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Assessment of Rice Market Competiveness Using Horizontal Price Transmission: Empirical Evidence from Southern Region of Nigeria

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Abstract

The study examined the horizontal price transmission and market integration between the local and foreign rice market in the Southern region of Nigeria. The study used average monthly prices of local and foreign rice in the rural and urban markets from January 2005 to June 2014. The findings show that, prices of local and foreign rice in the rural and urban markets have constant exponential growth rate of 0.60%. The Pearson correlation coefficient revealed a strong positive relationship between prices of local and foreign rice in both rural and urban markets. The cross-product Granger causality test revealed bidirectional relationship between prices of local and foreign rice in the region. The results of the cross co-integration test revealed the presence of co-integration between prices of the two products. The coefficients of the price variable in the cross co-integration equations for the local and foreign rice markets converge to the law of one price which connotes instantaneous price adjustment and competitiveness. The result of the cross - product error correction model also confirmed the existence of the short run market integration between the two markets. The study established the fact that, price of local rice competes favorably with its foreign counter part and thus a perfect substitute especially in the rural area. Based on the finding, it is recommended that, short term policies should be used to intervene in the rice sub sector in the region. Policies aimed at boosting local production of rice should be encouraged, while value additions in the domestic produced rice should be pursuit vigorously.

Keywords

Market, rice, integration, agricultural, Akwa Ibom, Nigeria.

JEL Classification: Q13

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Introduction

Rice is one of the most important staple foods in Nigeria. Among Nigerian, rice is a normal good, hence has positive income elasticity (Udoh et al., 2013). The country is an important producer of rice in West Africa (Daramola, 2005). The West African sub-region accounted for about 56% of the total production in Africa, and Nigeria produces about 23% of the quantity (Kehinde, 1999; Daramola, 2005). The production of rice is done basically by smallholder farmers who have limited farm resources, poor technology, and produce an average of 4.6 tons of paddy per year from an average crop area of 3.30 hectares (Erenstein et al., 2004; Daramola, 2005). Following the works of Akpokodje et al., (2001), Daramola (2005) a Imolehin and Wada (2000), rice is cultivated in five production systems in Nigeria, namely: rain-fed upland (30%),rain-fed lowland (47%), irrigated lowland (17%), deep water (5%) and mangrove swamp (1%). The level of domestic rice production in Nigeria is about 3.5 million metric tons per annum; while the domestic demand stood at about 6.1 million metric tons per annum (CBN, 2014 and USA, department of Agriculture, 2014). This shortfall in supply creates incentive for rice importation in the country as noted by Daramola (2005) and Awe (2006). Total import oscillates from 1.7 million tons to 3.2 million tons, depending on the demand strength, tariff structure, macroeconomic variability, and annual domestic production among others. Following this shortfall

in supply, the country spends about $4b per year for the importation of processed rice (CBN, 2014). This has huge implications on the country's' foreign reserve and the development of domestic rice sub sector.

Owing to the important of rice sector to the citizenry and the national economy, the federal government has implemented several policies to boost rice production in the country. Government has set up several tariff regimes, imposed banned on importation of rice, implemented import restriction license, quantitative restrictions, and abolished Commodity Boards among others. The Presidential Initiative on Rice was also inaugurated in 2002 with several aims including improved household food security and income, reduction in rural poverty, increase in domestic rice production such that supply will exceed demand and surpluses exported among others. Other institutional based policy includes; Nigerian National Rice Development Strategy (NNRDS) form in 2009. The agency was saddled with the responsibility of adding value to locally produced rice among others. Despite these incentives, the country domestic rice sector is still wallowed in low productivity, sluggish competition with foreign counterpart in terms of supply, quality (value addition) and consumer preference (demand). The resultant effect has been the relegation of the domestic rice sub sector and soaring of foreign rice imports in recent years.

The magnitude of foreign rice in the country's domestic market has a serious effect on the local production, competitiveness and the development of subsidiary rice markets. Unguided international trade policies can lead to dumping, diversification and neglect of vital sectors of the economy. It appears that, not much information are available in the country to analyze the interdepency between local and foreign rice markets. This could lead to mis-specification of policies. To avoid this situation, agricultural economist have devise ways to assess the degree of interaction and interdependency among tradable commodities in different markets. Price trend analysis, price transmission study and market integration study are among methodologies often used to assess the efficiency of commodity market interaction among, between and within markets (Listorti and Esposti, 2012). The study of price transmission has been motivated largely by the view that co-movement of prices in different markets can be interpreted as a sign of efficient markets, while the absence of price co-movement can be viewed as a sign of market failure (Ghoshray, 2011). Commodity prices and consumer food prices depends on horizontal and vertical price transmission (Ferrucci et al., 2012; Lloyd et al., 2012).

On the other hand, spatial market integration shows the efficiency of the market and also indicates the proficiency of marketing infrastructures in the region under consideration (Faminow and Benson, 1990). Understanding market integration is important particularly in needs assessments as policy makers need to avoid over-estimating or under-estimating the ability of markets to respond to price or any exogenous shock. Market integration helps in the optimization of resource use; increase in farm incomes; widening of markets; promote growth of agro-based industries, encourage value addition and also create employment (Acquah and Owusu, 2012). The analysis of spatial market integration thus, provides indication of competitiveness, effectiveness of market arbitrage, and the efficiency of pricing (Sexton, Kling and Carman 1991). This often associated with symmetric price integration.

This study employed these methodologies to assess the level of competitiveness between the local and foreign rice market in the southern region of Nigeria. The horizontal price transmission analysis was used because the two rice markets are distinct or differentiated (Esposti and Listorti, 2012). In an attempt to achieve this objective, the following specific objectives were pursuit:

1) To examine the trends and price differential in the local and foreign rice market in the region,
2) To determine the efficiency of horizontal information flow or horizontal price transmission between the local and foreign rice market, and
3) Access the extent of cross market integration and speed of price adjustment between the local and foreign rice markets in the region.

