on poorly paid peasant (Ansoms, 2013). In 2002, the productivity of land and labor assessed by the Rwandan Minister of agriculture and livestock was \$409/ha/year, or \$1.12 /ha/day. The daily wage of an agricultural labor force is estimated between \$0.91 and \$1.36/day. Labor fees below \$1.99/day according to the World Bank estimation are not enough (Republic of Rwanda, Ministry of Agriculture and Livestock, 2004).

It is insufficient compared to the high cost of living in Rwanda (Ansoms, 2013). The average farmed area per farm household is about 0.75 ha and 11.5% of rural households do not own land (Republic of Rwanda, Ministry of Agriculture and Livestock, 2004). In the Nyabarongo swamp, daily wage of 7 hours of agriculture labor force is paid 400Frw/day equivalent to 0.5 €/day sometimes fewer (Ansoms, 2013). The payment is regularised at the end of the month related to the number of days worked. Meanwhile, selling farm labor force is a way to earn some cash immediately to meet the urgent needs. This inadequate salary does not attract the peasants to work in so-called "modern" farms. According to Ansoms (2013), they prefer to work on their fields than to engage in large-scale sugar cane plantations hold by a foreigner investor. The situation is likely to generate "a rural proletariat" and transform poor peasants into poorly paid labor force (Ansoms, 2013). This situation does not improve access to land. Human Rights Watch (2001) cited by Leegwater (2015), reports that « the government intended to create modern, larger-scale agricultural production methods. Distancing peasants from their fields, a deputy reasoned, would cut their emotional attachment to the land and make them treat it more as an economic good valued only in terms of its productive capacity» Leegwater (2015).

6. Redistribution and concentration of land guide: hybrid reforms

The characterization of agrarian reforms

in Rwanda is not easy. They represent ambiguities or very striking contradictions. This shows, on the one hand, that the government is torn between market-led and state-led agrarian reforms. The application of the donor's obligations who advocate the liberalization of the economy is not matching with the reconciliation of the Rwandan people. The foreignization is not only the facts of foreigners facilitated by local elites involved in land grab (Fairbairn, 2013). Whenever governments are influenced by outside prototype of land and agrarian governance can be consider as land policy foreignization. On the one hand, the land policy gives the impression of highlighting the interest of the peasantry by questioning the big landowners. Land is taken over by the authorities from the large landowners and they are redistributed to the landless poor returnees. This decision is a minimum of social justice. The landholder obtains individual property certificate. At the same time, they are advised that these certificates of ownership are not considered as definitely acquired. Rational use of granted land is an obligation and not an individual farm management decision.

Once the land is obtained, it must be used in the respect of the instructions fixed by the administration who is the guarantor of the implementation of the agricultural policy (Kathiresan, 2012). In Rwanda, access to land is possible through several means of temporary or permanent appropriation such as inheritance, rent, gift or purchase. The government seeks to facilitate access to land and the rational use of agricultural resources through the liberalization of the land market. For instance, a hybrid land sharing scheme is being operate where redistribution of land coexists with the collectivization of redistributed lands. Kathiresan (2012) mentioned in his report that joining the land consolidation program is voluntary. However, he added that land consolidation is a condition for access to other services provided by the Crop Intensification Program (CIP). This proves that choices are limited for peasants. Although, making a choice not to participate in the agricultural intensification program is free, the opposite is a choice that hinders access to inputs and financing.

Pooling individual land properties in collective large bloc is therefore not voluntary but conditional. Land holders are involved in large scale economy. "Consolidated use of lands allows farmers to benefit from the various services under the Crop Intensification Program such as inputs (improved seeds, fertilizers), proximity extension services,

post harvest handling and storage facilities, irrigation and mechanization provided by public-private stakeholders" (Khatiresan, 2012).

Conclusion

The land reforms in Rwanda initiated in 2004 are based on the systematic registration of properties so that the landholder has an individual status of landowner. They were carried out under land redistribution program to former Tutsi refugees flee out in 1959 and other landless peasants returned after 1994 Rwandan Tutsi genocide. Land consolidation has been ordered as a way of sharing land to try to increase the access of many peasants "abahinzi" to the land. Farmers who pool together their plots are considered as legal shareholders who retain their individual property rights over the consolidated large-scale land. Formerly, the expected production on consolidated land is likely to increase. However, this is a simplified way to address the issue of farmers' access to land and increased productivity. Even in the land consolidation perspective, one hectare shared between 15 stakeholders remains inelastic. Landlessness prediction could decrease if the marginal individual property increases. In these perspectives, population growth is decreasing or agriculture population is declining over time.

On the structural level, traditional Rwandan agriculture is rooted in logic of recognition of the food function of agriculture to meet the nutritional needs of the family. On the other hand, it is economically justified for the farmer himself to cultivate the foodstuffs necessary for subsistence because the opportunity cost of purchasing price can double or triple the selling price. The risk of food insecurity is high and there is unlikelihood future for smallholders especially when agriculture labor force is poorly paid (Boussard, 1987 cited by Charlery de la Masselière, 1992; Ansoms, 2013). Maintenance of the certificate of land property is conditioned by the "rational use of land". Under penalty of being expropriated, the food function of agriculture has no longer priority over business interest. Agriculture operators do not just produce for themselves or their families. They must release a surplus for the market.

Since the 2004 land reforms policy, peasants and farmers are no longer self-employed workers. They have an account to provide of the use and assignment of the land they own. As the eminent land owner is the State, the boss is designated by land law as "the competent authority" (Organic Law on land tenure in Rwanda, 2005). Every

agriculture landholder is not definitely landowner for free management of his property. In fact, although he has received the rights of exploitation materialized by a certificate of registration, rather a right of land property, he has a usufruct one. Thus, he is considered as any service provider to the State. Logically, he requires an adequate remuneration of his labor force or investments. In accordance with what is officially advocated in the 2004 Land Policy, land is a tradable commodity. It is no longer a common good for redistribution to landless population. Adequate remuneration for agricultural work may be an inherent perspective of the authority's obligations. But, the free market principles are not compatible with such regulation.

Promoting the agricultural food production function means valuing the farmer and giving him a role recognized by the community in the production of the country's wealth. Thus, it is in this sense that changes in agricultural policies must evolve, not only in market logic but also in social protection. "Peasant dignity" depends on it (Niyonkuru, 2017). It is not enough to reform the land to follow the guidelines of the donors concerning the modernization of the agricultural sector (Ndayishimiye, 2005). The agricultural sector in Rwanda has already reached its breaking point. There is no possibility of grabbing land because there is not enough area. Whoever occupies a certain agricultural area should be advised that someone else has been somehow ejected. That's why the owner is responsible for optimally exploiting the land he occupies for general interest. However, optimal exploitation requires that the land owner gets access to adequate income. Land grabbing would only aggravate the situation. It is necessary to reduce pressure on agricultural land where it is not in abundance. The diversification of economic activities is very urgent. The size of farms tends to decline over time and exclusive individual ownership of large farms is detrimental to the future of Rwandan agrarian systems. These observations are consistent with those of Burundi, a neighbouring country whose socioeconomic configuration and historical context are comparable (Ndayishimiye, 2005).

Therefore, it is necessary to enhance the status of family farming whose rights and duties change with land reforms in Rwanda. The recognition of the agricultural food function needs legal framework which establishes a social, legal and economic status of family farms. It should be noted that the property tax is mandatory for any landowner (Article 68) and the fact of

enclosure land is not an act of rational management and sufficient conservation according to Articles 61 to 65 of the 2005 law land tenure system in Rwanda. This can be considered as a hoarding of agricultural land taken in the sense of a prolonged mobilization in time of a good by an individual who does not use it in productive way. Hoarding is denial to consume or invest in any form at all (Thuillier and Gaillard, 1965). However, one can ask the question if in fact a land not exploited according to the norms of the 2005 organic law on land tenure and the 2004 land policy reforms is automatically considered as non-productive use. In-depth research is required to refute or confirm if the land and agrarian reforms initiated by the Rwandan government in 2004 have contributed to rational use of rural lands. If so, is there any improvement in farmer access to local market as well as regional and international levels. The results of further research would also make it possible to evaluate if land sharing and regrouping of individual properties enables Rwandan peasant to improve land management. Have the land and agrarian reforms initiated by the Rwandan Government in 2004 improved the access to land ownership for peasant « Abahinzi » or investors "Abanyemari" in a balanced way? Has the redistribution and consolidation of individual land holdings helped to combat the non-productive use of rural land? The answers to these questions require further research that confronts the literature review with the realities on the field.

Furthermore, agrarian and land reforms must find a point of balance. The land reforms equilibrium may consist in reducing the pressure on the property assets by elites as well as it is improving the access to land and to inputs in favour of « market minded peasants » engaged in diversified food production (Allina-Pisano, 2004). Large-scale land in the context of land scarcity and growing population is a complex question. Therefore, the land sharing perspectives need large consultation and open debate. Large landowners could pay progressive taxes when their property size is beyond the marginal individual property. This marginal tax could be used to discourage land grabbing and facilitate the financing of economic projects initiated to avoid mass unemployment of dispossessed peasants in rural areas. Ali and Deininger (2015) have found an inverse relationship between farm size and productivity. The scale they used as small, medium and large farm is still open to discussion. Land consolidation has revealed that maize yield could be four times higher than the yield

on fragmented land (Ekise et al., 2013). Property rights does not predict the rational land use nor for large neither for small, local or foreigner landowners in Rwandan rural economy. It is fundamental to perform sustainable assessments about the effects of individual property rights and collective use of land on agrarian system transformation in Rwanda.

Moreover, the possibilities of extending the territory beyond its borders as it used to be in the past are no longer exist (Nkusi, 2000). The perspectives of agrarian evolution in Rwanda are inherent in collective agriculture intensification to avoid excessive fragmentation for increasing production (Ekise et al., 2013, Musabanganji, 2016). Rwandan peasants have no more choice. They need to deal with the evidence of the scarcity of farm land and collaborate in the agriculture transformation. The capitalist approach adopted by the government is based on the principles of collective liberalism through commercial cooperatives (Gisaro, 2013). This political choice requires transformation of the land-man relationship under global economy. Obviously, farmers and peasants face a critical situation. Those who could be involved in other small and medium enterprises must not hesitate to ask for mentorship to Rwanda agriculture board (RAB, 2017; MINEACOM, 2017). They must find together with the government and the international partners who are coaching them the more sustainable solutions for their agrarian system transformation whereas prevent unemployment. How could smallholders take advantage of the market and minimize the risk of dispossession? The most vulnerable people live in rural areas. Almost 97% have land and are raising livestock (National institute of statistics of Rwanda, 2015). The evidence of this research is that land in Rwanda is scarce and marginal individual property will continue to decrease over time in the high densely populated areas. Land sharing perspectives open a great debate on agrarian system transformation in Rwanda.

Corresponding authors:

Mireille Mizero

Département d'Economie et du Développement rural, Gembloux Agro-Bio Tech

Université de Liège, Belgium

Phone: +32 465916053, E-mail: mireille.mizero@doct.uliege.be

References

- [1] Ali, D. A and Deininger, K. (2015) "Is there a farm size productivity relationship in African Agriculture? Evidence from Rwanda", *Land economics*, Vol. 91, No. 2, pp. 317-343. E-ISSN 1543-8325, ISSN 0023-7639. DOI 10.1596/1813-9450-6770.
- [2] Allina-Pisano, J. (2004) "Land reform and social origin of private farmers in Russia and Ukraine", *The Journal of Peasant Studies*, Vol. 31, Vol. 3, 4, pp. 489-514. DOI 10.1080/0306615042000262661.
- [3] Amelot, X. (1997) "Pression démographique et dynamiques des systèmes ruraux au Rwanda", *Cahiers d'outres-mer. Environnement et développement*. Vol. 197, pp. 7-26. [On line] Available: http://www.persee.fr/doc/caoum_0373-5834_1997_num_50_197_3635. [Accessed: 7 May, 2018]. E-ISSN 1961-8603.
- [4] André, C. (1998) "Terre rwandaise, accès, politique et réformes foncières", In: Marysse, S. (Dir.). *Synergies. L'Afrique des Grands Lacs*. Annuaire, pp. 141-173. ISSN 2258-4307.
- [5] André, C. and Platteau, J. P. (1996) "Land tenure under unendurable stress: Rwanda in malthusian trap", *Cahier de la Faculté des Sciences économiques et sociales*, No. 164/7, Namur, Centre de Recherche en Economie du Développement, 49 p. [Online] Available <https://repositories.lib.utexas.edu/bitstream/handle/2152/5453/2744.pdf?sequence=1&isAllowed=y> [Accessed: 6 Sept 2017].
- [6] Ansoms, A. (2009) "Re-engineering rural society: the vision and ambitions of the Rwandan elite", *African affairs*, Vol. 108, No. 431, pp. 289-309. E-ISSN 1468-2621, ISSN 0001-9909. DOI 10.1093/afraf/adp001.
- [7] Ansoms, A. (2010) "Views from below on the pro-poor growth challenge: The case of rural Rwanda", *African Studies Review*, Vol. 53, No. 2, pp. 97-123. E-ISSN 1555-2462, ISSN 0002-0206. DOI 10.1353/arw.2010.0037.
- [8] Ansoms, A. (2013) "Large-scale land deals and local livelihoods in Rwanda: the bitter fruit of a new agrarian model", *African Studies Review*, Vol. 56, No. 3, pp. 1-23. E-ISSN 1555-2462, ISSN 0002-0206. DOI 10.1017/asr.2013.77.
- [9] Ansoms, A., Verdoodt, A. and Van Ranst, E. (2008) "The Inverse Relationship between Farm Size and Productivity in Rural Rwanda", No. IOB Discussion papers (2008.9), 34 p.
- [10] Burger, A. (2001) "Agricultural development and land concentration in a central European country a case study of Hungary", *Land use policy*, Vol. 18, No. 3, pp. 259-268. ISSN 0264-8377. DOI 10.1016/S0264-8377(01)00023-0.
- [11] Charlery de La Masselière, B. (1994) "Versant du Rwanda: la gestion de l'incertitude" (in French), *Les Cahier's d'outre-mer*, Vol. 185, pp. 7-22. [Online] Available: http://www.persee.fr/doc/caoum_0373-5834_1994_num_47_185_3501 [Accessed: 7 May 2018]. E-ISSN 1961-8603, ISSN 0373-5834.
- [12] Compagnon, D. (2003) "La prétendue 'réforme agraire' au Zimbabwe. A qui profite le crime?" (in French), *Études*, Vol. 398, No. 3, pp. 297-307.
- [13] Cousins, B. (2007) "More Than Socially Embedded: The Distinctive Character of 'Communal Tenure' Regimes in South Africa and its Implications for Land Policy", *Journal of Agrarian Change*, Vol. 7, No. 3, pp. 281-315. E-ISSN 1471-0366. DOI 10.1111/j.1471-0366.2007.00147.x.

- [14] Ekise, I. E., Nahayo, A., Mirukiro, J. D. and Mukamugema, B. (2013) "The impact of land use consolidation program on agricultural productivity: a case study of maize (*Zea mays* L.) production among households in Nyabihu district, Western Rwanda", *Nature and Science*, Vol. 11, No. 12, pp. 21-27. [Online] Available: <http://www.sciencepub.net/nature> [Accessed: 4 May 2018]. E-ISSN 2375-7167. ISSN 1545-0740.
- [15] Fairbairn, M. (2013) "Indirect dispossession: domestic power imbalances and foreign access to land in Mozambique", *Development and Change*, Vol. 44, No. 2, pp. 335-356. E-ISSN 1467-7660. DOI 10.1111/dech.12013.
- [16] Fond Monétaire International (2016) "*Perspectives économiques mondiales: Afrique Sub-Saharienne, un changement de cap s'impose*" (in French), Washington. ISBN 978-1-47551-544-2.
- [17] Gisaro, C. Y. (2013) "*La structuration du monde paysan au Rwanda: cas des coopératives et des stations de lavage de café de Maraba et de Karaba, district de Huye*" (in French), Ph.D. Dissertation, Université de Gembloux agro-biotech.
- [18] Herrera, A., Riddell, J. and Toselli, P. (1997) "Recent FAO experience in land reform and land tenure", *Land Reform, Land Settlement and Cooperatives*, Vol. 1, pp. 52-64. ISSN 0251-1894.
- [19] Kalibata, A. (2018) "Re-envisioning investment for African Agriculture: top priorities for growing food, jobs and economies", *Public Lecture*, 23 March 2018, University of Liege, Belgium [Online]. Available: <https://agra.org/wp-content/uploads/2018/03/University-of-Liege-Dr.-Kalibata-Speech.pdf> [Accessed: 4 May 2018].
- [20] Karangwa, A. (2008) "*Diagnostic et essai de typologie des exploitations agricoles de Gikongoro (au Rwanda). Formulation et analyse socioéconomique des interventions de développement agricole*" (in French), Ph.D. Dissertation, Université de Gembloux agro-biotech
- [21] Kathiresan, A. (2012) "*Land farm use consolidation in Rwanda: assessment from the perspectives of agriculture sector*", Republic of Rwanda, Ministry of Agriculture and Animal Resources, Report.
- [22] Klasen, S. and Reimers, M. (2014) "Looking at Pro-poor Growth from an Agricultural Perspective", Paper Prepared for the *IARIW 33rd General Conference Rotterdam*, the Netherlands, August 24-30.
- [23] Leegwater, M. E (2015) "*Sharing scarcity: land access and social relations in Southeast Rwanda*", Ph.D. Dissertation, Vrije Universiteit.
- [24] Lenoir, R. (1984) "*Le tiers monde peut se nourrir*" (in French), Report of Club de Rome., Fayard, France. ISBN 2-213-01385-3.
- [25] Maquet, J. J. (1967) "La tenure des terres dans l'État Rwanda traditionnel" (in French), *Cahiers d'Études africaines*, Vol. 7, No. 28, pp. 624-636. [Online] Available http://www.persee.fr/doc/cea_0008-0055_1967_num_7_28_3113. [Accessed: 07 May 2018]. E-ISSN 1777-5353, ISSN 0008-0055. DOI 10.3406/cea.1967.3113.
- [26] MINEACOM (2017) "*Small industries that deals with agricultural products in Rwanda*". [Online]. Available: <https://www.youtube.com/watch?v=3B0btnKm-xs> [Accessed: 10 May, 2018].
- [27] Ministère des ressources naturelles (2018) Arrêté ministériel n° 002/2008 du 01/04/2008 portant modalités d'enregistrement des terres. République du Rwanda (in French).
- [28] Ministère des terres, de l'environnement, des forêts, de l'eau et des mines (2004) "*Politique Nationale foncière. Républiques du Rwanda*". [Online]. Available: <http://www.amis.minagri.gov.rw/fr/documents/projet-de-politique-nationale-fonciere> [Accessed: 10 May, 2018].
- [29] Musabanganji, E., Karangwa, A. and Lebailly, P. (2016) "Intensification of smallholder agriculture in Rwanda: Scenarios and challenges toward a sustainable transformation", *5th international conference on AAAE*, United Nations Conference Center: Transforming smallholder agriculture in Africa, the role of policy and governance, 23-25 September, Addis Ababa Ethiopia.
- [30] National Institute of Statistics of Rwanda (NISR) Ministry of Finance and Economic Planning (MINECOFIN) (2012) "*Rwanda Fourth Population and Housing Census*", Thematic Report: Population size, structure and distribution.