Review of relevant literature

Several authors have applied the Law of One Price to study price transmission in agricultural commodities. Noticeably among them are: Ravallion (1986), Goletti and Babu (1994), Baffes and Ajwad (2001) and Barrett (2001) as well as Esfahani (2006). However, most of the results were controversial, and sensitive to the techniques employed. Also, co-integration, error correction model and Granger causality test have been used

to study agricultural price transmission. Some of the recent empirical evidences are included in the following: Acquah and Owusu (2012) in Ghana; Zahid et al. (2007) and Hussain (2010) in Pakistan, Gonz´alez-Rivera and Helfand (2001) in Brazil rice sector; Dawson and Dey (2002) and Hossain and Verbeke (2010) in Bangladesh rice sector; Bakucs et al. (2007) in Hungary tomato sub sector and Worako et al. (2008) in Ethopia coffee industry.

Enders and Silkos (1999) introduced threshold model to ascertain the asymmetric nature in price transmission in agricultural commodities. Abdulai (2002) and Sephton (2003) have employed this methodology to assess price transmission in agricultural commodities. This type of model is aimed at testing for the presence of non- linear transaction costs, and in general for the existence of price bands within which there is no transmission. Recently, Rezitis and Dimitris (2013) used Markov Switching vector error correction model to investigate price transmission mechanism of fresh tomato market in Greek. The results indicated that there were causality and leadership relationships between producer and consumer prices in the short and long runs. In a similar way, Hassan and Simmioni (2001) found that causality runs from producer to retailer in French tomato market. Moreover, Goodwin and Harper (2000) in US discovered that pork market price transmission shocks in the marketing channel are unidirectional and that information flows from producer to consumer. On the other hand, Ben–Kaabia and Gil (2007) explored the Spanish lamp market and observed that retailers benefit from shocks that affect the marketing channels for lamps. Vavra and Goodwin (2005), using a TVEC model, examined the price transmission mechanism of beef, chicken and eggs in the US. Jezghani et al. (2013) used vector error correction model (VECM) to investigate the spatial market integration in Iranian rice market. The result revealed significant market integration between Iran and Thailand rice market, with Thailand market been the lead market. Chirwa (2000) studied the food marketing reforms and integration of maize and rice markets in Malawi. He discovered that the rice market was more integrated than maize market. Suryaningrum et al. (2013) investigated the spatial market integration of Thailand and Vietnam rice market in Indonesia by using real price monthly data. Johanson co-integration test approach was employed to examine the long-run price relationship, while the short-term relationship was examined by vector error correction model (VECM). The results showed that, the long-run relationships existed among Thailand, Vietnam, and Indonesian rice markets. Furthermore, Dawson and Dey (2012) studied the spatial market integration among major domestic rice markets in Bangladesh. An integrated empirical framework tested long-run spatial market integration between price pairs using a dynamic vector autoregressive model and co integration. Hypotheses tests of market integration, perfect market integration, and causality were conducted sequentially using monthly prices from rice markets in Bangladesh since trade liberalization in 1992. The results showed that rice markets in Bangladesh were perfectly integrated.

In Nigeria few literature exist on agricultural price transmission. Methodologies ranging from descriptive, LOP, causality tests, co-integration and ECM are popular among Nigerian authors. For instance, in Nigeria, Okoh and Egbon (2005) examined the integration of Nigeria's rural and urban foodstuffs markets. The study concluded that, the rural and urban foodstuffs markets were well integrated. The results further suggested that the urban market price drives the rural market price. Akintunde et al. (2012) studied the long run price integration of grains in Oyo state, western Nigeria. The integration test showed that none of the markets examined had prices tied together in the long- run. Also, Debaniyu, (2012) investigated grain (cowpea) market integration in northern Nigeria. He employed time series methodology and discovered that some markets in the study area were integrated in the long run. Akpan et al. (2014) examined the price transmission and market integration in local and foreign rice in the rural and urban markets in Southern region of Nigeria. The findings show that, prices of local and foreign rice in rural and urban markets has a constant exponential growth rate of 0.59%. Also, the Pearson correlation coefficient matrix revealed that, the rural price of local and foreign rice has significant positive linear relationships with their corresponding urban prices. The Granger causality test revealed bidirectional relationship between rural and urban price of local and foreign rice in Akwa Ibom State, Nigeria. The results of the co-integration test revealed the presence of co-integration between the rural and urban prices of local and foreign rice as well as support the hypothesis of perfect price transmission between the two markets in the study area. The results of the error correction model also confirm

the existence of the short run market integration between the rural and urban prices of local and foreign rice in the study area.

Premised on the imbalance in the rice market in most developing countries like Nigeria, the myriad of literature available on price transmission and market integration have not delved into the relationship between the local (rice produced in Nigeria) and foreign rice (rice produced outside Nigeria) market in the domestic economy. This relationship is imperative due to the increasing dominant of foreign rice import in most developing economies. Hence, this research was specifically designed to provide empirical fact needed to understand and address this issue appropriately.

Materials and methods

Study area

The study was conducted in one of the states (Akwa Ibom State) in the South-South region of Nigeria. The state was picked because it is central and represents one of the viable economic centers in the region. It has a distinct rural and urban settlement and is not prone to violence as compared to other states in the region. The region is popularly called the Niger Delta region or the oil rich region of Nigeria. The state is located between latitudes 4°321 and 5°331 north and longitudes 7°251 and 8°251 east. It has a total land area of areas of 7,246 km^2. The mean annual temperature of the state lies between 26°C and 29°C and average sunshine of about 1,450 hours per year. The mean annual rainfall ranges from 2,000 mm to 3,000mm, depending on the area. Akwa Ibom State has a population of over 3,902,051 (National Population Commission, 2006). The state is basically an agrarian society where crops like maize, okra, cassava, yam and rice are cultivated in large quantities.

Source of data

Average monthly retailed prices (measured in Naira per kilogram) of foreign and local rice in rural and urban markets were used in this study. The data came from the quarterly publication of the Akwa Ibom State Agricultural Development Programme (AKADEP). The study period covered January 2005 to June 2014. A total of 114 average monthly prices (N/Kg) of local and imported rice from rural and urban markets were used in the study.

Analytical techniques

The study applied trend analysis, bi-variate correlation analysis and t-test, Granger causality tests, co-integration and Error Correction Model (ECM) to evaluate its objectives. Each of the tests is explained in both explicit and implicit below:

The trend tnalysis of average monthly retailed prices of local and foreign rice in rural and urban markets in Akwa Ibom State in Nigeria

The nature of growth rate in prices of local and foreign rice in both rural and urban market was investigated by employing the exponential price equation as specified below:

$$P_t = b_o\, e^{bt}\, e^{ut} \quad (1)$$

$$\log_e P_t = \log_e b_0 + b_1 t + U_t \quad (2)$$

Where exponential growth rate (r) = $(e^{b1} - 1)*100$.