- [31] National Institute of Statistics of Rwanda (NISR) (2015) "*Social protection and VUP Report, 2013/14*". [Online]. Available: <http://www.statistics.gov.rw/publication/rwanda-social-protection-and-vup-report-results-eicv-4> [Accessed: 5 May 2018].
- [32] Ndayishimiye, P. (2005) "*Relations cultures vivrières-cultures de rente et dynamiques agraires au Burundi: une étude de cas à partir de trois régions agro-écologiques (Buyenzi, Imbo-sud et Mugamba-sud)*" (in French), Ph.D. Dissertation, Université de Liège, Faculté universitaire des sciences agronomiques de Gembloux.
- [33] Niyonkuru, D. (2018) "*Pour la dignité paysanne : expériences et témoignages d'Afrique, réflexions, pistes méthodologiques*" (in French), Groupe de recherche et d'information sur la paix et la sécurité. Brussels, Belgium. ISBN 978-2-87291-115-8.
- [34] Nkusi, J. (2000) "*Problématique du régime foncier au Rwanda: contexte et perspective, relation avec l'habitat regroupé*" (in French). Report of consultancy. [Online]. Available: <https://repositories.lib.utexas.edu/bitstream/handle/2152/5932/3185.pdf?sequence=1&isAllowed=y> [Accessed: 10 May 2018].
- [35] UrbanLex (2005) "*Organic Law 08/2005, 14/07/2005 governing land tenure in Rwanda*". [Online]. Available: <http://urbanlex.unhabitat.org/law/194> [Accessed: 9 May, 2018].
- [36] RAB (2017) "*Rwanda agriculture board RAB activites*" [Online] Available: <https://www.youtube.com/watch?v=JGhPwDlcJZ0> [Accessed: 10 May, 2018].
- [37] Radio Itahuka (2018) "*Radio Itahuka Kuri Sw 19M 15420 Khz: Micombero & Mukombozi Barasubiza Ibibazo Twandikiwe*". [Online]. Available: https://www.youtube.com/watch?v=Ae_uwYc4oBQ [Accessed: 6 May 2018].
- [38] Republic of Rwanda, Natural Resources Authority (2016) "*Ugusaranganya ubutaka*". [Online]. Available: <https://www.youtube.com/watch?v=CXnpRkwv2Hk> [Accessed: 30 April 2018].
- [39] République du Rwanda, Ministère de l'agriculture et de l'Elevage (2004) "*Plan stratégique pour la transformation de l'Agriculture au Rwanda*" (in French). Main document. [Online]. Available: <http://www.amis.minagri.gov.rw/fr/documents/plan-strategique-pour-la-transformation-de-l%E2%80%99agriculture-au-rwanda> [Accessed: 6 May 2018].
- [40] République du Rwanda, Ministère des terres, de l'environnement, des forêts, de l'eau et des mines (2004), "*Politique Nationale foncière*". [Online]. Available: <http://www.amis.minagri.gov.rw/fr/documents/projet-de-politique-nationale-fonciere> [Accessed: 15 May, 2018].
- [41] Rwanda TV (2018) "*Umwihereho w'Abayobozi b'inzeho z'ibanze*", Kigali, Petit stade, 28th-29th March [Online]. Available: <https://www.youtube.com/watch?v=OjErl6McXxY> [Accessed: 4 May 2018]
- [42] Skrubbeltrang, F. (1953) "*Agricultural development and rural reform in Denmark*", Food And Agriculture Organization Of The United Nations: Rome, p. 320.
- [43] Thuillier, G. and Gaillard, Y. (1965) "*Sur la thésaurisation*" (in French), *Revue économique*, Vol. 16, No. 5, pp. 796-808. [Online]. Available: http://www.persee.fr/doc/reco_0035-2764_1965_num_16_5_407681 [Accessed: 7 May 2018].
- [44] Van Hoyweghen, S. (1999) "The urgency of agrarian and land reform in Rwanda", *African affairs*, Vol. 98, No. 392, pp. 353-372. E-ISSN 1468-2621, ISSN 0001-9909. DOI 10.1093/oxfordjournals.afraf.a008044.
- [45] Verwimp, P. (2011) "The 1990–92 massacres in Rwanda: A case of spatial and social engineering?", *Journal of Agrarian Change*. Vol. 11, No. 3, pp. 396-419. E-ISSN 1471-0366. DOI 10.1111/j.1471-0366.2011.00315.x.

Questionnaire vs. Social Media Analysis - Case Study of Organic Food

Ladislav Pilař¹, Lucie Kvasničková Stanislavská¹, George Gresham², Jana Poláková¹, Stanislav Rojík¹, Rosen Petkov³

¹ Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

² Davis College of Business, Jacksonville University, USA

³ Department of Electronics and Informatics, Technical University of Sofia, Bulgaria

Abstract

The amount of European farm acreage devoted to organic foods has been increasing each year over the past three decades, as farmers strive to meet consumer demand for these products. To understand what factors drive this demand, researchers have focused on the end customers' perception of organic food and their motivations to purchase it. The standard research methods are questionnaires and literature review; however, these tend to be expensive, time consuming, or involve work with secondary data. This paper compares 14 studies carried out using standard research methods with the results of a social network analysis based on 344,231 posts by 73,380 Instagram users. The result of the comparison shows that in the case of organic food, the characteristic of "healthy" is the most important one to customers, both based on questionnaire surveys and the social network analysis. Moreover, based on these two analyses, 4 key areas can be identified as factors that are important to customers buying organic food: (1) health consciousness, (2) ecological motives, (3) tasty and (4) hedonism. As the results indicate, social network analysis can be considered a method with a high potential for gaining a greater insight into customers' perceptions.

Keywords

Organic food, questionnaire, social media analysis, hashtag, healthy.

Pilař, L., Kvasničková Stanislavská, L., Gresham, G., Poláková, J., Rojík, S. and Petkov, R. (2018) "Questionnaire vs. Social Media Analysis - Case Study of Organic Food", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 93-101. ISSN 1804-1930. DOI 10.7160/aol.2018.100308.

Introduction

In the past three decades, organic farming and acreage devoted to organic foods have been growing in Europe every year. Currently, organic food is grown on 50.9 million hectares globally, i.e. on 1% of global agricultural land and 6.2% of agricultural land in the EU (Willer and Lernoud, 2016). The increase in ecological farming is related to consumers' interest in topics such as environmental protection, production of high-quality, safe food, and creation of good living conditions for animals (Brožová and Beranová, 2017). Consumers see ecological farming contributing to the production of environmentally-friendly, healthy, nutritious and high-quality food, thanks to the production processes and practical procedures (Vaněk et al., 2013; Pilař et al., 2018). These include using a limited amount of synthetic pesticides and fertilizers, only feeding animals with low amounts of concentrated feed (Popa et al., 2018) and producing food with a greater content

of vitamins and minerals compared to conventional food products (Worthington, 2001).

The changes in consumers' behaviour need to be identified and analysed. That's why in the past years, several studies have been carried out on customers' attitude to organic food and their motivations to buy it. The results of the studies have shown that organic food is very often connected with the characteristics of "more expensive" (Hasimuu et al., 2017; Bryla, 2016), "tastier" (Bryla, 2016; Lea and Worsley, 2007), and primarily "healthier" (Asif et al., 2018; Hansen et al., 2018; Hasimu et al., 2017; etc). However, the actual effect of organic food on human health hasn't been sufficiently proved, as indicated by the results of studies carried out by Popa et al., 2018; Brennan et al., 2003; Huber et al., 2011.

The above mentioned studies examined the customers' perception of organic food using questionnaire surveys and interviews. The most frequently used data collection methods in organic

food research involve online surveys or structured questionnaires. In spite of their popularity, questionnaire surveys have certain disadvantages. Questionnaire design requires a wide range of knowledge and training, questionnaires with many open-ended questions can generate large amounts of data, and it takes significant effort to analyse and even more time to interpret them. However, the greatest disadvantage is the low response rate and time consuming nature of the research (Wilson, 2013). In the studies concerned, the sample of respondents ranged between 100 and 1,000 people. In contrast, modern research methods, such as social network analysis, allow for collecting data from a sample of several hundred thousands of respondents.

Social media as a data opportunity to research

Currently, there are more than 2.5 billion social network users and it is expected that by 2021, there will be 3 billion of them (Statista, 2017). Social network users are no longer mere content consumers; they create their content themselves (Malthouse et al., 2013). The fastest growing social network is Instagram with 800 million active users (Aslam, 2018). Every day, Instagram users upload more than 95 million pictures and have 4.2 billion interactions using "like". This activity creates a huge potential for research organisations' analyses of this data.

Aim of the present study

The aim of the study is to identify the differences and potential added value of social media analysis based on social network analysis as a method to evaluate knowledge collected using questionnaire surveys in the field of customers' perception of organic food.

In this article, we review and discuss the perception of organic food by end customers and their motivations to buy organic food.

We describe the perception of organic food on social networks based on 344,213 posts of 73,380 unique users on Instagram worldwide by identifying the most commonly used hashtags on social networks related to the term organic food by means of a social network analysis.

The results of the social network analysis are compared to the results of 14 studies conducted using standard research methods.

Materials and methods

In this paper, two areas of research methods were used: social network analysis and literature review.

The aim of the social network analysis is to understand the structure of the network and identify the significance of individual nodes (or hashtags in this study) by defining their position and significance in the network (Oliveira and Gama, 2012). The input data for the analysis were collected by Netlytic (Gruzd, 2016) between 2017-07-30 and 2018-03-09 by identifying the hashtag #organicfood in the posts. Individual data is stored in data sets containing 100,000 posts. In total, the analysis involved 340,358 posts from 73,380 unique users. Considering the great amount of input data, with individual data packages containing from 1,719,329 to 1,912,679 unique words, the data to be further processed was filtered twice. At the first stage, hashtags were extracted starting with #. Using hashtags, Instagram users communicate the most important characteristics they want to relate together with the picture (Pilař et al., 2017). The second stage of filtering eliminated hashtags repeated in the data set less than 100 times. The filtering narrowed down the data set to 6,247 most frequently used hashtags. This data were then inserted into Gephi 0.9.2, creating a network containing 6,247 nodes (hashtags) connected by 1,992,499 edges. To identify the significance of the individual hashtags, the following statistical methods were used:

Degree centrality

This centrality measures the activity that the node shows in the network. High-value nodes have "centers" in a given network. The degree k_i of a node i is defined as the number of its neighbors, that is, the number of links incident to node i , where a_{ij} the elements of the adjacency A matrix Π_i and the neighborhood of node i (Antoniou and Tsompa, 2008):

$$k_i = \sum_{j \in \Pi(i)} a_{ij}$$

Eigenvector centrality

Eigenvector centrality is a score expressing the "importance" of a node in the network. The score of this parameter is based on the assumption that the connection with nodes of higher importance increases the importance of this node more than the connection with nodes of less importance. Eigenvector centrality is a relative score recursively defined as a function of the number and strength of connections to its neighbours and as well as those neighbours' centralities (Ilyas and Radha, 2011). X_i is score where A means the neighbourhood matrix. After editing, x meets the equation $A_x = \kappa_{1x}$,

where κ_1 is its largest own number (that means, κ is the number for which applies that $A_x = \kappa_x$, where x is the vector itself) and λ is the maximum eigenvalue of the matrix A_2 .

$$X_i = \frac{1}{\lambda} \sum A_{xj} X_j$$

The review process followed the procedures described in Systematic Reviews in the Social Sciences: A Practical Guide (Petticrew and Roberts, 2008). Research was looked up in the Science Direct and Google Scholar databases. To look up the relevant research, the following key words were used: “consumers’ attitude towards organic food”, “purchase intention for organic food” and “willingness to pay for the organic products”. Only the research using questionnaire surveys was included in the review.

Results and discussion

Based on our degree centrality analysis, it is possible to identify the 5 most significant hashtags in the network in terms of their connection to other hashtags. This value allows for identifying the 5 most significant hashtags: #healthyfood, #vegan, #healthy, #eatclean, #vegetarian, see Table 1.

Degree distribution corresponds with the long tail characteristic. There are only 5 hashtags with a degree higher than 5,200. On the other hand, most hashtags fall into the category with a degree between 0 and 1299, which is a strong indication of the standard behaviour in social networks regarding hashtag usage (Kordumova et al., 2016) see Table 1 and Figure 1.

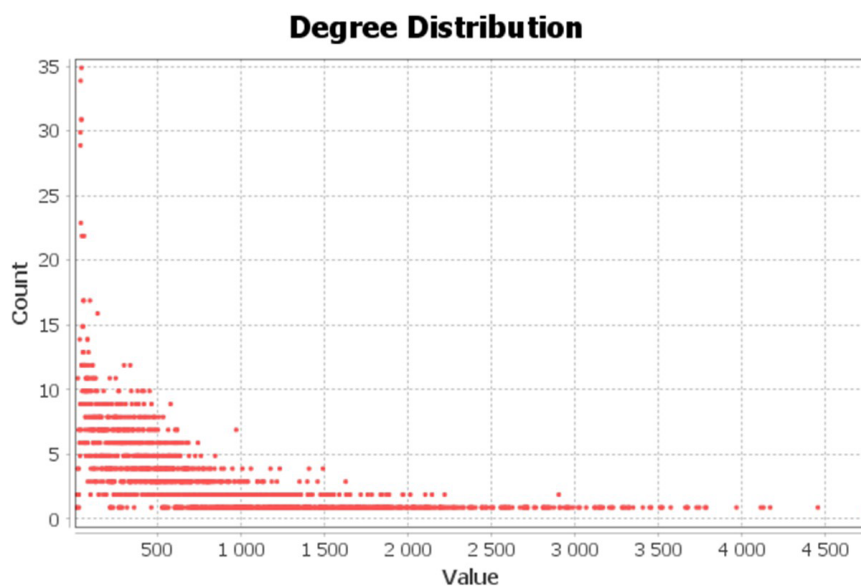
Based on our eigenvector centrality analysis, it is possible to identify the 5 most significant

Hashtags	#healthyfood	#vegan	#healthy	#eatclean	#vegetarian
Degree	5537	5483	5435	5110	4901
Degree range	5200- 6499	3900- 5199	2600- 3899	1300- 2599	0- 1299
No. of hashtags	5	43	134	566	5499
Percentage	0.08%	0.69%	2.15%	9.06%	88.03%
Eigenvector Centrality	0.981427	0.980745	0.978377	0.959511	0.950584
Eigenvector Centrality Range	0.8–1.0	0.6–0.79	0.4–0.59	0.2–0.39	0–0.19
No. of hashtags	73	194	474	1.7	3.806
Percentage	1.17%	3.11%	7.59%	27.21%	60.93%

Note: The highest degree: #organic food: 6.245

Source: own processing

Table 1: Degree Centrality and Eigenvector Centrality of hashtags at social network based on the #organicfood hashtag.



Source: own processing

Figure 1: Degree centrality distribution of hashtags connected to hashtag #organicfood.

hashtags in the network in terms of their connection to other hashtags. This value allows for identifying the 5 most significant hashtags: #healthyfood, #vegan, #healthy, #eatclean, #vegetarian, see Table 1.

Degree distribution corresponds to the long tail characteristic. There are only 73 hashtags with an eigenvector centrality greater than 0.8 and 28 hashtags with an eigenvector centrality greater than 0.9. On the other hand, most hashtags fall into the category with an eigenvector centrality between 0 and 0.2, which is a strong indication of the standard behaviour in social networks regarding hashtag usage (Kordumova et al., 2016) see Table 1 and Figure 2.

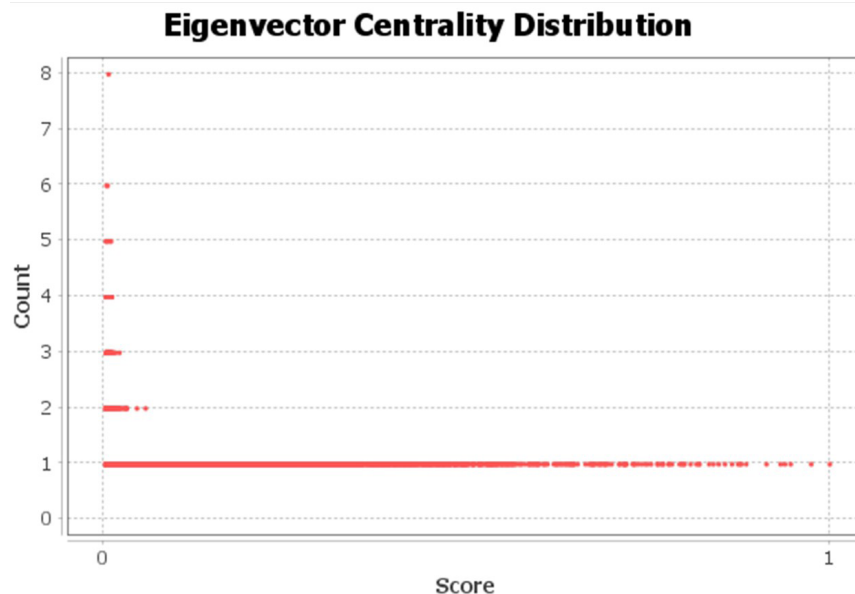
Based on the degree centrality and eigenvector centrality values, 5 main areas can be identified that are connected with organic food on Instagram: #healthyfood, #vegan, #healthy, #eatclean, #vegetarian. All these areas are closely related to the area of "healthy". In addition to the #healthyfood and #healthy hashtags, there are also #vegan and #vegetarian. Vegans were significantly more likely to consider themselves "healthy" (Heiss et al., 2017). Focusing on the practical implication of this study, the organic food can very much appeal to the segments of "vegans" and "vegetarians".

Table 2 presents the results of the literature review based on the 14 papers selected. The table contains the author(s) of the study, the aim of research, sample size and identified factors.

According to the aim of this paper, these were factors influencing consumers' attitude to organic food, factors affecting purchase intention and consumer motivation to buy organic food.

The factors identified in the studies can be divided into 7 groups: (1) health consciousness, (2) ecological motives, (3) tasty, (4) knowledge and attitude, (5) price, and (6) hedonism. Factors from all the groups – with the exception of price – support positive attitude and purchase intention of consumers. In this case, price can be seen as a barrier to the development of the organic food market (Bryla, 2016). Significantly represented are also the factors health, ecological motives, tasty, and knowledge and attitude. The "healthy" factor was identified in all the studies, "ecological motives" were identified in 7 studies, "tasty" in 5 studies and "knowledge and attitude" in 4 studies.

Even though the effect of organic food on human health hasn't been sufficiently proved (e.g. Popa et al., 2018), the results of the questionnaire surveys and of the social network analysis show that for consumers, the "healthy" aspect is the prominent motivation to buy organic food. The #healthy and #healthyfood hashtags are among the most frequently identified hashtags with the highest value of eigenvector centrality, and the "healthy" factor was identified as significant in all the studies (see Table 3). This is in agreement with the "health consciousness" area identified in the questionnaire surveys (see Table 2).



Source: own processing

Figure 2: Eigenvector centrality distribution of hashtags connected to hashtag #organicfood.

Citation (Authors)	Aim of research	Sample size	Identified factors
Asif, Xuhui, Nasiri and Ayyub (2018)	"Understanding the factors that affect the purchase intention of organic food.	736	"attitude health consciousness
Hansen, Sørensen and Eriksen (2018)	To develop model, which specifies expected relationships between consumer motivations, organic food identity, and organic food behaviour.	1.176	health consciousness
Singh and Verma (2018)	To examine the factors influencing the consumers' actual buying behaviour towards organic foods	611	health consciousness knowledge subjective norms price
Chekima et al. (2017)	To propose a new approach to determine factors influencing organic food consumption.	133	"Product-specific attitude health orientation sensory appeal
Bryla (2016)	To select aspects of organic food consumption.	1	more expensive healthier more environmentally friendly tasty
Teng and Lu (2016)	"To examine the effect of consumption motives on behavioural intention related to organic food consumption.	457	health consciousness ecological motives
Ueasangkomsate and Santiteerakul (2016)	To identify the consumers' attitudes and intention to buy organic foods.	316	health
Basha et al. (2015)	To identify the purchase intention of consumers towards organic foods	50	quality of products environmental concern health concern and lifestyle
Irianto (2015)	To study the variables affecting the consumer attitude to buy organic food.	200	health environment
Yadav and Pathak (2016)	To understand the consumer's intention to purchase organic food.	220	positive impact on their health
Mohamad, Rusdi and Hashim (2014)	"To investigate Malaysian consumers' awareness and purchase intention towards organic food consumption."	100	good for health
Bauer, Heinrich and Schäfer (2013)	To verify four main purchasing motives for organic food in Germany.	630	healthiness hedonism, environmental friendliness food safety
Zagata (2012)	To explain the behaviour of organic food consumers in the Czech Republic.	1.054	positive health effects, environmentally friendly production better taste of organic food
Lea and Worsley (2005)	To examine consumers' beliefs about organic food.	500	healthier tastier better for the environment

Source: own processing

Table 2: Results of studies carried out using questionnaire surveys.

Questionnaire survey	Social network analysis	Degree	Eigencentrality
healty (healthy) (14/14)	#healthyfood	5.537	0.981427
	#healthy	5.435	0.978377
	#eatclean	5.11	0.959511
more environmentally friendly, ecological motives (7/14)	#vegan	5.483	0.980745
	#vegetarian	4.901	0.950584
	#veganfoodshare	4.112	0.881119
tasty (5/14)	#yummy	4.578	0.925895
	#delicious	4.389	0.913018
hedonism (1/14)	#foodporn	5.059	0.958486
price, more expensive (2/14)	None	None	None
knowledge, attitude (4/14)	#pesticidefree	898	0.289581
	#pure	1.394	0.424845
	#natural	4.277	0.886909
	#nopesticides	1.047	0.324348
	#organicfertilize		0.06898

Source: own processing

Table 3: Hashtags corresponding to areas identified by a questionnaire survey at the organic food area.

In the social network analysis, also the #vegan and #vegetarian hashtags had a high value of eigenvector centrality. Vegans and vegetarians can be defined as *"persons who do not eat meat for health or religious reasons or because they want to avoid being cruel to animals"* (Cambridge, 2018). As such, it involves not only the "healthy" motive, but also motives related to "environmentally friendly" and "ecological motives" (Stehfest, 2014). These hashtags can be included both in 1) health consciousness and 2) ecological motives and more environmentally friendly. The third area identified in the literature review is 3) tasty. In 5 studies, consumers claimed organic food was tastier. This opinion can be found in the social network analysis as well in relation to hashtags #yummy and #delicious. The fourth area is knowledge and attitude. The consumers' knowledge on organic food cannot be confirmed based on a specific hashtag directly related to "knowledge". Singh and Verma (2017) claim that consumers have inconsistent knowledge on what is "organic". That's why in their research on customer knowledge about organic food, they assess consumers' knowledge about the following characteristics: free from pesticides and chemical fertilizers, and are pure, natural and healthy (Singh and Verma, 2017). In the social network analysis, these areas can be found in the following hashtags: #pesticidefree, #pure, #natural, #nopesticides, #organicfertilize. Based on the degree and eigenvector centrality values (see Table 3), only the #natural hashtag can be identified as significant.

Among the five factors examined, "price" has a specific position being the only one that can be seen as a barrier to the development of the organic food market (Basha et al., 2015), with the other factors supporting the market development. In spite of that, there are many consumers for whom the higher price range of organic food is acceptable (Bryla, 2016). These are mostly more educated consumers with higher income (Singh and Verma, 2018). Price is also the only factor not involved in the broader concept of the social network analysis. Its absence in the social network hashtags can be related to the consumers' reluctance to publish information provoking discussion on the amount of their income. The last area discussed is "hedonism", as confirmed by Berry (2016) who claims that food brings delight. He even states that 60% of the sample agreed that eating could be as pleasurable as sex. This is obvious from the #foodporn hashtag, mainly used by young people posting pictures of food on social networks (Vaterlaus et al., 2015).

Future research

Analysing hashtags on social networks identified 5 out of the 6 groups described based on questionnaire surveys, and in reaction to that, it is desirable to carry out more case studies identifying the behaviour of customers. Another option would be an analysis on farmers markets (#farmersmarket), on local food (#localfood), on veganism and vegetarianism (#vegan and #vegetarian) or on opinions on genetically modified food (#gmofood).

The only area not identified in both types of research was price. We can assume that its absence in the social network hashtags can be related to the consumers' reluctance to publish information provoking discussion on the amount of their income. This assumption needs to be confirmed or proven false in further studies.

Conclusion

The study shows that the "healthy" area is the most communicated one on Instagram in relation to organic food, which is in line with the results of an analysis on studies conducted using questionnaire surveys. The "healthy" area is most frequently communicated using hashtags such as #healthy, #healthyfood, #vegan, #vegetarian and #cleaneating. It is a combination of two most prominent areas: 1) health consciousness and 2) ecological motives and more environmentally friendly. In analysing hashtags with an eigenvector centrality greater than 0.9 (28 hashtags), 4 other basic areas can be identified, which were also found in the 14 studies carried out using questionnaire surveys: (1) health consciousness, (2) ecological motives and more environmentally friendly, (3) tasty and (5) hedonism. As for knowledge attitudes, hashtags can be found in the given set, but with a lower degree and eigenvector centrality. The only area that couldn't be confirmed by the social network analysis was price, which is a significant factor when buying organic food. There is an assumption that this could be related to the consumers' reluctance to publish information provoking discussion on the amount of their income, which needs to be confirmed by further studies.

Acknowledgements

This research article was supported by IGA PEF CZU (CULS) 20171033 - Regionální značení jako konkurenční výhoda, Nr. 00001959.

Corresponding authors:

Ing. Ladislav Pilař, MBA, Ph.D.

Department of Management, Faculty of Economics and Management

Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Praha – Suchbát, Czech Republic

Phone: +420 22438 2024 E-mail: pilarl@pef.czu.cz

References

- [1] Antoniou, I. E. and Tsompa, T. (2008) "Statistical analysis of weighted networks", *Discrete Dynamics in Nature and Society*, Vol. 1, pp. 1-16. ISSN 10260226. DOI 10.1155/2008/375452.
- [2] Asif, M., Xuhui, W., Nasiri, A. and Ayyub, S. (2018) "Determinant factors influencing organic food purchase intention and the moderating role of awareness: A comparative analysis", *Food Quality and Preference*, Vol. 63, pp. 144-150. ISSN 09503293. DOI 10.1016/j.foodqual.2017.08.006.
- [3] Aslam, S. (2018) "Instagram by the Numbers: Stats, Demographics & Fun Facts. [Online]. Available: <https://www.omnicoreagency.com/instagram-statistics>. [Accessed: 18 April, 2018].
- [4] Basha, M. B., Mason, C., Shamsudin, M. F., Hussain, H. I. and Salem, M. A. (2015) "Consumers Attitude Towards Organic Food", *Procedia Economics and Finance*, Vol. 31, pp. 444-452. ISSN 22125671. DOI 10.1016/S2212-5671(15)01219-8.
- [5] Bauer, H. H., Heinrich, D. and Schäfer, D. B. (2013) "The effects of organic labels on global, local, and private brands. More hype than substance?", *Journal of Business Research*, Vol. 66, No. 8, pp. 1035–1043. ISSN 01482963. DOI 10.1016/j.jbusres.2011.12.028.
- [6] Brennan, C., Gallagher, K. and McEachern, M. (2003) "A review of the 'consumer interest' in organic meat", *International Journal of Consumer Studies*, Vol. 27, No. 5, pp. 381–394. ISSN 1470-6423. DOI 10.1046/j.1470-6431.2003.00307.x.
- [7] Brožová, I. and Beranová, M. (2017) "A Comparative Analysis of Organic and Conventional Farming Profitability", *AGRIS on-line Papers in Economics and Informatics*, Vol. 9, No. 1, pp. 3-15. ISSN 1804-1930. DOI 10.7160/aol.2017.090101.
- [8] Bryla, P. (2016) "Organic food consumption in Poland: Motives and barriers", *Appetite*, Vol. 105, pp. 737-746. ISSN 10958304. DOI 10.1016/j.appet.2016.07.012.
- [9] Cambridge Dictionary (2018) "vegetarian", Cambridge Dictionary. [Online]. Available: <http://www.organic-word.net/yearbook/yearbook-2017.html> [Accessed: 20 April, 2018].
- [10] Gruz A. (2016) "Netlytic: Software for Automated Text and Social Network Analysis", [Online]. Available: <http://netlytic.org>. [Accessed: 15 April, 2018].
- [11] Hansen, T., Sørensen, M. I. and Eriksen, M. L. R. (2018) "How the interplay between consumer motivations and values influences organic food identity and behavior", *Food Policy*, 74, pp. 39-52. ISSN 03069192. DOI 10.1016/j.foodpol.2017.11.003.
- [12] Hasimu, H., Marchesini, S. and Canavari, M. (2017) "A concept mapping study on organic food consumers in Shanghai, China", *Appetite*, Vol. 108, pp. 191-202. ISSN 10958304. DOI 10.1016/j.appet.2016.09.019.
- [13] Heiss, S., Coffino, J. A. and Hormes, J. M. (2017) "Eating and health behaviors in vegans compared to omnivores: Dispelling common myths", *Appetite*, Vol. 118, pp. 129-135. ISSN 10958304. DOI 10.1016/j.appet.2017.08.001.
- [14] Huber, M., Rembialkowska, E., Średnicka, D., Bügel, S. and Van De Vijver, L. P. L. (2011) "Organic food and impact on human health: Assessing the status quo and prospects of research", *NJAS - Wageningen Journal of Life Sciences*, pp. 103-109. ISSN 15735214. DOI 10.1016/j.njas.2011.01.004.
- [15] Chekima, B., Oswald, A, Wafa, S. A. W. S. K. and Chekima, K. (2017) "Narrowing the gap: Factors driving organic food consumption", *Journal of Cleaner Production*, Vol. 166, pp. 1438-1447. ISSN 09596526. DOI 10.1016/j.jclepro.2017.08.086.

- [16] Irianto, H. (2015) "Consumers' Attitude and Intention towards Organic Food Purchase: An Extension of Theory of Planned Behavior in Gender Perspective", *International Journal of Management Economics and Social Sciences*, Vol. 4, No. 1, pp. 17-31. [Online]. Available: <http://www.ijmess.com>. [Accessed: 20 April, 2018]. ISSN 2304-1366.
- [17] Lea, E. and Worsley, A. (2007) "Australian consumers' food-related environmental beliefs and behaviours", *Appetite*, Vol. 50, No. 2-3, pp. 207-214. ISSN 01956663. DOI 10.1016/j.appet.2005.07.012.
- [18] Malthouse, E. C., Haenlein, M., Skiera, B., Wege, B. and Zhang, M. (2013) "Managing customer relationships in the social media era: Introducing the social CRM house", *Journal of Interactive Marketing*, Vol. 27, No. 4, pp. 270-280. ISSN 10949968. DOI 10.1016/j.intmar.2013.09.008.
- [19] Mohamad, S. S., Rusdi, S. D. and Hashim, N. H. (2014) "Organic Food Consumption among Urban Consumers: Preliminary Results", *Procedia - Social and Behavioral Sciences*, Vol. 130, pp. 509-514. ISSN 18770428. DOI 10.1016/j.sbspro.2014.04.059.
- [20] Petticrew, M. and Roberts, H. (2008) "Systematic Reviews in the Social Sciences: A Practical Guide", 336 p. ISBN 9781405121101. DOI 10.1002/9780470754887.
- [21] Pilař, L., Poláková, J., Gresham, G., Rojík, S. and Tichá, I. (2017) "Why People use Hashtags when Visiting Farmers' Markets", *Agrarian Perspectives XXVI: Competitiveness of European Agriculture and Food Sectors: Proceedings of the 26th International Scientific Conference on Agrarian Perspectives*, Prague, Czech Republic, pp. 287-292. ISBN 1804-1930X.
- [22] Pilař, L., Balcarová, T., Rojík, S., Tichá, I. and Poláková, J. (2018) "Customer experience with farmers' markets: what hashtags can reveal", *International Food and Agribusiness Management Review*, Vol. 21, No. 6, pp. 755-770. ISSN 1559-2448. DOI 10.22434/IFAMR2017.0039.
- [23] Popa, M. E., Mitelut, A. C., Popa, E. A., Stan, A and Popa, V. I. (2018) "Organic foods contribution to nutritional quality and value", *Trends in Food Science & Technology*, in press. ISSN 0924-2244. DOI 10.1016/J.TIFS.2018.01.003.
- [24] Singh, A. and Verma, P. (2017) "Factors influencing Indian consumers' actual buying behaviour towards organic food products", *Journal of Cleaner Production*, Vol. 167, pp. 473-483. ISSN 09596526. DOI 10.1016/j.jclepro.2017.08.106.
- [25] Stehfest, E. (2014) "Diet: Food choices for health and planet", *Nature*, Vol. 515, pp. 501-502. ISSN 1476-4687. DOI 10.1038/nature13943.
- [26] Statista (2017) "Number of worldwide social network users 2010-2021", Statistic. Statista. [Online]. Available: <https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/> [Accessed 15 April, 2018].
- [27] Teng, C. C. and Lu, C. H. (2016) "Organic food consumption in Taiwan: Motives, involvement, and purchase intention under the moderating role of uncertainty", *Appetite*, Vol. 105, pp. 95-105. ISSN 10958304. DOI 10.1016/j.appet.2016.05.006.
- [28] Ueasangkomsate, P. and Santiteerakul, S. (2016) "A Study of Consumers' Attitudes and Intention to Buy Organic Foods for Sustainability", *Procedia Environmental Sciences*, Vol. 34, pp. 423-430. ISSN 18780296. DOI 10.1016/j.proenv.2016.04.037.
- [29] Vaněk, J., Brožová, I., Masner, J., Šimek, P. and Vogeltanzová, T. (2013) "Information support of regions - organic farming", *Agris On-line Papers in Economics and Informatics*, Vol. 5, No. 3, pp. 97-104. ISSN 18041930.
- [30] Willer, H. and Lernoud, J. (2016) "The world of organic agriculture. Statistics and emerging trends", Research Institute of Organic Agriculture FiBL and IFOAM Organics International. [Online]. Available: <http://www.organic-world.net/yearbook/yearbook-2017.html>. [Accessed 5 April, 2018]. ISSN 0014-4797.
- [31] Wilson, C. (2013) "Questionnaires and Surveys", in "Credible Checklists and Quality Questionnaires", Morgan Koufmann, pp. 29-79. ISSN 9780124103924. DOI 10.1016/B978-0-12-410392-4.00002-7.