"P_t" is represented by:

L_{rt} = Average monthly price of local rice in rural market in Naira/Kg

F_{ut} = Average monthly price of foreign rice in Urban market in Naira/Kg

L_{ut} = Average monthly price of local rice in urban market in Naira/Kg

F_{rt} = Average monthly price of foreign rice in rural market in Naira/Kg

t = time trend (1, 2, …, 114)

The exponential price equation was used because, several literature have supported consistence rise in prices of agricultural commodities for some years past in Nigeria (Akpan, 2009, Famine Early Warning Systems Network (FEWSNET) 2008, Odozi and Bolarin 2012). Hence, it was assumed that, changes in prices of local and foreign rice in Akwa Ibom State should be investigated using non-linear model.

Bilateral Granger Causality Test between Prices of local and Foreign Rice in Akwa Ibom State, Nigeria

A long run cross product Granger causality model was used to test the relationship between price movement in local and foreign rice in Akwa Ibom State. The number of lags used in the estimation was determined by Akaike and Schwarz information criteria. The primary model in Vector Autoregressive Regression forms are represented as thus:

$$\left\{\begin{array}{l}\Delta LnL_{rt} = \beta_0 + \beta_1 \sum_{i=1}^{n} \Delta LnL_{rt-1} + \beta_2 \sum_{i=1}^{n} \Delta LnF_{ut-1} + \varepsilon_{1t} \quad (3)\\ \Delta LnF_{ut} = \delta_0 + \delta_1 \sum_{i=1}^{n} \Delta LnF_{ut-1} + \delta_2 \sum_{i=1}^{n} \Delta LnL_{rt-1} + \varepsilon_{2t} \quad (4)\end{array}\right\}$$

$$\left\{\begin{array}{l}\Delta LnL_{ut} = \gamma_0 + \gamma_1 \sum_{i=1}^{n} LnL_{ut-1} + \gamma_2 \sum_{i=1}^{n} \Delta LnF_{rt-1} + \varepsilon_{3t} \quad (5)\\ \Delta LnF_{rt} = \alpha_0 + \alpha_1 \sum_{i=1}^{n} \Delta LnF_{rt-1} + \alpha_2 \sum_{i=1}^{n} \Delta LnL_{ut-1} + \varepsilon_{4t} \quad (6)\end{array}\right\}$$

A unilateral Granger causality implies inefficiency in price movement between foreign and domestic rice sub sectors in the long run. This will also connotes that, both markets are weakly competitive in the region. On the other hand, mutual or bidirectional Granger causality implies smooth or symmetric price movement between the local and foreign rice market in the study area. This connotes strong substitutability and competitiveness of both markets.

Co- integration test on prices of local and foreign rice in Akwa Ibom State, Nigeria

Co- integration involves the determination of the long-run relationship among non-stationary time series. If two markets are integrated, then there exists an equilibrium long run relationship between these markets (Goodwin and Schroeder, 1991; Gonzalez-Rivera 2001; Sexton, Kling, and Carman, 1991). The study applied the Engle and Granger two-step technique and Johansen co-integration approach to examine the co-integration relationships between local price and foreign price of rice in the study area. The specification is shown in equation 7 and 8. If two markets are perfectly integrated, then $\gamma_1 = 1$ in equation 7 (law of one price). In this case, price changes in local rice in the rural market are fully reflected in the foreign rice prices in the urban market. When $\gamma_1 \neq 1$ ($\gamma_1 < 1$ or $\gamma_1 > 1$), then the degree of market integration needs to be determined by investigating the variance of γ_1 from the threshold mark of 1.

$$LnL_{rt} = \gamma_0 + \gamma_1 \sum_{i=1}^{n} LnF_{ut} + U_{1t} \quad (7)$$

$$LnF_{rt} = \varphi_0 + \varphi_1 \sum_{i=1}^{n} LnL_{ut} + U_{2t} \quad (8)$$

Co-integration between the price series analyzed implies that two prices may behave in a different way in the short run, but that they will converge toward a common behaviour in the long run. If this property is verified, the characteristics of the dynamic relationship between the prices can be described by an Error Correction Model (ECM). Following the work of Barrett and Li (2002), the short-run adjustment parameter of the ECM can be interpreted as a measure of the speed of price transmission, while the long run multiplier can be interpreted as a measure of the degree of price transmission of one price to the other. The properties of co-integrated series also imply the existence of a causality relation, as defined by Granger, that can be tested by assessing if the past observations of one of the two prices (fail to) predict those of the other. Following the Granger Representation Theorem, we specify the Error Correction Model (ECM) for the co-integrating series in the study. The general specification of the ECM that was estimated for the rural price equations for local and foreign rice in the state is shown below:

$$\Delta \mathrm{LnL}_{rt} = \gamma_0 + \gamma_1 \sum_{i=1}^{n} \Delta LnL_{rt-1} + \gamma_2 \sum_{i=1}^{n} \Delta \mathrm{LnF}_{ut-i} + \gamma_3 ECM_{t-1} + U_{1t} \quad \textbf{(9)}$$

$$\Delta \mathrm{LnF}_{rt} = \vartheta_0 + \vartheta_1 \sum_{i=1}^{n} \Delta LnF_{rt-1} + \vartheta_2 \sum_{i=1}^{n} \Delta LnL_{ut-i} + \vartheta_3 ECM_{t-1} + U_{2t} \quad \textbf{(10)}$$

Variables are as defined previously in equation (2), and coefficients (γ_3) and (ϑ_3) lie in the range of ($-1 < \gamma_3, \vartheta_3 < 0$), and measure the deviations from the long-run equilibrium in period (t_{-1}) in both L_{rt} and F_{rt}. In order to obtain a parsimonious dynamic ECM for the rural price equation, the study adopted Hendry's (1995) approach in which an over parameterized model is initially estimated and then gradually reduced by eliminating insignificant lagged variables until a more interpretable and parsimonious model is obtained.