- [32] Worthington, V. (2001) "Nutritional quality of organic versus conventional fruits, vegetables, and grains ", *Journal of alternative and complementary medicine (New York, N.Y.)*, Vol. 7, No. 2, pp. 161-173. ISSN 1075-5535. DOI 10.1089/107555301750164244.
- [33] Yadav, R. and Pathak, G. S. (2016) "Intention to purchase organic food among young consumers: Evidences from a developing nation", *Appetite*, Vol. 96, pp. 122-128. ISSN 10958304. DOI 10.1016/j.appet.2015.09.017.
- [34] Zagata, L. (2012) "Consumers' beliefs and behavioural intentions towards organic food. Evidence from the Czech Republic", *Appetite*, Vol. 59, No. 1, pp. 81-89. ISSN 01956663. DOI 10.1016/j.appet.2012.03.023.

Czech Agrarian Foreign Trade According to the Degree of Processing

Karina Pohlová¹, Luboš Smutka², Adriana Laputková³, Miroslav Svatoš²

¹ Institute of Agricultural Economics and Information, Prague, Czech Republic

² Department of Economics, Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

³ Department of Languages, Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

Abstract

Added value of Czech agrarian trade is a frequently discussed topic. The goal of the New Strategy of the Ministry of Agriculture with the outlook until 2030 and of the Export Strategy of the Czech Republic for 2012-2020 is to improve the commodity structure of Czech agrarian exports and to increase the proportion of exported processed products and food with high added value. One of the key aspects to understanding the current state of the development of agrarian trade added value is methodology used for trade performance analysis. In fact, there are several methodologies related to attempts to estimate the real state of added value distribution in relation to foreign trade performance. None of the methods seems flawless, each is suitable for a different purpose in understanding the commodity structure specifics. Czech authorities apply methodology originally proposed by Regmi (2005) which, however, does not truly reflect the real state of the current commodity structure. The Research Institute of Agricultural Economics and Informatics is interested in developing its own method suitable for better understanding of the Czech agrarian foreign trade specifics. The objective of this paper is to specify the basic idea of the proposed methodology, to compare it with the already applied methodology and to present basic differences between the old and the new approaches. Presumably, the new classification can serve as a suitable tool for Czech agrarian trade analysis and provides a more precise overview of the degree of processing of traded commodities than other types of categorisation. Its advantages prevail over the disadvantages, which are less important. The new classification of unprocessed and processed products requires regular inspection and more frequent updates, as the 8-digit codes of the customs nomenclature continually change. At the end of the paper the agricultural trade performance is calculated according to the currently applied methodology and also according to the new proposed methodology. The results between both applied approaches are significant especially in mutual relation between processed and unprocessed items share in total trade. There are significant differences both in relation to EU countries and also non-EU countries.

Keywords

Agrarian foreign trade, degree of processing, unprocessed commodities, processed products.

Pohlová, K., Smutka, L., Laputková, A. and Svatoš, M. (2018) "Czech Agrarian Foreign Trade According to the Degree of Processing", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 103-118. ISSN 1804-1930. DOI 10.7160/aol.2018.100309.

Introduction

Added value of Czech agrarian trade has recently been the focus of attention. There are many studies focused on agricultural sector value performance (e.g. Vokorokosova, 2005; Nešvera, 2006; Pulkrábek et al., 2007; Pohlová and Mezera, 2014; Burianová 2011a and 2011b; Šimáková and Stavárek, 2015; Honig et al., 2018; Pohlová et al., 2016; Rovný et al., 2010; Čermák et al., 2017; Maitah et al., 2016a; Maitah et al., 2016b; Řezbová et al., 2015). The goal of the New Strategy

of the Ministry of Agriculture with the outlook until 2030 and of the Export Strategy of the Czech Republic for the period between 2012 and 2020 is to improve the commodity structure of Czech agrarian exports and to increase the proportion of exported processed products and food with high added value. To attain it, it is necessary not only to change the physical structure of agricultural trade, but also to identify the trade commodity structure accurately. Its qualified assessment is impossible without adequate classification of processed products within the agrarian products category

(defined by HS 01-24). Examination of available materials has revealed that there is no suitable definition; furthermore, it cannot be formulated without some inaccuracy and simplification. However, a degree of simplification influences practical application (simplicity/rapidity of use and the necessity for subsequent updates when changes of customs tariffs occur, with the changes occurring more frequently in the high-digit level of the nomenclature). The types of classification currently available differ from each other, providing various viewpoints, purposes, and level of details. For example, when using the Harmonised¹ or the SITC systems, international comparisons are possible. Moreover, less detailed categorization occurs most frequently in analyses and models of all economic sectors, not only of agriculture. For this reason, categories of unprocessed and processed products within various classifications overlap and sometimes diverge, and a review of the existing types of classification and creation of a new one is necessary.

The following is the available classification of processed and unprocessed agrarian products:

Regmi et al (2005) define four categories: bulk commodities, horticultural products, semi-processed products, and processed products. The first two depend on the availability of land, geography and climatic conditions while the last two are less dependent on these factors and undergo some transformation prior to their final use and, in principle, can be produced almost anywhere (they require mainly technological know-how, labour and capital). This classification is based on 4 and 6-digit HS codes and allows international comparison; however, it is insufficiently detailed. Furthermore, live animals are defined by Regmi et al. (2005) as semi-processed products, which is questionable as they could also be considered a raw material. Moreover, one of the most important Czech export items - raw milk – included in “non-concentrated milk and cream” (HS 0401) pertains to (high) processed products in such classification. Additionally, the classification was created for agrarian products defined by the Agreement on Agriculture by WTO, which also contains cotton, silk, furs and other commodities (several chapter headings in CN 33, 35, 38, 41, 43 and 51 – 53),

¹ The Harmonized Commodity Description and Coding System generally referred to as "Harmonized System" or simply "HS" is a multipurpose international product nomenclature developed by the World Customs Organization (WCO, 2017). The 8-digit combined nomenclature of EU (CN), based on 6-digit HS, is a tool for classifying goods, set up to meet the requirements both of the Common Customs Tariff and of EU's external trade statistics. CN is also used in intra-EU trade statistics.

but does not include fish, seafood and the products thereof. The IEEI currently uses slightly modified Regmi classification, which provides a base for several OECD documents (OECD, 2007; OECD, 2011; Liapis 2011).

Monthly, the European Commission publishes Monitoring on EU Agri-Food Trade. Agri-food products are specified based on the WTO definition, on 6-digit HS codes (previously 4 digit) and divided into six categories: commodities, other primary agricultural products, agricultural processed products including wine, food preparations, beverages, and non-edible products (the originally-applied methodology divided the trade items only into three categories: bulk commodities, intermediates, customer-oriented products). Apart from unprocessed commodities, the Commodities and Other primary agricultural products also include milling products, malt, starch, meat, dairy products except for cheese, dried and frozen fruit, and other. All vegetable oils are considered commodities, but olive oil is regarded as a processed product.

Lindland (1997) uses the FAOSTAT agricultural commodity list in his study. His classification consists of three categories, namely primary commodities ($L=0$), processed commodities processed directly from a primary commodity ($L=1$), and processed commodities that are a product of two or more processing operations ($L>1$). Contrary to the FAOSTAT definition, livestock products, such as meat, fat and offal, have been considered as processed products rather than primary commodities. In the RIEE's² project with FAO (FAO, 1994), Rättinger and Matthews (1999) created four categories of commodities: one unprocessed and three with processed products, depending on the degree of finalisation. Two categories of agrarian products, raw and processed, are used in Bureau et. al's study (2014) which does not contain any complete list of codes, although it does contain some information in its annex. For example, fresh or chilled fish, dried pulses, and dried fruit (in contrast to dried vegetables) are classified as raw goods. In addition, the agri-food sector does not refer to the products mentioned in HS 01-24 only, but also to modified starches, raw furs and skins, as well raw and fuel wood. The authors use the BACI database by CEPII³ (that is UN Comtrade data) as a source. International commerce in processed foods is analysed by Henderson et al. (1996) who discuss food and related products

² Research Institute of Agricultural Economics (RIAE) is a predecessor of Institute of Agricultural Economics and Information (IAEI).

³ CEPII - Centre d'Etudes Prospectives et d'Informations Internationales.

defined by the SIC⁴ (code 20). According to Pierce and Schott's explanation (2009), SIC and HS codes cannot be matched directly due to the differences in how the two systems classify the products. Gálik (2013) refers to simplified classification of agrarian products based on 4-digit HS used by the Research Institute of Agriculture and Food Economics - RIAFE. Apparently, using 4-digit codes results in inaccurate categorization of some products. For instance, categorisation of rice (HS 1006) is problematic. Czech imports and exports contain husked semi-milled and wholly milled rice, which could be considered a processed product (of milling industry). Regarding fresh fruit within HS 0801-0806, a small proportion of dried fruits (for example raisins, bananas, and figs) is included in the RIAFE classification. In the period between 2004 and 2007, the Green reports of the CR contained categorization based on a 2 digit code. Chapters 01-14 of HS (Section I Live animals; animal products and Section II Vegetable products) were considered as unprocessed, and chapters 15-24 (Section III Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes, Section IV Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes) as processed. The inaccuracy is obvious; meat and dairy products should not be classified as unprocessed products. In 2008, this indicative classification was abandoned.

Another source of differentiation of processed agrarian products proceeds from the NACE⁵. It is possible to consider products as processed when these are output of food and beverage industry, that is of NACE 10 and 11 divisions which correspond to the CPA⁶ 10 and 11 divisions. Possibilities of actual convergence of CN and CPA were investigated by the Internal Research Project (IRP) no. 1290 ("Trends in the food market, food support system and the financial health of the food industry") in 2014 and, in more detail, only concerning the meat industry, as part of the IRP no. 1294 („Meat - Strategy analysis of the meat processing industry in the Czech Republic") in 2015.

Generally, the following are the major disadvantages of the available types of classification:

- Excessive simplification which results in inaccurate assessment [categorization used by RIAFE, as well as Green News for the period between 2004 and 2007],

- Based on other than customs nomenclature, no conversion possible, let alone accurate (Lindland, 1997),
- The source list for commodities in individual categories is missing (Bereau et al., 2014; Henderson et al., 1996; Ratering and Mathews, 1999),
- A higher number of categories or categories created using a different viewpoint than the degree of processing hinder interpretation and representation of (un)processed products (monthly analyses of EC (2004) as well as Regmi et al., 2005).

In fact, there are several methodologies related to attempts to evaluate the real state of added value distribution in relation to foreign trade performance. None of these is flawless. Each of the above methods is suitable for different purposes in understanding the commodity structure specifics. Czech authorities apply the methodology originally proposed by Regmi (2005) which, however, does not truly reflect the real state of the current commodity structure. The Research Institute of Agricultural Economics and Informatics is interested in developing its own method suitable for better understanding of the Czech agrarian foreign trade specifics. The objective of this paper is to specify the basic idea of the proposed methodology, to compare it with the already applied methodology and to present basic differences existing between the old and new approaches.

Materials and methods

The procedure for creating a new type of classification consists of:

- A decision made about its character and utilization.
- Examination of available types of classification and documents, and their comparison.
- Factual assessment of the degree of processing, experts' findings and present knowledge can also be considered.
- Analysis of Common Customs Tariff, that is of Customs Nomenclature⁷. Explanatory notes to the Harmonized System (HS) and to Combined Nomenclature (CN) of EU, Changes in CN⁸ published by Czech

⁴ SIC – Standard Industry Classification.

⁵ NACE - Nomenclature générale des Activités économiques dans les Communautés Européennes (Statistical classification of economic activities)(EC, 2015).

⁶ CPA - Statistical Classification of Products by Activity in the European Economic Community (EC, 2015).

⁷ Customs Nomenclature uses Combined Nomenclature of the EU (8-digit codes). It is based on Harmonized Commodity Description and Coding System (2, 4 and 6-digit codes).

⁸ CN is revised to a certain degree every year. More considerable changes are managed in years when a revision of Harmonised system by the World Customs Organisation is performed (the latest in 2012).

Customs Administration (2015) and official converters between various nomenclatures determined by the Czech Statistical Office (for example, between CN and CPA⁹) have also been used.

Firstly, the decision has been made that the new classification should primarily serve the analyses of Czech foreign agrarian trade, therefore should be as specific and accurate as possible. Furthermore, the classification must incorporate chapters 01 – 24 of the customs nomenclature, as agrarian products in all the IAEI reports on Czech agrarian foreign trade are defined accordingly.

Examination of the above types of classification reveals their drawbacks.

- Excessive simplification and subsequent imprecision of trade analysis thereof.
- Inapplicable for foreign trade data in customs nomenclature (no conversion possible).
- Missing source for the commodity (code) list.
- Different viewpoints regarding processing, too few or too many categories.

The factual assessment of products encounters a wide range of problems:

- It is necessary to determine which operation is and which is not considered processing (shelling, milling, drying, and other).
- Processing chains can be shorter for some commodities and longer for other; however, the same number of phases for all the products of HS 01-24 needs to be established.
- The margin between post-harvest handling and primary processing is not clear, what stage (shelling, milling, drying, and chilling/

freezing, among others) is relevant when determining the beginning of the process.

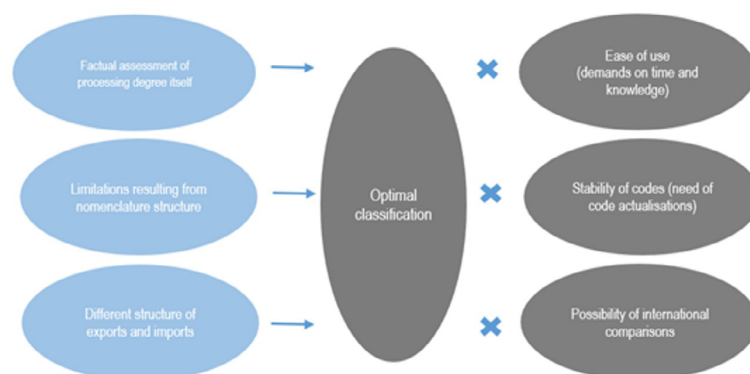
- Assessment of the degree of processing of the commodities produced in other areas and under different conditions and using different technology (coffee, tea, tobacco, fruit).
- The degree of processing might not reflect labour-intensity; livestock production is more labour-intensive than crop farming, even though live animals, along with cereals, are classified as an unprocessed raw material.
- Seeds and breeding animals are products with higher added value, although they are unprocessed and serve as production inputs.
- Processing can consist of sorting and packaging.

The nomenclature limitations are as follows:

- The customs nomenclature distinguishes products that are shelled, milled, dried, frozen, boned, etc. but does not include all the cases.
- Distinction of products per package size is sporadic.
- Some items (even 8-digit CN codes) include processed and unprocessed commodities (for example, fresh and dried fruits; often as part of less frequently traded items).
- It is not possible to determine (even using the Explanatory notes) what items are represented by “others”.
- The converters between nomenclatures are imperfect (however, should not be since various nomenclatures have different nature, purposes, and objects) (Figure 1).