Results and discussion

Descriptive analysis of urban and rural monthly prices of local and foreign rice in Akwa Ibom State

The descriptive statistics of price variables used in the analyses is shown in Table 1. The average prices of local and foreign rice in the rural market stood at N161.19/kg and N219.77/kg respectively. In urban market, the mean price was N158.11/kg and N215.14/kg for local and foreign rice respectively.

Parameters	Local rice		Foreign rice	
	Rural market (N/Kg)	Urban market (N/Kg)	Rural market (N/Kg)	Urban market (N/Kg)
Mean	161.19	158.11	219.77	215.14
Median	166.78	163.15	233.97	226.73
Minimum	100.42	98.75	129.63	139.17
Maximum	224	232.09	308	307
Standard deviation	34.601	34.184	45.462	45.483
Coefficient of Variation	0.218	0.216	0.207	0.211
Skewness	-0.112	0.002	-0.245	-0.062
Kurtosis	-1.184	-1.039	-1.276	-1.172

Note: Prices are expressed in nominal terms
Source: Own processing

Table 1: Descriptive statistics of rice variables used in the analysis.

The minimum and maximum prices of local rice in the rural markets were N100.42 and N224.00 respectively. Likewise, it was N98.75 and N232.09 repectively in urban market. Prices of foreign rice has larger ranges in both rural and urban markets compared to local rice. This shows evidence of price variations between the rural and urban markets for local and foreign rice in the study area. The standard deviations in prices of local and foreign rice rotate around 34 and 45 respectively. Similarly, the coefficient of variability in price variables fluctuate approximately around 22% and 21% for local and foreign rice market respectively. This implies that, change in prices of local and foreign rice in both markets assumes relatively the same magnitude.

Exponential trend analysis of prices of local and foreign rice in rural and urban markets in Akwa Ibom State

The exponential trend equation for each of the price variables specified in equations 2 is presented in Table 2. The result also contains the estimated exponential growth rate for each of the price variables and the nature of such growth rate over time. The result revealed that, prices of local and foreign rice in the rural and urban markets showed positive significant relationship with time. This implies that, fluctuation in prices of local and foreign rice in both markets is influenced by time. A stationary exponential growth rate of about 0.60% for all price variables was discovered in both markets. This result suggests that, variance and growth rate in prices of local and foreign rice in rural and urban markets are relatively stable over time. The nature of growth in each price variable showed that, over increase time the price of foreign rice in rural and urban markets exhibited significant marginal declined in the state. However, the marginal declined was insignificant in the local rice market.

Graphically, price trend in the local and foreign rice in both rural and urban markets was compared by using plotted linear trend diagrams and is presented in figure 1 and 2. Trend in prices of local rice in the rural market and foreign rice in the urban market is shown in figure 1. The result shows significant dispersion between the two prices. Both price trended upward significantly showing strong correlation, but the price of foreign rice exhibited higher trend, suggesting that, price difference in both products is conspicuous and relatively similar during the study period.

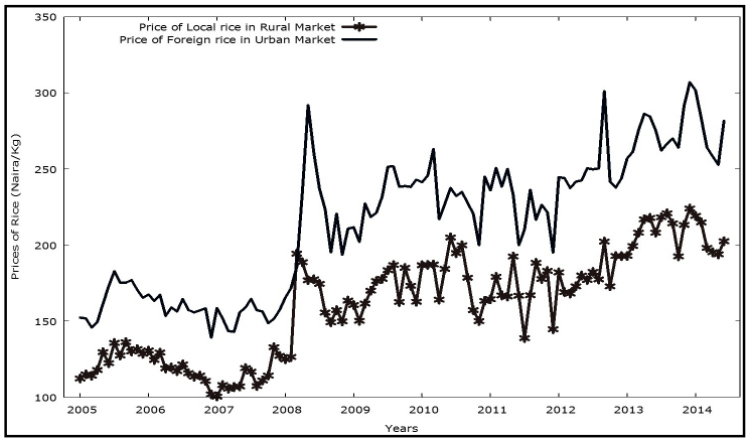
In the similar manner, figure 2, shows the linear trend in prices of local rice in the urban market and foreign rice in the rural markets. The result is similar to what is obtained in figure 1. To compare the nature of price fluctuation in both products in rural and urban market, it is obvious that, price gap existed between them, but both showed strong correlation in pattern of fluctuation. This result again pointed to the fact that, there is market competition between the local and foreign rice market in Southern region of Nigeria. One of the possible reasons for this result could be that, the foreign rice is a good substitute of the local rice probably due to consumers' preference, quality, and availability among others.

Further descriptive techniques were employed to analyze price movement in both products. Since both variables are similar and measured in the same unit, the paired t-test and Pearson

Variables	LnL_{rt}	LnL_{ut}	LnF_{rt}	LnF_{ut}
Constant	4.73(208.3)***	4.70 (219.7)***	5.05 (221.7)***	5.02(236.1)***
Time	0.006(16.77)***	0.006(18.12)***	0.006(16.03)***	0.006(17.80)***
F- cal.	281.141***	328.18***	257.03***	316.90***
R-square	0.715	0.746	0.696	0.739
Exponential GR (%)	0.6	0.6	0.6	0.6
Nature of Growth Rate				
Constant	4.69(136.7)***	4.69 (144.0)***	4.97(150.4)***	4.98(155.8)***
Time (b_1)	0.008 (5.47)***	0.006 (5.02)***	0.009 (7.46)***	0.008(6.16)***
Time (b_2)	-1.55e-05(-1.34)	-6.19e-06 (-0.56)	-3.80e-05(-3.51)***	-1.91e-05 (-1.77)*
F- cal.	142.45	163.24	146.47***	163.01***
R-square	0.719	0.746	0.725	0.746
Inference	**In significant GR**	**Insignificant GR**	**Sig. decelerated GR**	**Sig. decelerated GR**

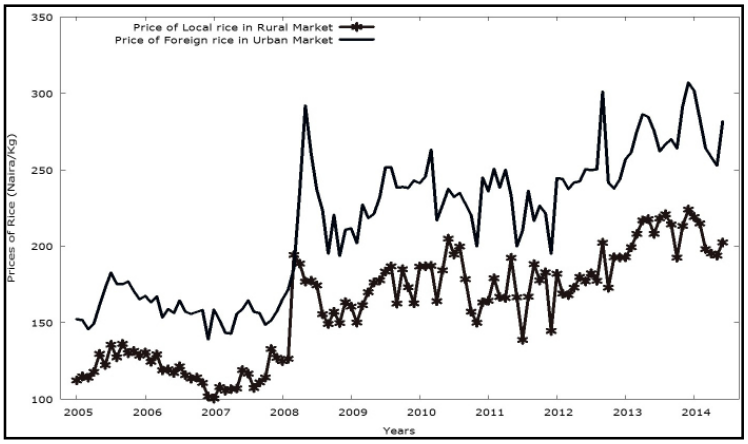
Note: Values in bracket represent t-values. The asterisks * and *** represent 10% and 1% significance levels respectively.
Source: Own processing

Table 2: Exponential trend analysis of monthly average prices of local and foreign rice in rural and urban markets in Akwa Ibom State.



Source: Own processing

Figure 1: Trends in prices of local rice in urban market and foreign rice in urban market in Akwa Ibom State.



Source: Own processing

Figure 1: Trends in prices of local rice in urban market and foreign rice in rural market in Akwa Ibom State.

correlation coefficients were estimated. The result is presented in Table 4. The result indicates that, the mean price of local rice in the rural market was significantly different from the mean price of foreign rice in the urban market. In the similar manner, the mean price of local rice in the urban market was significantly different from the mean price of foreign rice in the rural market. Within the same market, mean prices of foreign and local rice were also significantly different. This result further substantiates the possibility of high degree of competitiveness and substitutability of local rice for foreign rice. Fundamentally, this result suggests the presence of a strong market competition potential between the local and foreign rice market in the state. However, there is also an evidence of significant positive and linear relationship among price paired. This implies that, factors that affect rural price of both foreign and local rice are relatively similar to those in urban market.

Paired price sample	Paired t-test (2-tailed)	Paired sample correlation
L_{ut} — L_{rt}	3.754***	0.968***
F_{rt} — L_{rt}	34.294***	0.932***
F_{rt} — L_{ut}	-36.083***	0.934***
F_{ut} — L_{rt}	-32.561***	0.938***
F_{ut} — L_{ut}	36.759***	0.953***
F_{ut} — F_{rt}	-4.358***	0.969***

Note: Computed by authors, and variables as defined in equation 2. Null hypothesis of no significance difference in means of paired prices were rejected at 1% probability level. Asterisk means significant at 1% significant level.

Source: Own processing

Table 3: Paired t-test and correlation of price variables used in the analysis.

Augmented Dicker Fuller Unit Root Test result

The stationary status of series was examined by the unit root tests. One of the most commonly used unit root tests is the Augmented Dicker-Fuller test (Dickey and Fuller, 1979). The ADF test was conducted by including constant on one part and constant and trend on the other part. Only 1% critical value (or 99% of repeatability) was used to determine the unit root of variables. For instance, a price series is stationary if its mean and variance are constant over time under consideration. The summary of the result of the ADF root tests is presented in Table 4. The result shows that, all price variables were non-stationary at levels but stationary at first difference for ADF equation that contains constant. However, mixed result was obtainable for ADF equation that contains both constant and trend. To avoid incidence of spurious regression, the study was built on the assumption that price variables were non-stationary at level but stationary at first difference.

The result implies that, the specified price variables equation should be tested for the existence of co-integration among variables (Johansen, 1988; Johansen and Juselius, 1990). This result, however, conforms to the findings of Chirwa (2000); Acquah and Owusu (2012) and Akpan, Inimfon and Udoka (2014). They opine that, most agricultural commodity prices in the Sub-Saharan Africa are integrated at the first order.

Bilateral Granger causality test between prices of local and foreign rice

The long run causality relationship between the rural and urban prices of local and foreign rice was investigated in Akwa Ibom State. The result of the analysis is presented in Table 5. The result

Logged variables	Augmented Dicker Fuller Test for unit root					
	With constant			Constant and trend		
	Level	1st diff.	OT	Level	1st diff.	OT
LnL_{rt}	-2.209	-13.58**	1(1)	-4.035	-13.52**	1(1)
LnF_{ut}	-1.951	-12.28**	1(1)	-3.839	-12.22**	1(1)
LnL_{ut}	-2.232	-14.70**	1(1)	-4.205**	-	1(0)
LnF_{rt}	-2.243	-13.84**	1(1)	-4.064**	-	1(0)
1%	-3.489	-3.49		-4.04	-4.04	

Note: OT means order of integration. Critical value (CV) is defined at 1% significant level and asterisks ** represent 1% significance level. Variables are as defined in equation 2.

Source: Own processing

Table 4: Result of the unit root test for price variables used in the analysis.

Hypotheses	Lag	Sample size	F-Statistic	Prob.	Decision
LnL_{rt} does not Granger cause LnF_{ut}	1	113	12.568	0.000***	Rejected
LnF_{ut} does not Granger cause LnL_{rt}	1	113	7.189	0.009***	Rejected
LnL_{ut} does not Granger cause LnF_{rt}	1	113	9.615	0.003***	Rejected
LnF_{rt} does not Granger cause LnL_{ut}	1	113	11.380	0.001***	Rejected

Note: Variables are as defined in equation 2.
Source: Own processing

Table 5: A cross product Granger Causality estimates.

suggests that there is an evidence of bi-directional Granger causality between the rural price of local rice and urban price of foreign rice and vice versa.

This means that, the urban price of local rice significantly impacted on the rural price of foreign rice and vice versa. In a similar way, the previous price of local rice in urban market significantly determined the current price of foreign rice in the rural market and vice versa. The presence of bi-directional Granger Causality relationships between the price of local and foreign rice in the rural and urban markets indicates that, both product prices have strong co-movements. This means that, local rice is a good substitute for foreign rice and vice versa. It is inferred that, price of local rice is endogenously determined by price of foreign rice in both markets and vice versa. This result suggests possible co-integration between the local and foreign rice market in the study area. The symmetric price movement between these two markets is an indication of the presence of strong competition and substitutability of the two products.