⁹ CPA - Classification of Products by Activity. This product classification concerns activities as defined by NACE Rev. 2 (Classification of economic activities in the European Communities) (EC, 2015).

Based on the examination of the available types of classification, assessment of the production



Source: Institute of Agricultural Economics and Information, 2018

Figure 1: Factors and implications of categorization.

verticals and consideration of the customs nomenclature, three categories of products have been created: one containing unprocessed commodities and two with processed products – less and highly-processed (Figure 2).

A distinction between unprocessed and processed products has been primarily made by the fact that the product is output of food industry (or other, non-food, industry). The division of the products into less and highly processed is based on the numbers of the degree of processing. What has also been considered is whether the product is comprised of one or more raw materials as well as whether some input has already been processed. The newly proposed list of items under the individual categories is possible to find in appendix part this paper.

Results and discussion

1. Overview of the types of classification, their characteristics, strengths and weaknesses

1.1 Currently used classification for assessment of Czech agrarian foreign trade (AFT)

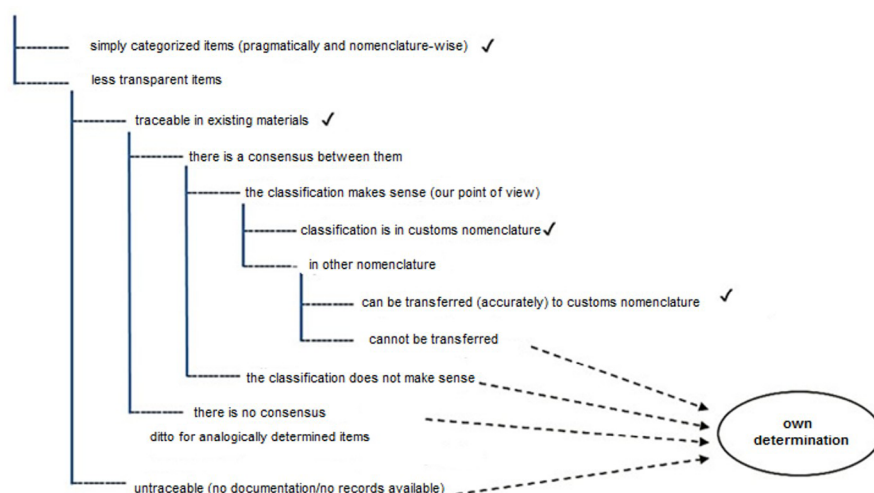
Since 2011, IEAI has been using classification based on Regmi et al. (2005) in its publications and agreement with the Ministry of Agriculture (2004-2007). It defines two categories of agricultural products that demonstrate dependence on soil and climatic conditions, and two categories of processed products independent of soil that can be produced under any conditions, the production of which chiefly requires technological knowhow, workforce and capital. Based on the classification, unprocessed commodities firstly consist of bulk commodities

and secondly of horticultural products, including fruit and vegetable production. Both partially-processed (semifinished/intermediate) and processed products (those closest to the consumer and their “kitchen table”) are regarded as products with a higher degree of processing (see appendix 1).

The classification derives from a maximum 6-digit HS code which enables international comparison; however, it is not sufficiently detailed. In addition, it is based on the definition of agricultural products by WTO – UK GATT Agricultural Agreement (that is, on the one hand, does not contain fish and seafood, and on the other, contains cotton, silk, furs and other commodities).

The major drawback lies in the fact that the semi-processed products also include live animals. These are not dependent on soil, nevertheless, regarding the degree of processing, they could be considered a material.

IAEI uses the classification in a slightly modified form. First, some evident mistakes have been corrected, for instance, according to the materials available, aggregation *HS 0811 9 „other frozen fruit“* is included in agricultural products, whereas the whole category *HS 0811 „frozen fruit“* is then mentioned in the processed products as well, or *HS 1806 „chocolate and other preparations containing cocoa“* is mistakenly mentioned in both semi-processed and highly-processed products. Furthermore, the item *CN 0401 20 99 „milk exceeding 3% but not exceeding 6 % of fat in maximum 2-litre packaging“* has been moved from processed products into semi-processed. This was caused by the fact that the group also contains



Source: Institute of Agricultural Economics and Information, 2018

Figure 2: General procedure for creating new classification.

raw milk, which is one of the most significant commodities on the Czech export market, and results in considerable distortions.

Moreover, after reaching an agreement on AFT with the contracting authority at the Ministry of Agriculture, the classification was modified in order to include agrarian products specified in chapters HS 01-24. Items from other chapters have been excluded and some also amended.

Disadvantages of classification:

- The original classification was created for the commodities delimited by the Agricultural Agreement UK GATT, whereas IAEI has long-term used the traditional delimitation using chapters HS 01 – 24 of the customs tariff.
- It derives from a maximum 6-digit HD code, that is from more general categorization, which is completely inadequate for some items.
- It concerns connection to soil more than to the degree of processing (for example, animals are thus considered semi-processed, or eggs in shells and honey are regarded as processed products).
- Publishing results without any commentary on the content of the given categories might be misleading.
- The original material (and other subsequent materials) contained evident, although less significant mistakes in the code list (code duplication in several categories).

Advantages of classification:

- Can be utilized for international comparison
- Already in effect (in the original form, for example, in some OECD materials) and is linked to other IAEI materials (Almanac and quarterly analyses of Czech AFT used since 2011).
- A clear code list and its simple use in data processing.
- Relative stability in time without any necessity to modify codes within the delimited categories.

2. New classification

2.1 Specification of requirements for new classification

The fundamental requirement for the new classification is based on the fact that it primarily and realistically needs to define the status

and development of Czech agrarian foreign trade. The main purpose is to meet the demand for assessing Czech agrarian import and export. Therefore, international comparison is a less important criterion (other, less accurate types of classification can be used for year-on-year comparisons). The new classification also needs to include chapters HS 01-24 of the customs tariff, since agrarian goods are defined accordingly in all the publications by IAEI discussing Czech AFT, which it should comply with.

Furthermore, three categories appear optimal: 1) unprocessed commodities, 2) less processed products and 3) highly processed products. Having two categories only seems inadequate, while assessment of AFT according to four and more categories might cause certain disorganization. The categories with less-processed and highly-processed products can be assessed separately or can be fused to one category with processed products. The previous IRP no. 1255/2016 mentions factors influencing the formation of classification, possibilities of factual delimitation of the degree of processing of agrarian commodities and limits of the customs nomenclature. This paper focuses on describing the methodology used when forming the new classification, both at a general level and for specific items. In the majority of cases, scheme 1 was followed to categorize the items.

2.2 Own categorization

The dividing line between processed and unprocessed products has predominantly been given by the fact whether the product is the output of one of food (or other) industries. If it is, the product is considered processed. In this regard, the research follows IRP No. 1290/2014 and 1294/2015 conducted by IAEI. The distinction between less and highly processed products normally depends on the number of degrees of processing that the products have undergone. In addition, what has been considered is whether the product derives from one or more raw materials or whether any of the raw materials have been processed or not. This matter concerns, for instance, sugar, regarding which the customs tariff distinguishes a number of commodities, with and without added sugar. For example, dairy products with added sugar are automatically regarded as highly processed products in the research. It is necessary to state that simplification cannot be avoided when classifying items into the defined categories even though certain logic has been respected. Since the categorized products are heterogeneous,

the procedure mentioned cannot be applied to all the items without exceptions.

2.2.1 Unprocessed commodities

Live animals (as well as fish and aquatic invertebrates) are regarded as unprocessed commodities and raw materials intended for subsequent processing or production. This also refers to pure-bred breeding animals, although these are commodities with more added value traded at higher unit prices. Similarly, cereal and oil crops, and seeds are also considered unprocessed. What needs to be added is that cereal and oil crops for seeding are assessed separately in the customs tariff only when this concerns their most important varieties, therefore, in a number of cases, it would be impossible to distinguish them from common cereal or oil crops. Eggs in shells are regarded as unprocessed commodities, although they are further classified as packed and sold in the same state to the end customer. Both immature and mature legumes are considered unprocessed commodities. The fact that they can be shelled or split is thus disregarded, as the customs tariff does not enable this. Like cereal crops, drying of legumes is regarded as post-harvest treatment. Their shelling usually takes place on the field and is a part of the harvest. According to the classification in this paper, unprocessed commodities also contain fresh potatoes, vegetables, fruit and nuts, and other plant products from commodity aggregation *HS 1212*, except for sugar beet, dried (or in the powder form), kelp and other types of seaweed (which, presumably, appear on the market in a modified form). The aggregations *HS 1212* mentioned in some items are included as both unprocessed and processed at a detailed level, however, overall, in terms of trade, these are minority goods. Regarding spices, the uncrushed / unground have been incorporated in the unprocessed commodity category. The size and the method of packing is determined by the customs tariff only regarding an insignificant number of commodities, which is the reason why this criterion was not considered for classification (it would be impossible to use). In addition, with the majority of the products, the packaging size would not influence the perception of their degree of processing. Dairy products and tea were exceptions, and their packaging was considered. Item *CN 0401 20 99 „milk exceeding 3% but not exceeding 6% of fat in packaging exceeding 2 litres“* is regarded as a raw material owing to the fact that it mainly contains raw milk. It represents a very important Czech export product, while it is less significant in import. The nomenclature distinguishes between black

and green tea and, in both cases, it is divided into packets not exceeding 3 kg and exceeding 3 kg. The former is considered semi-processed (teabags, packed), whereas the latter is categorized into unprocessed commodities. Fermentation is not perceived as a processing phase. Regarding coffee, the size of packaging is not considered by the customs tariff. The only distinction is made between roasted and unroasted coffee, with and without caffeine. This research considers only unroasted caffeinated coffee as unprocessed. Regarding cocoa beans, the nomenclature does not distinguish raw and roasted beans, therefore they are all defined as unprocessed. Unprocessed tobacco and tobacco waste, although dried, is also regarded as a raw material and an unprocessed commodity. The unprocessed commodity category also contains straw and chaff, feeding roots, shellac, natural rubber, resin and other commodities (*HS 1301*), plant fibres and plant products not mentioned elsewhere, raw plant and insect wax, which are insignificant in terms of trade. Regarding beverages, unsweetened water (*KN 2201 90 00*) has been categorized into unprocessed commodities, which also include ordinary water.

2.2.2 Less processed products

With some commodities, peeling, crushing/grinding, drying and freezing are considered partial processing. Regarding vegetables and fruit, drying and freezing are considered primary types of processing as they usually require preparation stages such as sorting, washing, or cutting and similar activities. The varieties of fruit which commonly appear in a dried form are classified and distinguished separately as fresh and dry by the customs tariff. The fruit that does not enable distinction between its dried and fresh parts (for instance, dates, pineapple or citrus fruits) is categorized into unprocessed commodities (it is presumed that the dried part is less significant and is traded less frequently in this form). In accordance with the majority of the remaining types of classification, a distinction is also made with nuts and spices as to whether these are shelled or crushed / ground / in a powder form. The items that started to be considered unprocessed and processed by the nomenclature at a later stage (for example, some nuts or spices as late as after 2012) were, in the years when this did not occur, categorized based on the form they were traded in when the information was available. It is possible to determine the contribution of the commodities that were traded both in their unprocessed and processed form, however, the importance of these is insignificant; therefore, each item

was included in the one with greater importance. Exceptionally, the level of classification in the customs tariff declined over the years (this signifies that, due to low importance, the codes were gradually removed).

Moreover, mill products (which represent the first stage of processing cereal crops, legumes, root and tuber crops), malt and starch, decorticated oil crops, provided that decortication occurs, and the customs tariff identifies this, as well as flour and semolina from oil seeds were categorized into less-processed products. Oils and fats, sugar excluding additives and dyes, treacle and cocoa products after the first stage of processing, including cocoa powder (only that excluding added sugar) are also regarded as less-processed products. Regarding animal products, meat (while taking into consideration that it might be in the form of either half carcass for further processing or boned and intended for the consumer), offal and fat have been classified into the less-processed category of commodities. Concurrently, only fresh meat, refrigerated or frozen, is regarded as a less processed product. A similar procedure was followed with fish and aquatic invertebrates, while taking into consideration that the whole fish (which does not enable distinction as to whether they are disembowelled or not) were classified into this category along with fish meat. Regarding dairy products, those not marked by a higher number of processing phases have been included in the less processed. Eggs without shells are another type of less processed products.

2.2.3 Highly processed products

Meat products as well as meat that have undergone another phase of processing (such as drying, salting, smoking) are considered as highly processed products. Fish products have also been classified similarly. Regarding dairy products, those that have undergone more production operation processes as well as those containing added sugar have been classified into this category. The majority of other products included in this category are found in the chapters with higher numbers, which usually contain food products. This concerns for example white sugar and confectionery, food preparations containing cocoa (for example chocolate), cereal crop products (pasta, bakery products and other commodities), fruit and vegetable products or other food products. Alcoholic and non-alcoholic beverages and cigarettes are regarded as highly-processed products.

Disadvantages of classification:

- Requires more frequent updates of codes in individual categories due to the fact that more frequent changes occur at a more detailed commodity level which need to be considered in classification.
- Processing data from other databases than that of CSO is time-consuming.
- More thorough processing is required in connection with more extensive code lists in individual categories.
- Less suitable for international comparison.

Advantages of classification:

- Provide a more realistic overview of Czech AFT in terms of assessing the degree of processing of commodities.
- The degree of processing of commodities is the main criterion.
- The data from CSO, with the code lists updated regularly, are relatively easy to process and enable regular publication.

3 Comparison of old and new classification

3.1 Currently used classification for assessment of Czech AFT by Regmi et al. (2005)

- 4 product categories – bulk commodities, horticultural products, semi-processed products and highly-processed products.
- Derives from HS nomenclature (maximum 6-digit HS codes).
- The original classification incorporating agrarian goods defined by WTO had to be adjusted in order to consider customs tariff chapters *HS 01-24*.
- The category with bulk commodities and horticultural products is well-interpretable.
- Only plant commodities are considered as unprocessed.
- Horticultural products also contain those that are partially processed (ground, crushed, dried).
- The name of the category of semi-processed products is misleading as it contains raw materials as well.
- Semi-processed products contain live animals (*HS 0101 to 0106*), dried legumes (*HS 0713*), seeds, fruit and spores for planting (*HS 1209*) or straw and chaff

(*HS 1213*), and fodder crops (*HS 1214*).

- (Highly) processed products contain honey (*HS 0409*) or eggs in shells (*HS 0407*). The original classification by Regmi et al. (2005) also contained raw milk.

3.2 New classification

- 3 product categories – unprocessed commodities, less-processed products and highly-processed products.
- Uses CN nomenclature (up to 8-digit CN codes), more detailed.
- Incorporates customs tariff chapters HS 01-24.
- Live animals are considered a raw material. Breeding animals are classified into unprocessed.
- Grinding, crushing, drying and freezing are considered as processing phases with the majority of commodities.

4 Comparison of analysis of Czech AFT according to the degree of processing of commodities based on old and new classification

This concerns the structure of Czech agrarian export, import and the balance between 2011 and 2016 within AFT overall, both with EU 28 and the third countries, according to both old and new classification. The unprocessed and highly processed commodity categories are compared as they are the closest in both types of classification in terms of their nature and definition.

4.1 Analysis of Czech agrarian export and import based on the degree of processing of commodities

In 2016, the contribution of **unprocessed products**¹⁰ to Czech agrarian export, including „*tobacco and tobacco products*“ using the old classification is lower than using the new methodology (15% vs 22 %), please see tables 1 and 2 below. Regarding import, the contribution amounted to 21% using both old and new classification. This signifies that, using the old classification, the representation of unprocessed commodities in export in comparison with import was considerably lower, whereas it was slightly higher using the new methodology. The contribution of unprocessed products to export using both the old and the new methodology has been on the decrease since

2011, at a similar rate. In terms of import, it was on the decrease until 2014 (at the same rate, using both old and new methodologies), and subsequently developed identically. Using the old methodology, the contribution of the **highly processed product** category including „*tobacco and tobacco products*“ to Czech agrarian export in 2016 was 62%, while using the new methodology it reached 54% (that is to a lesser degree using the new classification). Regarding import, their contribution amounted to 64% using the old methodology and 46% using the new one (that is, using the new classification, equally to a lesser degree). Using the old methodology, the contribution of highly-processed products was slightly higher concerning import, while using the new methodology it was higher regarding export. Since 2011, using old and new methodologies, the development of the contribution to both export and import has been similar. No upward or downward trend is evident (almost no change is evident) (Table 1, 2).

Assessment of the structure of Czech AFT according to the degree of processing of commodities differs relatively significantly depending on whether this concerns trade with **EU 28** or with **the third countries**, please see Tables 3 and 4.

Regarding export, an identical difference was recorded in 2016 using both types of classification (assessed in percentage points) in the representation of unprocessed commodities. Regarding Czech agrarian export to the third countries, the contribution of these commodities was 7 pp lower than to the European Union. A contrary difference is subsequently evident in the case of export in the representation of highly-processed products. Using the old classification, the contribution of Czech agrarian export to the third countries is 3 pp higher than to the European Union, whereas using the new classification it exceeds 10 pp.

Regarding import (*HS 01-24*) and using the old classification, the contribution of unprocessed products to Czech AFT with the third countries in 2016 was 23 pp higher than with EU 28, while using the new methodology it exceeded 16 pp. Using both old and new classification, the representation of highly-processed products in AFT outside EU in comparison with trade with EU decreased, namely by 21 pp in the first case, and by 17 pp in the second.