Co-integration model for the local and foreign rice markets

The result of the Engle and Granger two-step technique of co-integration regression tests for the residuals (ECM) generated in the long run equations specified in equations 7 and 8 is presented in the lower portion of Table 6 and 7. The results show that at 1% probability level of significance, the ADF for the residuals is greater than the critical value (-4.05). Thus the Engle–Granger co-integration test rejected the null hypothesis of no co-integration for the pair of price equations described in Table 7 and 8. Hence, there exist a stable long run equilibrium relationship between the local rice market and foreign rice market in the region.

Variable	**$LnL_{rt} = f(LnF_{ut})$**	**Variable**	**$LnF_{ut} = f(LnL_{rt})$**
Constant	-0.129 (-0.783)	**Constant**	0.659 (4.434)***
LnP_{2t}	0.9699 (31.59)***	**LnP_{4t}**	0.927 (31.59)***
F-cal	997.99***	**F-cal**	997.99***
R^2	0.899	**R^2**	0.899
DW- test	1.376	**DW- test**	1.351
ADF test for errors from above equations			
ECM_t	-7.642***		-7.680***

Note: the equation for the ADF test include constant and trend. Critical value at 1% = -4.05, Values in bracket represent t-values. The asterisk *** represents 1% significance level. Variables are as defined in equation 2.
Source: Own processing

Table 6: Long run relationships between prices of local and foreign rice.

The Johansen co-integration test was also used to verify the Engle Granger two-step methodology. The Johansen co-integration test result showed that, the trace and maximum eigenvalues were significant at first rank level. The result is presented in Table 9 and Table 10. The two results are similar, the calculated trace test and maximum eigenvalue test statistics are greater than the critical values at 5% probability level. These further confirm the presence of at least one co-integration relationship between the specified price variables. The upper part of Table 6 and Table 7 present the long run estimates of the respective pair equation.

Variable	**$LnL_{ut} = f(LnF_{rt})$**	**Variable**	**$LnF_{rt} = f(LnL_{ut})$**
Constant	-0.168 (-0.987)	**Constant**	0.727 (4.79)
LnP_{2t}	0.969 (30.63)***	**LnP_{4t}**	0.921 (30.63)***
F-cal	938.45***	**F-cal**	938.45***
R^2	0.893	**R^2**	0.893
DW- test	1.446	**DW- test**	1.462
ADF test for errors from above equations			
ECM_t	-8.233***		-7.979***

Note: The equation for the ADF test include constant and trend. Critical value at 1% = -4.05, Values in bracket represent t-values. The asterisk *** represents 1% significance level. Variables are as defined in equation 2.
Source: Own processing

Table 7: Long run Relationships between prices of local and foreign rice.

The Johansen co-integration test results further reaffirmed the presence of potential stable long run relationship between price of local rice and price of foreign rice in rural and urban market of the state.

Error Correction Model for the local and foreign rice market

The presence of co-integration between the specified variables demanded the specification of the Error Correction Model. Table 10 contains estimates of the error correction model (ECM) generated for the rural price equations of local and foreign rice market; while Table 11 contains estimates of ECM generated for the urban price equations. Coefficient of the error correction term in each equation is negative and statistically significant at 1% probability level. The result established the existence of a long-run equilibrium relationship between the price of local and foreign rice in the rural markets. This means that, there is a long run sustainable and stable substitution or competition between the local and foreign rice in the region. The result further implies that, the rural prices of local and foreign rice are sensitive to departure from their equilibrium states or levels in the previous periods. For the rural price equations, the slope coefficient of the error correction term (-0.667 for the local rice) and (-0.581 for foreign rice) represent the speed of adjustment and also is consistent with the hypothesis of convergence towards the long-run equilibrium once the rural price equation is disturbed. This means that, it will take the rural price of local rice about 6 weeks and rural price of foreign rice about 6 weeks 6 days to adjust fully to stable equilibrium position in the long run due to disturbances in the marketing system. Hence, it seems the local rice market leads the foreign rice market in the rural area of the state. This means that substitution and competitiveness favours the local rice market in the rural areas. This satisfies a priori expectation given the poverty rate in the rural areas of the country. It is likely that most rural dwellers could not afford the foreign rice due to high price.

Rank	Eigen value	Trace test	p-value	Lmax. test	p-value
0	0.3560	53.126	[0.0000]	49.730	[0.0000]
1	0.0296	3.395	[0.0654]	3.395	[0.0654]

Note: Unrestricted constant; Log-likelihood = 606.57 (including constant term: 285.89). Lag length = 1.
Source: Own processing

Table 8: Results of Johansen cointegration test (unrestricted constant) for $LnL_{rt} = f(LnF_{ut})$.

Rank	Eigen value	Trace test	p-value	Lmax. test	p-value
0	0.3753	57.039	[0.0000]	53.155	[0.0000]
1	0.0338	3.883	[0.0488]	3.883	[0.0488]

Note: Unrestricted constant; = 596.843 (including constant term: 276.163) Lag length = 1.
Source: Own processing

Table 9: Results of Johansen Cointegration Test (unrestricted constant) for $LnP_{3t} = f(LnP_{4t})$.

Variable	Urban price of local rice	Urban price of foreign rice
Constant	0.002 (0.263)	0.002 (0.349)
ΔLnSelf-Lag	0.0874 (0.854)	-0.084 (-0.847)
ΔLnRural price (level)	**0.706 (8.058)*** **	**0.619 (7.732)*** **
ΔLnRura price (lag 1)	-0.1307 (-1.267)	0.011 (0.116)
ECM_{t-1}	**-0.667 (-5.733)*** **	**-0.581 (-5.194)*** **
R^2	0.447	0.454
F-cal	21.629***	22.269***
DW	1.978	1.976

Note: Values in bracket represent t-values. Asterisk * and *** represent 10% and 1% significance level respectively. Variables are as defined in equation 2.
Source: Own processing

Table 10: ECM estimates for the rural Price of Local and Foreign rice in Akwa Ibom State, Southern Nigeria.

Variable	Urban price of local rice	Urban price of foreign rice
Constant	0.003(0.543)	0.003 (0.575)
ΔLnSelf-Lag	-0.159 (-1.707)*	0.124 (1.376)
ΔLnRural price (level)	**0.561 (7.710)*** **	**0.510 (7.860)*** **
ΔLnRura price (lag 1)	0.049 (0.524)	-0.210 (-2.463)**
ECM_{t-1}	**-0.520 (-4.971)*** **	**-0.681 (7.055)*** **
R^2	0.473	0.486
F-cal	24.010***	25.321***
DW	2.093	1.912

Note: Values in bracket represent t-values. Asterisk * and *** represent 10% and 1% significance level respectively. Variables are as defined in equation 2.
Source: Own processing

Table 10: ECM estimates for the rural Price of Local and Foreign rice in Akwa Ibom State, Southern Nigeria.