¹⁰ That is, considering old classification, the sum of two categories – bulk commodities and horticultural products, while considering the new classification, of one category with unprocessed commodities.

	Category	2011	2012	2013	2014	2015	2016
Export	Bulk commodities	14	14	13	12	12	11
	Horticultural products	5	4	5	4	4	4
	Unprocessed commodities	18	19	18	17	17	15
	Semi-processed products	21	23	23	23	22	23
	Highly-processed products	61	59	59	60	61	62
	Processed products	82	81	82	83	83	85
Import	Bulk commodities	6	7	6	6	5	5
	Horticultural products	16	15	15	15	15	16
	Unprocessed commodities	22	21	21	20	20	21
	Semi-processed products	14	14	15	15	15	15
	Highly processed products	64	65	64	64	64	64
	Processed products	78	79	79	80	80	79

Source: Foreign trade database of CSO, data „without additional calculations“, 2018

Table 1: Structure of Czech AFT overall based on the degree of processing of commodities using the old methodology (in %)

	Category	2011	2012	2013	2014	2015	2016
Export	Unprocessed commodities	27	27	26	25	24	22
	Less processed products	22	24	24	25	26	24
	Highly processed products	50	49	50	50	50	54
	Processed products	73	73	74	75	76	78
	Unprocessed commodities	22	22	21	20	20	21
	Less processed products	31	31	32	34	35	33
	Highly processed products	47	47	47	46	45	46
	Processed products	78	78	79	80	80	79

Source: Foreign trade database of CSO, data „without additional calculations“.

Table 2: Structure of Czech AFT based on the degree of processing of commodities using the new methodology (in %), with tobacco and tobacco products.

	Category	AFT overall		with EU 28		With third countries	
		with HS 24	without HS 24	with HS 24	without HS 24	with HS 24	without HS 24
Export	Bulk commodities	11	12	11	13	4	4
	Horticultural products	4	5	4	5	4	5
	Unprocessed commodities	15	17	15	17	8	9
	Semi-processed products	23	26	23	26	27	29
	Highly-processed products	62	57	62	57	65	62
	Processed products	85	83	85	83	92	91
Import	Bulk commodities	5	4	4	4	10	7
	Horticultural products	16	17	14	14	31	32
	Unprocessed commodities	21	21	18	18	41	39
	Semi-processed products	15	16	16	17	14	14
	Highly processed products	64	63	67	65	46	47
	Processed products	79	79	82	82	59	61

Source: Foreign trade database of CSO, data „without additional calculations“, 2018

Table 3: Structure of Czech AFT according to the degree of processing of commodities using the old methodology (in %), in 2016, in terms of territory

	Category	AFT overall		with EU 28		with third countries	
		with HS 24	without HS 24	with HS 24	without HS 24	with HS 24	without HS 24
Export	Unprocessed commodities	22	25	23	26	16	18
	Less processed products	24	27	25	27	21	23
	Highly processed products	54	49	53	47	63	60
	Processed products	78	75	77	74	84	82
Import	Unprocessed commodities	21	21	18	19	34	32
	Less processed products	33	35	33	34	35	36
	Highly processed products	46	44	48	47	31	32
	Processed products	79	79	82	81	66	68

Source: Foreign trade database of CSO, data „without additional calculations“.

Table 4: Structure of Czech AFT according to the degree of processing using the new methodology (in %), in 2016, in terms of territory

4.2 Czech AFT balance analysis based on the degree of processing of commodities

The balance of the overall Czech AFT regarding chapters *HS 01-24* with **unprocessed commodities** using the **old classification** is negative and amounted to 16 billion CZK in 2016. In comparison with 2011, it was 44 % higher (considering the fact that between 2012 and 2014 the deficit did not exceed 10 million CZK). In the trade with EU 28 (*HS 01-24*) in the monitored period 2011-2016, the development concerning unprocessed commodities was similar, while the deficit in 2016 amounted to 4.9 billion CZK (although the lowest liability was reported in 2014, and not in the overall trade in 2012). Regarding trade with the third countries (*HS 01-24*) and unprocessed commodities and using the old classification, it might be concluded that the deficit value was on the increase (with more regular development than regarding trade with EU) and amounted to 11.2 billion CZK in 2016. Excluding „*tobacco and tobacco products*“ (that is excluding chapter *HS 24*), a difference is evident in the development in the Czech agrarian trade with EU 28. In 2016, the deficit in the trade with unprocessed commodities amounted to 4.3 billion CZK using the old classification, nevertheless, in 2012, 2014 and 2015 the balance was active (maximum 1.1 billion CZK in 2015).

Using the **new classification**, the balance of Czech AFT with unprocessed commodities (*HS 01-24*) changed twice, from negative in 2011 to positive in the following four years and, subsequently, to negative in 2016, after a sharp year-on-year decline, to level 1.4 billion CZK. Excluding the chapter *HS 24*, the direction of the development during the monitored period was similar, however,

in 2016 the balance remained slightly positive (168 mil. CZK). Regarding unprocessed commodities (za *HS 01-24*), the development of the trade balance with EU 28 was similar to that overall, although its value remained active in the entire period. In 2016, the active balance amounted to 6.3 billion CZK (and, excluding *HS 24*, to 6.9 billion CZK). Regarding the third countries, the balance of the trade with unprocessed commodities is passive using the new classification (*HS 01-24*). The value of the deficit until 2015 oscillated between 6.6 – 7.0 billion CZK, however, in 2016 it increased considerably year on year, namely to 7.7 billion CZK (excluding chapter *HS 24*, to 6.7 billion CZK).

Concerning **highly processed products** and using the **old classification**, the long-term negative balance of Czech AFT of chapters *HS 01-24* between 2011 and 2016 gradually decreased by 32 % to 17.4 billion CZK. In the trade with EU 28 (*HS 01-24*), the declining trend in the deficit was slightly more irregular, and its value between 2011 and 2016 increased by 36 % to 13.2 billion CZK. The value of passive balance of trade with the third countries in highly processed products (*HS 01-24*) does not demonstrate any trend, the deficit oscillated between 2.6 and 4.6 billion CZK, while in 2016 it amounted to 2.9 billion CZK. When excluding „*tobacco and tobacco products*“ from agrarian goods, the negative balance in highly processed products using the old classification within the overall Czech AFT, but also within the trade with EU 28, developed differently (its development was irregular). In the first case, in 2016, the overall AFT amounted to 29.3 billion CZK (and remained practically unchanged against 2011), whereas in the second, in trade with EU, it reached 23.9 billion CZK (that is 3.7 % less than

in 2011). Using the old classification, regarding the trade in highly processed products with the third countries and excluding chapter *HS 24*, the deficit oscillated between 2.9 and 6.0 billion CZK (in 2016 it amounted to 4.1 billion CZK).

Using **the new classification**, the balance of the overall Czech AFT in highly processed products (*HS 01-24*) in the period between 2011 and 2016 also improved. In 2015, its value even changed from passive to active, and in 2016 reached 4.1 billion CZK. Regarding trade with EU 28 and using the new classification (*HS 01-24*), the status changed as early as in 2014. In 2016, the active balance amounted to 4.7 billion CZK and the positive balance of Czech AFT with the third countries in highly processed products incorporated in the new classification (*HS 01-24*) amounted to 1.2 billion CZK (while in 2011, it was still negative and reached 2.6 billion CZK). In the entire monitored period, excluding „*tobacco and tobacco products*“, the balance of Czech agrarian trade in highly processed products using the new classification both with EU and with the third countries was negative. Concerning overall AFT in 2016, the balance deficit amounted to 6.6 billion CZK and against EU to 6.4 billion CZK. However, in both cases its value in the monitored years improved, that is it was on the decrease. Regarding the third countries, the development of the deficit recorded year-on-year fluctuations against these, while considering the fact that in 2016 it amounted to minimum 42 mil. CZK, that is the balance was almost level. The above significant differences between the balances in the monitored categories are levelled by the remaining categories. The balance of the trade in semi-processed products, that is the category in the old classification, is fairly active – for example, in 2016 within the Czech AFT (*HS 01-24*) it amounted to 11.9 billion CZK, while the balance of the trade in less-processed products, that is the category in the new classification, is highly negative - in 2016 in the overall Czech AFT (*HS 01-24*) it amounted to 24.2 billion CZK.

Conclusion

Classification of agrarian goods into three categories is considered the most suitable, namely into unprocessed commodities, less processed products and highly processed products. When forming the categories, the priority was given to the degree of processing over, for instance, added value or labouriousness. When classifying the commodities into the defined categories, a combination of assessment of the commodity

in terms of the degree of processing as well as of how it is treated in other available types of classification has been applied. The final classification is thus influenced by the customs nomenclature and its possibilities. The research also states the reasons why, when analysing Czech AFT, it is not suitable to use the presently-used and adjusted classification by Regmi et al. (2005), nor its strengths and weaknesses. Furthermore, it also mentions that it is necessary to create new classification that would involve the degree of processing in Czech export and import more effectively. Such classification could then become a part of assessment of Czech AFT by IAEI. Despite repeated revisions made in 2017 in the product lists created in individual categories, no alterations have been made in the classification created as part of IRP in 2016. However, the new classification has been interpreted again and more effectively, while this concerns both general methodology and specific categorization of individual commodities. It is the presentation of the methodology that has improved, rather than the methodology itself. The main reason why the first goal of the internal project was not achieved to the full extent was failure in establishing planned cooperation with a partner at CULS due to time and capacity. Nevertheless, a joint paper should be completed next year. In order to assess Czech AFT according to the degree of processing of commodities, that is to create the new classification, an 8-digit level of the EU nomenclature was used, although such classification requires more frequent updates and does not enable international comparison outside EU countries or the countries the foreign trade of which is monitored by Eurostat (that is the countries of the European Free Trade Association and those in the Western Balkans, as well as the candidate countries which provide data about their foreign trade based on CN). For this purpose, one of the existing types of classification deriving from the Harmonised system of description and from product coding (although HS level is completely insufficient for more accurate assessment of Czech AFT) would have to be used. Regarding comparison within EU, some distortion might be caused by the fact that categorization of some commodities in order to monitor Czech AFT might not correspond with the trade reality of other countries. The code lists included in the research can be used only in the CSO database of foreign trade, nevertheless, the attached code lists in individual categories also enable to process Eurostat data. The major disadvantage

is that the process is time-consuming. In regard to receiving more regular information, receiving data from the database could possibly be automated. A regular revision is an essential prerequisite for using the newly-created classification. More frequent and necessary updates involve regular annual assessment of changes in the customs tariff (that is checking whether these are reflected in the classification) and their transfer to the code list. No future changes or estimation of the development of the nature of the goods nor the range in the customs codes have been considered beforehand in the currently created classification. It is presumed that the prospective development in this regard can be projected in the code list at a later stage without any major disruptions in comparison in time. This derives from the assumption that if some codes currently contain mainly unprocessed products, they should be included in the unprocessed, and if they contain mainly processed items, they should be included in the processed (this way they will reflect the state of Czech AFT based on the degree of processing

of commodities adequately). However, this requires continuous monitoring of the issue. For the future, it would be suitable to propose implementation of the new methodology to the Ministry of Agriculture to the contracting party determining the assignments related to Czech AFT. Any adjustments to the classification suggested by the opponents of this project and by potential users of the outcome can be negotiated. Based on the research, it is recommended that the issue remains the focus of attention. There have not been almost any changes in the references. Those that serve as sources for the available classification have been retained, and other, newly used, have been added. Some documents and links to these (referring mainly to customs nomenclature) have been updated.

Acknowledgements

The paper was supported by the internal development project (IDP n. 1111) provided by the Institute of Agricultural Economics and Information.

Corresponding authors:

prof. Ing. Luboš Smutka, Ph.D.

Department of Economics, Faculty of Economics and Management

Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Prague – Suchbátka, Czech Republic

E-mail: smutka@pef.czu.cz

References

- [1] Bureau, J.-Ch., Disdier, A.-C., Emlinger, Ch., Fouré, J., Felbermayr, G., Fontagné, L. and Jean, S. (2014) "*Risks and opportunities for the EU agri-food sector in possible EU-US trade agreement*", Study IP/B/AGRI/IC/2013_129 for the European Parliament. Brussels. [Online]. Available: [http://www.europarl.europa.eu/RegData/etudes/STUD/2014/514007/AGRI_IPOL_STU\(2014\)514007_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2014/514007/AGRI_IPOL_STU(2014)514007_EN.pdf). [Accessed: 15 Dec. 2017].
- [2] Burianová, J. (2011a) "Effect of the 2008-2009 economic crisis on the results of agricultural foreign trade of the Czech Republic", *Agricultural economics - Zemědělská ekonomika*, Vol. 57, No. 5, pp. 226-231. ISSN 0139-570X.
- [3] Burianová, J. (2011b) "Agrarian foreign trade of the Czech Republic in the period of 2004-2008, competitiveness of commodities", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. 59, No. 4, pp. 37-42. ISSN 1211-8516. DOI 10.11118/actaun201159040037.
- [4] Customs Administration of the Czech Republic (2015) "*Změny kombinované nomenklatury*" (Changes of the CN since 2007) (In Czech), Work aid. Customs Administration of the Czech Republic. General Directorate of Customs. [Online]. Available: <https://www.celnisprava.cz/cz/clo/sazebni-zarazeni-zbozi/spolecny-celni-sazebnik-es/Spolen%20celn%20sazebnk%20ES%202015/Korelace2015.pdf>. [Accessed: 17 May 2016].
- [5] Čermák, M., Malec, K. and M. Maitah. (2017) "Price Volatility Modelling-Wheat: GARCH Model Application", *Agris on-Line Papers in Economics and Informatics*, Vol. 9, No. 4, pp. 15-24. ISSN 1804-1930. DOI 10.7160/aol.2017.090402.
- [6] European Commission (2015) "*Agri-food trade presentation – details of the 6 classes of products*", Directorate General for Agriculture and Rural Development [Online]. Available at: https://ec.europa.eu/agriculture/sites/agriculture/files/trade-analysis/statistics/outside-eu/2015/product-classes-details_en.pdf [Accessed: 15 Nov. 2017].

- [7] European Commission (2015) "Common tariff of the EU. For 2016: Commission Implementing Regulation (EU) No 1754/2015", *Official Journal of the EU L* 285. [Online]. Available: <https://publications.europa.eu/en/publication-detail/-/publication/d20e7f04-7ed4-11e5-b8b7-01aa75ed71a1> [Accessed: 17 May 2018].
- [8] European Commission (2015) "Explanatory Notes to the Combined Nomenclature of the European Union (2015/C 076/01)", *Official Journal of the EU C* 76, Vol. 58. [Online] Available: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2015:076:FULL&from=EN> [Accessed: 7 Nov. 2017].
- [9] European Commission (2014) "*Agricultural trade statistics 2005 – 2014*". [Online]. Available: https://ec.europa.eu/agriculture/statistics/trade/2014_en [Accessed: 10 May 2018].
- [10] FAO (1994) "*Definition and Classification of Commodities*", FAO, Rome. [Online]. Available: <http://www.fao.org/waicent/faoinfo/economic/faodef/faodefe.htm> [Accessed: 15 May 2018].
- [11] Gálík, J. (2013) "*Agrarian foreign trade book of the Slovak Republic 2012*", RIAFE. Bratislava. ISBN 80-7137-722-8.
- [12] Henderson, D. R., Sheldon, I. M. and Pick, D. H. (1996) "International commerce in processed foods: Patterns and curiosities", Working paper 96-3, International Agricultural Trade Research Consortium. [Online]. Available: <https://ageconsearch.umn.edu/bitstream/51211/2/96-3.pdf> [Accessed: 15 Nov. 2017].
- [13] Honig, V., Procházka, P., Linhart, Z. and Smrčka, L. (2018) "Effect of tax policy changes on bioethanol market", *Listy cukrovarnické a řepářské*, Vol. 134, No. 2, pp. 74-78. ISSN 1210-3306.
- [14] Liapis, P. (2011) "Changing Patterns of Trade in Processed Agricultural Products", OECD Food, Agriculture and Fisheries Working Papers No. 47. OECD Publishing. [Online] Available: <https://www.oecd-ilibrary.org/docserver/5kgc3mq19s6d-en.pdf?expires=1531302597&id=id&accname=guest&checksum=5BABEEA5AB38B90A54CE9C7375D3D761> [Accessed: 6 Nov. 2017].
- [15] Lindland, J. (1997) "The Impact of the Uruguay Round on Tariff Escalation in Agricultural Products", *ESCP*, No. 3, FAO. [Online] Available: <http://www.fao.org/3/a-w4357e.pdf> [Accessed: 6 Nov. 2017].
- [16] Maitah, M., Procházka, P., Čermák, M. and Šrédli, K. (2016a) "Commodity Channel Index: Evaluation of Trading Rule of Agricultural Commodities", *International Journal of Economics and Financial Issues*, Vol. 6, No. 1, pp. 176-178. ISSN 2146-4138.
- [17] Maitah, M., Procházka, P., Pachmann, A., Šrédli, K. and Řezbová, H. (2016b) "Economics of Palm Oil Empty Fruit Bunches Bio Briquettes in Indonesia", *International Journal of Energy Economics and Policy*, Vol. 6, No. 1, pp. 35-38. ISSN 2146-4553.
- [18] Ministry of Agriculture of the Czech Republic (2004 -2007) "*Green report of the Czech Republic*", RIAI and Ministry of Agriculture, Prague. [Online]. Available: <http://eagri.cz/public/web/mze/ministerstvo-zemedelstvi/vyrocní-a-hodnotící-zpravy/zpravy-o-stavu-zemedelstvi/> [Accessed: 17 May 2018].
- [19] Nešvera, V. (2006) "Prices in trade of the Czech Republic with member countries of the European Union", *Politická ekonomie*, Vol. 54, No. 2, pp. 214-226. ISSN 2336-8225.
- [20] OECD (2007) "*The OECD-FAO Agricultural Outlook 2007-2016*". [Online]. Available: <https://www.oecd.org/tad/agricultural-trade/38893266.pdf> [Accessed: 6 Nov. 2017].
- [21] OECD (2011) "*Globalisation, Comparative Advantage and the Changing Dynamics of Trade*", OECD Publishing. [Online]. Available: <http://www.oecd.org/publications/globalisation-comparative-advantage-and-the-changing-dynamics-of-trade-9789264113084-en.htm> [Accessed: 6 Nov. 2017].
- [22] Pierce, J. R. and Schott, P. K. (2009) "A concordance between ten-digit U.S. Harmonized system codes and SIC/NAICS product classes and industries", Working Paper 15548, National Bureau of Economic Research. [Online]. Available: <http://www.nber.org/papers/w15548> [Accessed: 6 Nov. 2017].

- [23] Pohlová K. and Mezera J. (2014) "Analysis of Development of Czech Foreign Trade in Foods and Beverages", *Agris on-line Papers in Economics and Informatics*, Vol. 6, No. 4. p. 121-131. ISSN 1804-1930.
- [24] Pohlová, K., Mezera, J. and Špička, J. (2016) "Czech foreign trade with meat and meat products", *Acta Oeconomica Pragensia*, Vol. 24, No. 2, pp. 63-80. ISSN 0572-3043. DOI 10.18267/j.aop.532.
- [25] Pulkrábek, J., Peterová, J., Řezbová, H. and Urban, J. (2007) "Competitive ability and economy of bioethanol production crops", *Listy cukrovarnické a řepařské*, Vol. 123, No. 7-8, pp. 216-220. ISSN 1210-3306.
- [26] Pohlová, K. (2017) "*Agrarian Foreign Trade Yearbook 2016*", Information study No. 114/2017, IAEI. Prague. ISBN 978-80-7271-226-7.
- [27] Ratering, T. and Matthews, A. (1999) "The competitiveness of the Czech agro-food sector in the context of EU Accession", FAO project TCP/CEH/8821.1999.
- [28] Regmi, A., Gehlhar, M., Wainio, J., Vollrath, T., Johnston, P. and Kathuria, N. (2005) "Market Access for High-Value Foods", Agricultural Electronic Report, the Economic Research Service, USDA/ERS Report No. 840, 2005.
- [29] Rovný, P., Kováčiková, E. and Peprný, A. (2010) "Price development evaluation of chosen plant commodities in agrarian market in the Slovak Republic", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. 58, No. 3, pp. 225-232. ISSN 1211-8516. DOI 10.11118/actaun201058030225.
- [30] Řezbová, H., Maitah, M., and Sergienko, O. I. (2015) "EU Quota Sugar Market Concentration - the Main Drivers of EU Sugar Market", *Agris on-Line Papers in Economics and Informatics*, Vol. 7, No. 4, pp. 131-142. ISSN1804-1930.
- [31] Šimaková, J. and Stavárek, D. (2015) "The effect of exchange rate on industry-level trade flows in Czechia", *E & M Ekonomie a management*, Vol. 18, No. 4, pp. 150-165. ISSN 2336-5604. DOI 10.15240/tul/001/2015-4-011.
- [32] Vokorokosova, R. (2005) "To some methods for measuring competitiveness of Slovak and Czech foreign trade", *Ekonomický časopis*, Vol. 53, No. 8, pp- 808-823. ISSN 0013-3035.
- [33] World Customs Organization (2017) "Harmonized System database", World Customs Organization. [Online]. Available: <http://harmonizedsystem.wcoomdpublishings.org/> [Accessed: 6 Nov. 2017].

APPENDIX

Old methodology – basic codes Regmi et al. (2005)

I. Bulk commodities

4-digit codes:

0902,0903,1001,1002,1003,1004,1005,1006,1007,1008,1201,1202,1204,1205,1206,1207,1801,2401

6-digit codes:

090111,090112,140420

II. Horticultural products

Calculated as the difference between total agricultural trade (HS 01 – 24) minus the sum of other (three) categories.

III. Semi-processed products

4-digit codes:

0101,0102,0103,0104,0105,0106,0209,0301,0501,0502,0504,0505,0506,0507,0508,0510,0511,0713,1101,1102,1103,1108,1109,1203,1208,1209,1211,1213,1214,1301,1302,1401,1404,1501,1502,1503,1505,1506,1507,1508,1509,1510,1511,1512,1513,1514,1515,1516,1518,1520,1521,1522,1802,1803,1804,1805,2301,2302,2303,2304,2305,2306,2308,2309

6-digit codes:

090190,170111,170112,170113,170114

IV. Highly processed products

4-digit codes

0201,0202,0203,0204,0205,0206,0207,0208,0210,0302,0303,0304,0305,0306,0307,0401,0402,0403,0404,0405,0406,0407,0408,0409,0410,0710,0711,0712,0811,0812,0814,1104,1105,1106,1107,1504,1517,1601,1602,1603,1604,1605,1702,1703,1704,1806,1901,1902,1903,1904,1905,2001,2002,2003,2004,2005,2006,2007,2008,2009,2101,2102,2103,2104,2105,2106,2201,2202,2203,2204,2205,2206,2207,2208,2209,2402,2403

6-digit codes:

090121,090122,121220,170191,170199,121221,121229

Newly proposed methodology – Pohlava et al. (2017)

I. Unprocessed commodities

01,0301,03062210,03063210,030710,030711,030721,030731,030741,030742,030751,03076090,03076000,030771,030781,030782,030791,030811,030821,03083010,03089010,04012099,0407,0409,0410,0501,0503,0508,05090010,05119931,06,0701,0702,0703,0704,0705,0706,0707,0708,0709,0713,07141000,07141091,07141098,07141099,07142010,07143000,07144000,07145000,07149011,07149019,07149020,07149090,080119,080121,080131,080211,080221,080231,080241,080251,080261,080240,080250,08030011,08030019,08031010,08039010,080410,08042010,080430,080440,080450,0805,080610,0807,0808,0809,0810,090111,090220,090240,0903,090411,09042010,09042030,09042110,09042190,090500,090510,090610,090611,090619,090700,090710,09081000,09082000,09081010,09082010,090811,090821,090831,090921,090931,090961,09091000,09092000,09093000,09094000,09095000,09093011,09093019,09094011,09094019,09095011,09095019,091010,091011,09102010,09109110,09109931,09109933,09109991,09109910,09109950,09104011,09104013,09104090,1001,1002,1003,1004,1005,100610,1007,1008,1201,120210,120230,120241,1204,1205,12060010,12060099,1207,1209,121010,1211,12129180,12121010,121292,121293,121294,12121091,12129941,12129095,12129910,12129920,12129930,12129970,12129980,12129990,1213,12149010,1301,1401,1402,1403,1404,15211010,15219091,220190,2401

II. Less processed products

Calculated as the difference between total agricultural trade (the sum of HS 01 – 24) minus the sum of other two categories (Unprocessed commodities and highly processed commodities).

III. Highly processed products

021011,021012,021019,021020,021091,021092,021093,02109010,02109011,02109019,02109021,02109029,02109031,02109039,02109041,02109049,02109060,02109071,02109079,02109080,02109910,02109921,02109929,02109931,02109939,02109941,02109949,02109951,02109959,02109960,02109971,02109979,02109980,02109985,030520,030530,030531,030532,030539,030541,030542,030543,030544,030549,030551,030553,030554,030559,030561,030561,030562,030563,030564,030569,030571,030572,030579,04021091,04021099,040229,040299,0403,04041002,04041004,04041006,04041012,04041014,04041016,04041026,04041028,04041032,0404034,04041036,04041038,04041072,04041074,04041076,04041078,04041082,04041084,040490,040520,0406,1517,16,170191,170199,1702,1704,1806,1901,1902,1904,1905,20,21,2202,2203,2204,2205,2206,2207,2208,2209,2309,2402,240311,240399

Business Process Management in Linking Enterprise Information Technology in Companies of Agricultural Sector

Peter Polakovič¹, Edita Šilerová², Klára Hennyeyová¹, Ivana Slováková³

¹ Department of Informatics, Faculty of Economics and Management, Slovak University of Agriculture in Nitra, Slovak Republic

² Department of Infotation Technologies, Faculty of Economics and Management, Czech University of Life Sciences in Prague, Czech Republic

³ Institute of Foreign Languages, Technical University in Zvolen, Slovak Republic

Abstract

Business Process Management is one of the most important components of a process-driven organization that we perceive as a sum of processes that are more or less follow-up. By adjusting and managing these processes, we can greatly influence the organization's performance, efficiency, flexibility and competitiveness. Business Process Management is important to support the technical infrastructure of modern information systems and communication technologies. These systems are part of the overall enterprise information system. The following article focuses on information and communication technologies for the proper and efficient functioning of process management in agro sectoral companies. This article presents a summary of theoretical knowledge and practical recommendations for creating and maintaining a process management system in enterprises with the support of information and communication technologies. For a more detailed analysis of this issue, statistical research, the partial results of which are subjected to statistical testing, are presented in the following article.

Keywords

Business process management, enterprise information systems, business infrastructure, process management.

Polakovič, P., Šilerová, E., Hennyeyová, K. and Slováková, I. (2018) "Business Process Management in Linking Enterprise Information Technology in Companies of Agricultural Sector", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 119-126. ISSN 1804-1930. DOI 10.7160/aol.2018.100310.

Introduction

Nowadays, information and communication technologies (ICT) are an increasingly important factor in supporting the achievement of corporate goals (Host'ovecký et al., 2015). The development of information and communication technologies leads the company to process electronic documents more and more (Tvrđíková, 2008). ICT becomes an element that enables growth and development of an organization. This is why ICT demands are rising. Gradual developments have shown that ICT helps create value where it enables business processes to be supported by making profits in the technology and business parts of the enterprise (Hallová et al., 2017). In general, an ICT value for an enterprise can be viewed from an analytical or pragmatic point of view. It is a problem for many companies to link the ICT with their strategic interests and daily routines (Vaněk et al., 2011).

In order for an organization to function effectively, it must identify and manage a number of related activities. The application of the process system within the organization along with process identification and interaction, as well as their management, can be seen as a process approach (McAdam, 2003). According to Ringim et al., (2012) is the ability to innovate and change to become a necessary competitive weapon, closely linked to the knowledge potential of the organization and the ability of an organization to learn. The basic principle is the collective effort to achieve the desired, shared goal by increasing the team's action potential in the process of personal and team learning. The essence of enhancing the action potential is to be able to respond based on acquired knowledge and to develop solutions (Carda et al., 2001).

We can see each enterprise as a system of processes, activities, and activities to achieve the goals. They

differ with each other, in particular, in how and how effective the individual processes are performed, respectively. as they are managed (Řepa, 2012). Process management is defined as a methodology for evaluating, analyzing and improving key business processes, based on customer needs and requirements. An interesting basis for understanding the procedural approach is systemic theory, which emphasizes the necessity of a comprehensive understanding of the partial management processes and their coordinated alignment in the target behavior of an integrated functioning unit. The advantage of these approaches is that they are based on the abstraction of reality on a set of elements and their linkages. They also try to identify inputs to the system that are essential to the behavior of the system so that the system achieves a goal (Ahmad et al., 2007).

Process Management and Business Process Management (BPM) are the most common terms in today's business and ICT world. Process management is a natural and comprehensive management approach to business creation, creating the prerequisites for a highly efficient, agile, innovative and adaptable organization that far exceeds the reachable by traditional management approaches (Smith, 2003). The aim of the article is to analyze the use of information systems infrastructure and technologies in agribusinesses in connection with process management, and to describe their dependencies on the basis of a questionnaire survey of agriculture companies sample. With processes we meet today at almost every step. The most popular is this term in companies, corporations that are moving in the area of information systems and technologies. When it sometimes appears that processes and information technologies are the same, which of course is not the case. However, the real nature of IT governance is very much supported. The word process can be used almost anytime, anywhere in any meaning.

According to Luftman (2003) process management is an activity leading to the transformation of a functionally oriented organization into a process-based organization. The process of implementing a process organization requires personnel and project security. Task solving with such a high degree of abstraction and complexity in an organization's heterogeneous ICT infrastructure environment must support appropriate ICT technologies. A technology cluster created within the organization from a variety of non-interconnected software products, which

aims to cover the whole area of process design, process implementation, implementation, and tracking, does not need to meet the expectations of the organization effectively. Zairi et al., (1995) says that procedural management means a substantial change in the notion of the information system over the traditional view. The arrival of the process management terminated the concepts of the information system as a non-monolithic monolith with a given structure, determined by a properly designed database and its associated functionality.

Process management requires that the information system is flexibly adapted to the business process, because its only purpose is to support it. Business processes, however, naturally change. This has a significant impact, for example, on the concept of information system standardization, as is known from the ERP, whose concept has traditionally led to a single, universal, definitive solution, generally applicable to each organization. This concept is overcoming today, precisely in the context of knowledge that has brought about process management ideas, as evidenced by SAP's approach, the market leader in systems in this area. In the past, it has come up with the new SAP Net Weaver product, meaning a significant conceptual turn in the concept of ERP by this company (Crowe, 2002).

The requirements of the organization's process system for its information system are as follows (Ozcelik, 2010):

- The information system must, as far as possible, support all activities of business processes, that is to say they have to be covered by their functionality,
- The information system must support the management of the business processes of the workflow process, so it must enable the processes to be monitored during the process and the process,
- The information system must, as far as possible, support all the patterns of the business in question, so it must, by its function, be assisted by the process of respecting as far as possible all the restrictions and rules of the business,
- The information system must enable the natural transformation of business processes, so it cannot prevent its conceptual or other changes in its structure.

While the data stored in the information system database represents its information potential (about the facts of the corporate system and its contexts), its functionality represents an action potential (the ability to process data). The workflow management system then has the role of a link between the data and the functions of the system, which also allows the enterprise process to use its system data through its functions (Dennis et al., 2003). The process-managed organization information system differs from the traditional one by separating the functions of the system from the way they are used. The functionality of the system for him represents the net potential of information support for activities, which is maximally universal, and therefore independent of the particular use procedure. While the functions of the system - the support of routine activities from processes are basically relatively unchanging, standard, their combining is always specific, each time given by a particular situation. The procedure for using system features is always given by the current business processes. Therefore, a process-managed organization can not suffice with a traditional information system, because it preserves some form of procedures by encoding them into functionality and thus makes business processes virtually immobilized (Mouzaz, 2006). If an organization is to become dynamic, naturally variable through its diverse business processes, its infrastructure must also support this variability. Instead of frozen practices for the use of their functions, they must support their eventual combinability according to the ever changing needs of processes (Vaněk, 2009; Landa, 2010).

The main trend in the further development of the BPM segment is SOA (Service Oriented Architecture). BPM solutions are a key component of service-oriented architecture. They represent the top layer of the architecture that organizes the implementation of various services in the sense of progressive implementation of the individual steps of the business process. BPM solutions must be closely interconnected with other software components of SOA implementations such as Enterprise Service Bus (ESB), SOA lifecycle management solutions, service register, and so on (Ozcelik, 2010). The reported BPM solution development confirms the trend of BPM connectivity with SOA. Business Process Management solutions help design, deploy, implement and track business processes. They allow the organization of individual partial automatic or manual operations according

to the requirements of a complex business process. They manage the execution of processes within rules that are derived from valid legislation, standards, and organization guidelines. They support the integration of applications and services into the organization's information system. Customize process execution to business requirements and track the current state of execution of processes. According to Ahmad et al., 2007, the benefits of implementing BPM technology into the corporate IS environment is to improve the organization's ability to cope with business-related requirements and opportunities. Organizations must flexibly respond to environmental changes to maintain their market position. Flexible customization of custom business processes, strategies, needs, services or products varies with customer, partner, and regulator requirements. Most changes require changes in the IT structure of the organization. The ability to flexibly change the information system is therefore a major constraint in implementing process changes resulting from the need to cope with organizational requirements and opportunities (Porter et al., 1993). BPM solutions enable fast change of IT infrastructure related to business process modeling. BPM solutions enable one group of tools to capture processes from a business perspective and then link them to the IT applications that are necessary to implement them.

BPM sets of software packages include a set of software tools for the entire process development cycle, from design to monitoring of real-world processes. Their approach eliminates the repetition of the standard deficiencies of the current process analysis, to the maximum extent linked to process and application analysis, the related processes and roles are defined and documented in a structured manner. There is no difference between what has been proposed and applied in practice. BPM has a very wide-ranging application due to the provided process modeling capabilities and to cover the entire development cycle. It provides efficient tools for process modeling by providing the benefits of EAM (Enterprise Application Integration), EAM (Enterprise Architecture Modeling). BPM technology is a general platform in terms of independence from the vertical line of business or the type of organization (Řepa, 2012; Ahmad et al., 2007). Introducing BPM is the most important prerequisite for the successful operation and advancement of any type of organization. BPM allows not only to analyze and monitor processes but, above all,

to target, organizationally and efficiently to reveal new opportunities for organizational improvement (Mouzas, 2006; Tvrdíková, 2008).