ECM for the urban price of local and foreign rice market

For the urban price of local and foreign rice, the respective slope coefficient of the error correction term is (-0.520) and (-0.681), and are statistically significant at 1% level. This implies that, the rural prices will always react to bring stability in the urban prices whenever there is significant variation between them. About 52.20% and 68.10% of the urban price adjustment takes place within every month due to exogenous shock. This means that, it will take about 7 weeks 5 days and 5 weeks 5 days for the urban price of local rice and foreign rice respectively to adjust fully to a stable equilibrium position in the long run. By implication, movements in urban prices of local and foreign rice are significantly detected by its respective rural prices. The adjustment is faster in foreign rice than the local rice. This result implies that, the foreign rice market is more active and possibly dominates the local rice market in urban areas of the state. This result fit into the apriori outcome; given the income level, awareness, preference, education and other social attributes of urban dwellers in Nigeria. Predictably, urban dwellers preferred high quality foreign rice to locally produce one. This speed up the activities in the foreign rice market compared to local rice market. The diagnostic test for the urban price equation revealed the R2 value of 0.473 and 0.486 for the local and foreign rice market respectively. The F-statistic of 24.01 and 25.32 are significant at 1% probability level respectively, indicating that, both equations have goodness of fit.

Discussion of the long run and short run models

The empirical results presented above, revealed that, the long run model for the rural and urban prices of local and foreign rice almost converged to the postulate of the law of one price. The long run market integration coefficient for each of the commodity was approximately unity. This confirms the existence of the long run stable price integration in each of the specified equation. This means that, there is evidence of stability in price movement between the local and foreign rice in the long run in both rural and urban market. In other words, the substitution or the competition between the local and foreign rice showed sign of stability in the long run in both rural and urban markets in Akwa Ibom State. Hence, price change in the local rice in the rural market is instantaneously transmitted into price change in foreign rice in urban market and vice versa. This result shows the high degree of competiveness and substitutability of local rice for foreign rice especially in the urban market. It means that, in the long run the price of foreign rice determined the price of local rice and vice versa. The constant terms in the four long run equations give pictures of transfer cost or the extent of price differential between the dependent and independent market price. The result further revealed insignificant influence of transfer costs in the marketing process of local and foreign rice in the state. This perhaps suggests high efficiency in information transmission between the rural and urban markets and improvement in the marketing infrastructures in the state. In the ECM models; the short run market integration coefficients are significantly different from unity for both rural and urban markets. These results imply that, in the short run, price change in local rice does not instantaneously lead to price change in foreign rice and vice versa in both markets. This means that, in the short run the level of competiveness and substitutability

of local rice for foreign rice is low. The same is also applied for the reverse situation.

Conclusion

The study employed statistical and econometric techniques to analyze the horizontal price transmission between the local and foreign rice market in the rural and urban markets in Akwa Ibom State, Southern Nigeria. The results showed that, prices of local and foreign rice in the rural and urban markets have positive relationship with time and constant exponential growth rate of 0.60% in the period under consideration. The graphical trend analysis showed that, both rural and urban prices co-moved with noticeable deviations within the period under consideration. The result suggested the prevalence of strong market competitiveness and substitutability between the local and foreign rice commodity in Akwa Ibom State. Price variability was higher in local rice compared to foreign rice. It was discovered that, the price of local rice was cheaper in urban market compared to the rural market. This clearly showed that, consumers in the region preferred foreign rice to local rice. Also, the Pearson correlation coefficient revealed that, the price of local rice has a strong positive linear symmetric relationship with the price of foreign rice in the state. The result connotes the existence of efficient and symmetric market information flows between the local and foreign rice markets in the region. The pair wise t-test result revealed a significant difference between the mean price of local and foreign rice in both markets. The Granger causality test revealed bidirectional relationship between the price of local and foreign rice in both rural and urban markets in the region. This also suggested that, the price transmission mechanism between the local and foreign rice markets is efficient; and a high tendency for market integration as well as competitiveness and substitutability. The results of the co-integration test revealed the presence of the cross price co-integration between the local and foreign rice market in the region. The coefficients of the long run market integration in the co-integration equations for local and foreign rice market almost converged to unity; which connotes instantaneous and stable long run price relationship between the two markets. The results of the short run model also confirmed the existence of the short run co movement between the local and foreign rice markets in the study area. In addition, it shows that, the rural price of local rice and urban price of foreign rice adjusted faster than their respective counterpart. However, the result revealed that, the substitution and the competition between the local and foreign rice market is stronger in the long run than the short run.

Using the price transmission analysis, this study has confirmed that, there is a strong short and long run relationship between the price of the local rice and foreign rice in the study area. It is assumed that, the strong price relationship arose from the strong competition or substitutability in the two categories of rice. Hence, it is established in this study that, there is a strong price competition and endogenity characteristic between the local and foreign rice markets in the region. This means that, the local rice market has potentials to compete and substitute for the foreign rice market in Nigeria. It is an established fact that, the local rice market is less competitive in terms of value addition, quantity and quality compared to the foreign rice market; comparing the price trend over time, our result revealed that the local rice market has a lot of potentials to compete efficiently with foreign counterpart in the region.

Based on the finding, it is recommended that, short and long term price policies should be used to intervene in the rice sub sector in the state. Policies aimed at boosting local production of rice should be encouraged. Value additions in locally produced rice should be included in any policy framework meant to boost rice production in the region.

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Economic Comparison of Agricultural Sector of Eurasian Countries – Is There Any Potential for Development Through Economic Cooperation?

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Abstract

Eurasia represents an important economic region for the majority of the post-Soviet republics. The structure of their economies is highly dissimilar and reflects the status of agriculture. The aim of the paper is to analyse the relation between agriculture index and GDP per capita Using the basic economic indicators in agriculture (contribution of agriculture to GDP, share of employment in agriculture, agriculture value added per worker and share of rural population) as well as the cluster analysis, the countries were divided into four groups. There are sub-groups within the post-Soviet republics, differing considerably in the status of agriculture in their national economy. A negative correlation between GDP per capita (PPP) and the level of the agriculture index has been proved in the monitored countries.