Material and methods

In 2017, the Department of Computer Science conducted a survey focused on the issue of Process Management in agro-business enterprises. The thesis focuses on the analysis of the use of process management in connection with the infrastructure of enterprise information technologies and systems. Hence, the following hypotheses also seek to clarify the main patterns and links in contemporary businesses. Based on the main goal of the thesis, we have formulated the following hypotheses.

H1: The use of process management in enterprises depends mainly on the amount of annual turnover than on the size of the enterprise by number of employees.

H2: Companies with implemented process management use a significantly different set of software as enterprises that do not use process management.

A survey of enterprises was made up of 51 agro-sector enterprises focused on agriculture and food. Several scientific methods have been used in the survey. The main method was the analysis and comparison, which, based on the questionnaire survey, identified the current situation and the current state of use of BPM and information infrastructure in practice. We used the synthesis method to process the knowledge from the literature. We have applied the induction method to formulate conclusions based on the evaluation of the survey. Using the deduction method, we have applied the lessons learned from the literature to draw conclusions. To find the data for our analysis, we chose a questionnaire survey, which was distributed to individual entities. Statistical calculations were made by SPSS Statistics. The questionnaire, through its results, was textured to the reliability of its construct. Analysis of selected parts of the survey was performed in the SPSS IMB statistical software. Reliability was tested by Cronbach's Alpha. Cronbach's Alpha is one of the most frequently used indexes for investigating the reliability of a measuring tool (questionnaire). Based on the structure of the questionnaire and the results obtained:

$$\alpha = (k/(k-1)) * [1 - \sum (s_{2i}) / s_{2sum}], \text{ where}$$

k – number of items (number of questions, quality criteria)

s_{2i} – variance for the items

s_{2sum} – variance for the sum of items

Several statistical methods have been used for statistical evaluation. Verification of dependencies between the examined characters was performed using the Chi-square test (χ^2), respectively (χ^2) - square contingency. This test consists of a comparison of empirical and theoretical abilities, from what would be empirical abilities if the characters were independent. For statistical tests where the Chi-square independence test could not be used because the cell count assumption in the contingency table was not followed, Fisher's exact test was used. Fisher's exact test is based on a contingency table and verifies the null hypothesis of the equality of two shares, i.e. the independence of the two binary variables. This test is based on the assumption that all marginal frequencies (row totals / columns) in the pivot table are fixed. This assumption is rarely met. Typically, only line counts or only total abundance are fixed.

Results and discussion

The benchmark sample consisted of 8 small enterprises, 33 medium-sized enterprises and 10 large enterprises. In the survey, we focused mainly on enterprises that implement modern information systems and management methods, so we focus mainly on large and medium-sized businesses that usually have to deal with this issue first, have more extensive experience, and have generally come to a halt in implementation. In the following part, we focus on the analysis of the use of modern management methods and IS / IT infrastructure in enterprises, the existence or absence of elaboration of strategies, concepts, whether using different management tools and methods but also information technology as a supporting mechanism in management. We also explore the use of IT and software in companies. In the survey, we analyzed the existence of plans and strategies for business areas and the use of different management methods. With the greatest percentage of occurrence and workmanship, the main strategies, strategic goals, visions and missions are found in enterprises. Secondly, there are established performance measurement systems and enterprise benchmarking, mostly for large companies. For small businesses, percentages are down towards other groups, but they are held with more than

half of the sample examined. Managerial methods and techniques are listed in the Table 1.

When deciding on implementing a new enterprise information system, or upgrading or completing the current functionality, businesses are considering a number of criteria that will require the selection of this IS / IT facility. On the occasion of conducting our survey in companies and organizations of various sizes, we have included this assessment in the survey as well. We've offered the manager a choice and evaluation, which criteria are the most common in their organizations. The report is created based on the size of the business, and therefore the individual percentages are calculated as the average value of the weights that the respondents have assigned within one enterprise size group - Table 2.

In the next section, we present the results of the questions on the most important areas

of business processes in IS / IT implementation or innovation. It is not just the areas that IS / IT implementation is most affected, but it is also areas that affect implementation itself, its superior or even the controlling element. The survey was closed by a selection of options. The interviewed managers could first see all areas or processes, then consider whether they were in IS / IT implementation in their company and most of them checked that they were. Therefore, this report is only informative, and we have used it to sort business processes according to the significance attributed to them by the practice managers - Table 3.

The survey focuses on analyzing the use of process management in linking to existing enterprise information technology and systems infrastructure. Hence, the hypotheses set by us are intended to clarify the main patterns and relationships in today's businesses. Among

Organization	Small enterprises	Medium-sized enterprises	Large enterprises
Introduced and standardized project management methodology	6.1%	22.7%	45.3%
Developed strategic plan at the level of functional areas	26.4%	56.5%	64.2%
Introduced graphical model of processes	3.3%	11.7%	27.9%
Established process management	24.6%	40.3%	56.1%

Source: own research and processing

Table 1: Overview of the introduction and use of management methods and techniques.

Organization	Small enterprises	Medium-sized enterprises	Large enterprises
Software Compatibility	65.6 %	71.6 %	75.0 %
Software functionality	88.7%	89.8%	89.6%
Software price	78.7%	75.6%	67.0%
Software extensibility	56.7%	67.9%	94.8%
Software availability in SK language	94.5%	90.0%	78.4%
Local support availability	87.0%	80.7%	78.9%
Software editing	60.3%	76.0%	87.1%

Source: own research and processing

Table 2: Criteria for selecting management software or business system.

Organization	Small enterprises	Medium-sized enterprises	Large enterprises
Analysis of product sales	63.6 %	68.6 %	67.0 %
Budgeting	69.7%	75.8%	85.6%
Human Resources	89.7%	80.6%	91.0%
Marketing	84.7%	87.9%	87.8%
Inventory management	52.1%	55.3%	56.0%
Financial analysis	74.7%	76.2%	80.9%

Source: own research and processing

Table 3: Areas of Business Process Changes in IS / IT Implementation and Innovation.

the businesses we have analyzed, we have selected only the ones that surveyed to use, in part, the process management, its tools, or have it fully implemented. The breakdown of enterprises into groups by number of employees is similar to the overall distribution of enterprises across the sample. However, when we look at the breakdown by turnover, there is a significant non-proportionality, 46% of process-managed enterprises being enterprises with a turnover of more than EUR 3.5 million. It follows that companies apply procedural management mainly because of work, that is, to better manage the burden of activity that we can monitor by dependence on the amount of turnover, rather than on the size of the number of employees. We can also evaluate that a process-managed enterprise is at a higher level of management, that is, it has the necessary skills needed for successful growth, as well as the strategy and strategic goals of the company, the established performance measurement system and, in particular, targeted IT / IT infrastructure management. So we can say that hypothesis 1 has been confirmed. Businesses can target their IS / IT investments effectively and aiming to maximize the resulting effect reflecting their benefits, to automate and modernize their processes, or to postpone, save, expose, intuitively, and sometimes inadvertently or impulsively, and mitigate for their inadequate result. We believe that if a company is process-driven, that is, at a higher level of management, it should know how to help with technology and purposefully and purposefully invest its resources. Under hypothesis 2, spending is remarkable for small and medium-sized enterprises that use process management up to 45.6%. This means that small and medium enterprises using process management spend more than twice as much funding on IS / IT as enterprises that are not process-driven. Thus, in the case of small and medium-sized enterprises, we assess that this hypothesis is confirmed.

Conclusion

At the time of the arrival of BPM from theory into practice, there were also certain exaggerated expectations. Particularly in smaller organizations, they welcomed the abandonment of traditional organizational structures and functional systems, and expected procedural management to have some management release and automatic ability to quickly adapt to changing conditions

and improvement. Ciccio (2015) argues that adapting to new conditions, takes some time to ensure that integrated systems deliver the expected results. As is also the case with habit technology, the human dimension is the cornerstone of an accident. It is critical, and everything that is well thought out and planned can go wrong. While we can use engineering approaches, we must count on it, oftentimes on the illogical resistance of workers, not to try new things, even if they later save their jobs, time and performance. Therefore, the human dimension becomes a decisive factor, mainly human motivation and education. The process view requires the need to find a superior reason for the activities we perform in such a way that it is independent of the rules of operation of individual business objects. It is argued that for every business process there must be some reason in the form of purpose, purpose, and eventually also external impetus. Then we get the shifts that are important for modeling the enterprise information system. In business processes, it is essential that the outcome of the process is a product or service that is directed to a customer, predominantly external, but also within an enterprise. As a result of the process management process, the executive team's proposal is to organize the company so that the key processes that are important for competitiveness are effectively implemented and meet the expectations of both internal and external customers. After accepting the proposal by the company, the processes are introduced into the routine running of the company. The benefits of process management depend on the objectives of the project. As we have already said, the way we design processes and therefore the benefits can be influenced by the goals.

However, process management gives a fresh insight into the importance of the activities carried out and helps to better define the concrete responsibilities for their implementation and quality. Distorting the traditional line structure and placing emphasis on results and totals, not on parts. So we pay attention to the process across the organizational structure, contributing to better teamwork and corporate culture (van der Aalst).

Corresponding authors:

PaedDr. Peter Polakovič, Ph.D.

Department of Informatics, Faculty of Economics and Management

Slovak University of Agriculture, Tr. A. Hlinku 2, Nitra, 949 01, Slovak Republic

E-mail: peter.polakovic@uniag.sk

References

- [1] van der Aalst W. M. P., La Rosa, M. P. and Santoro, F. M. (2016) "Business Process Management", *Business and Information Systems Engineering*, Vol. 58, No. 1. pp. 1-6. E-ISSN 1867-0202, ISSN 2363-7005. DOI 10.1007/s12599-015-0409-x.
- [2] Ahmad, H. Francis, A. and Zairi, M. (2007) "Business process reengineering: Critical success factors in higher education", *Business Process Management Journal*, Vol. 13, No. 3, pp. 451-469. ISSN 1463-7154. DOI 10.1108/14637150710752344.
- [3] Carda, A. and Kunstová, R. (2001) "Workflow, řízení firemních procesů" (In Czech), Grada Publishing, 136 p. ISBN 80-247-0200-2.
- [4] Ciccio, C. (2015) "Knowledge - Intensive Processes: Characteristics, Requirements and Analysis of Contemporary Approaches", *Journal on Data Semantics*, Vol. 4, No. 2. pp. 29-57. ISSN 1861-2032 29-57.
- [5] Crowe, T. J., Fong, P. M, Bauman, T. A. and Zayas-Castro, J. L. (2002) "Quantitative risk level estimation of business process reengineering efforts", *Business Process Management Journal*, Vol. 8, No. 5, pp. 490-511. ISSN 1463-7154. DOI 10.1108/14637150210449148.
- [6] Dennis, A., Carte, T. and Kelly, G. (2003) "Breaking the rules: success and failure in groupware-supported business process reengineering", *Decision Support Systems*, Vol. 36, No. 2, pp. 31-47. ISSN 2050-6996. DOI 10.1016/S0167-9236(02)00132-X.
- [7] Hallová, M., Polakovič, P., and Slováková, I. (2017) "Current Trends in Training of Managers in the Field of Information and Communication Technologies and identifying the barriers to education of managers", *AGRIS on-line Papers in Economics and Informatics*, Vol. 9, No. 4, pp. 45-52. ISSN 1804-1930. DOI 10.7160/aol.2017.090405.
- [8] Host'ovecký, M., Mišút, M. and Pribilová, K. (2015) "Web based testing in science education". In *"Innovations and advances in computing, informatics, systems sciences, networking and engineering: lecture notes in electrical engineering"*, CISSE 2013 virtual conference, Springer international publishing, Vol. 313, pp. 247-254. ISBN 978-3-319-06772-8. ISSN 1876-1100.
- [9] Landa, O. (2010) "Jakou roli ve strategii dnes hraje HR?" (in Czech), *Human Resources Management*, Vol. 6, No. 9, pp. 231-300. ISSN 1801-4690.
- [10] Luftman, J. (2003) "Assessing It/Business Alignment, Information Systems", *Management*, Vol. 3, No. 4, pp. 9-15, ISSN 1846-3363. DOI 10.1201/1078/43647.20.4.20030901/77287.2.
- [11] McAdam, R. (2003) "Radical Change: A Conceptual Model for Research Agendas", *Leadership & Organization Development Journal*, Vol. 24, No. 4, pp. 226-35. ISSN 0143-7739. DOI 10.1108/01437730310478093
- [12] Mouzas, S. (2006) "Efficiency versus Effectiveness in Business Networks", *Journal Of Business Research*, Vol. 59, No. 10, pp. 1124-1132. ISSN 0148-2963. DOI 10.1016/j.jbusres.2006.09.018.
- [13] Ozcelik, Y. (2010) "Do business process reengineering projects payoff?", *International Journal of Project Management*, Vol. 28, No. 1, pp. 7-13. ISSN 0263-7863. DOI 10.1016/j.ijproman.2009.03.004.
- [14] Porter, L. J. and Parker, A. J. (1993) "Total quality management – the critical success factors", *Total Quality Management*, Vol. 4, No. 1, pp. 13-22. ISSN 1360-0613. DOI 10.1080/09544129300000003.

- [15] Ringim, K. J., Razalli, M. R. and Hasnan, N. (2012) "Critical Success Factors for Business Process Management for Small and Medium Banks in Nigeria", *Business And Management Review*, Vol. 2, No. 1, pp. 83-91. ISSN 2047-0398.
- [16] Řepa, V. (2012) "*Procesně řízená organizace*" (In Czech), Grada Publishing, 304 p. ISBN 978-80-247-4128-4.
- [17] Smith, M. (2003) "Business process design: correlates of success and failure", *The Quality Management Journal*, Vol. 10, No. 2, pp. 38-49. ISSN 10686967. DOI 10.1080/10686967.2003.11919062.
- [18] Tvrdíková, M. (2008) "*Aplikace moderních informačních technologií v řízení firmy*". Grada Publishing, 176 p. ISBN 978-80-247-2728-8.
- [19] Vaněk, J., Jarolímek, J. and Šimek, P. (2009) "Information Services and ICT Development in Agriculture of the Czech Republic", *AGRISon-line Papers in Economics and Informatics*, Vol. 1, No. 1, pp. 47-52. ISSN 1804-1930.
- [20] Vaněk, J., Jarolímek, J. and Vogeltanzová, T. (2011) "Information and Communication Technologies for Regional Development in the Czech Republic – Broadband Connectivity in Rural Areas", *AGRISon-line Papers in Economics and Informatics*, Vol. 3, No. 3, pp. 67-76. ISSN 1804-1930.
- [21] Zairi, M. and Sinclair, D. (1995) "Business process re-engineering and process management", *Business Process Management Journal*, Vol. 1, No. 1, pp. 161-173. ISSN 1463-7154. DOI 10.1108/14637159510798248.

Editorial board

President of Editorial Board

Prof. Ing. Miroslav Svatoš, CSc., Czech University of Life Sciences Prague

Members of Editorial Board

Prof. Dr. Ulrich Bodmer, Weihenstephan-Triesdorf University of Applied Sciences

Prof. Philippe Burny, Walloon Center for Agricultural Research, Gembloux

Prof. J. Stephen Clark, Ph.D., Dalhousie University, Halifax

Prof. Ing. Lukáš Čechura, Ph.D., Czech University of Life Sciences Prague

Assoc. prof. Ing. Zdeněk Havlíček, CSc., Czech University of Life Sciences Prague

Prof. Dr. Miklós Herdon, University of Debrecen

Prof. Dr. Heinrich Hockmann, Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle

Prof. Ing. Jan Hron, CSc., DrSc., dr.h.c., Czech University of Life Sciences Prague

Assoc. prof. Ing. Milan Kučera, CSc., Slovak University of Agriculture in Nitra

Assoc. prof. PhDr. Michal Lošťák, CSc., Czech University of Life Sciences Prague

Assoc. prof. Ing. Zuzana Pálková, Ph.D., Slovak University of Agriculture in Nitra

Assoc. prof. Ing. Mansoor Maitah, Ph.D. et Ph.D., Czech University of Life Sciences Prague

Assoc. prof. Ing. Ivana Rábová, Ph.D., Mendel University in Brno

Ing. Helena Řezbová, Ph.D., Czech University of Life Sciences Prague

Derek Shepherd BSc, MSc, MTS, Plymouth University, Plymouth

Prof. RNDr. PhDr. Antonín Slabý, CSc., University of Hradec Králové

Prof. Ing. Luboš Smutka, Ph.D., Czech University of Life Sciences Prague

Ing. Pavel Šimek, Ph.D., Czech University of Life Sciences Prague

Ing. Jiří Vaněk, Ph.D., Czech University of Life Sciences Prague

Prof. Dr. Viktor Vasilyonok, ITMO Saint Petersburg

Agris on-line Papers in Economics and Informatics

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

<http://online.agris.cz>

ISSN 1804-1930