Keywords

Eurasia, post-Soviet countries, agriculture index, economic indicators, cluster analysis, economic development.

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Introduction

Agriculture represents one of the essential parts of any national economy. In the past decades, agriculture of the majority of the world countries have undergone a fundamental transformation connected with the growth of innovations and the use of new technologies. These have led to the increase of productivity as well as effectiveness in the agricultural sector as a whole. As early as in 1961, (Mellor, 1961) it was proved that agriculture has a positive impact on economic growth regardless of its technological maturity.

After the Second World War, there were theories which explaining the prospects of economic development. (Rosentein-Rodan, 1943) discovers two possible solutions for post-war industrialization – the Russian model based on the planned economy and autarchy or integration into the international economy while using free workforce.

The post-war literature focusing on economic growth is characterized by four classic approaches to development. These can also be understood as development stages related to the area. Each of these theories contains at least basic concepts (concerning for example competitive advantage, international labour distribution, decreasing revenues and their relation to human capital or other resources, the relation between income per capita and population growth, technological progress and economic growth), for instance, works of A. Smith, D. Ricard, T. Malthus and later of J. Schumpeter.

Regarding agriculture, dual economy theories are most frequently applied in which, using a set of measures, an under-developed economy highly dependent on a traditional agricultural sector is gradually transformed into more modern and more industrial production. This theory was originally based on the works of Higgins (1956) and Myint (1971), as well as Lewis (1955; 1979; 1954) and Chenery and Bruno (1962) later Barro and Sala-i-Martin (2003), Carter (2004), Robertson and Landon-Lane (2001) or Robertson (1999) might also be mentioned.

The term Eurasia is used from a geographic perspective, with no geological border between Europe and Asia. Based on similar historical development, Europe and Asia have been connected to form a single unit. In this regard,

Mostafa (2013) points out that no definition states what the term "Eurasia" contains. Vinokurov and Libman (2012) understand the issues connected with "Eurasia" in three different areas: post-Soviet Eurasia, Eurasianism and Eurasia as a continent. In this research, the term Eurasia is used in connection with the region of the post-Soviet countries. The integration process between individual countries with a different level of the economy can gradually contribute to reduction of disparities between individual member states. The key to successful regional cooperation is in using comparative advantages of all the participating countries (Fathipour and Ghahremanlou, 2014), which will enable them to be presented at a global level as a part of the whole and this way defend their mutual interests. In addition to this, functional regional cooperation encourages the influx of capital and enhances productivity (Kumar, 2015). It might be stated that unless regional cooperation is functional, the paradigm of globalization cannot function (Dutta, 2002). Eurasian countries usually face the same problems which need to be solved together, through closer cooperation. These concern political, economic and security problems, while cooperation is the logical outcome of interconnectedness of the countries' economies and of their interdependency (Obydenkova, 2011).

Over the last two decades, agriculture of the post-Soviet republics has undergone significant changes (Svatoš, Smutka, and Ishchukova, 2014); however, it remains one of the most protected parts of the national economy in the majority of the world countries (Garmann, 2014; R. Barro, 2004; Hansen, 2016; Wegren, 2016; Anderson et al., 2014). Therefore, the question arises as to whether agriculture can be the driver of economic cooperation that will lead to economic growth. This is derived from the fact that, provided that the economic structure of agriculture in these countries is similar, they are likely to converge. Nevertheless, this similarity might be apparent between some countries only and the so called sub-clubs (King, 2016b; King, 2016a) or the hub-and-spoke principle might be created (Chong and Hur, 2008; Hur et al., 2010; Kirkow, 1999). The aim of the paper is to analyse the similarities of the agricultural between post-Soviet countries and to find the relation between agriculture index and GDP per capita for these countries.

Materials and methods

The countries in the Eurasian region are highly heterogeneous. The countries in question are as follows: Armenia (ARM), Azerbaijan (AZE), Belarus (BLR), Georgia (GEO), Kazakhstan (KAZ), Kyrgyzstan (KGZ), the Republic of Moldova (MDA), the Russian Federation (RUS), Tajikistan (TJK), Turkmenistan (TKM), Ukraine (UKR) and Uzbekistan (UZB). The three Baltic States (Estonia, Latvia and Lithuania) have not been considered, as these are now members of the European Union.

Regarding the post-Soviet countries and their possible cooperation, one fundamental problem has been identified, namely insufficient data available in order to analyze individual cross-border agricultural activities. For this reason, there are no studies discussing this important sector of the national economy. Libman and Vinokurov (Libman and Vinokurov, 2012) are an exception in this regard, since they incorporate one agricultural indicator (contribution of grain trade to the total GDP) into their overall evaluation of cooperation between the post-Soviet republics.

The data have been obtained from the FAOSTAT database, International Labour Organization (ILO), Interstate Statistical Committee of the CIS, Eurasian development bank and from national statistical institutes of the monitored countries.

Not all the data are available for all of the countries. Whenever the data are unavailable, this fact will be mentioned in the paper. The analysis has been conducted for years 2000 – 2012. We are aware of the fact that the time period may be inadequate, especially its end. Unfortunately, the latest data in the field of agriculture which can be compared for the majority of the countries have been unavailable after 2012. Whenever these are available, the newest data will be used. Whenever necessary, the data entering the analysis were extrapolated to the population, which enabled to reduce the influence of substantial differences given by different sizes of the states.

The paper can be divided into two main parts. At first, descriptive and comparative statistics and data visualization are used for comparison.

The second part of the paper include cluster analysis and the creation of the agricultural index. This stage can be divided into four consequential steps:

1) The original dataset consisted of 50 variables. All the original variables are mentioned

in appendix 1. Due to significant interregional differences between the monitored countries as well as the fact that the data contained a large number of outliers, identification of these was required. Subsequently, these data were eliminated from further research and standardization of variables was carried out in order to avoid misrepresentation of the results due to differences in unit sequences.

The input data were standardized using the norming Z-function. Each attribute was normalized into its Z-score by deducting the average and by dividing the standard deviation.

$$z = \frac{x - \mu}{\sigma} \quad (1)$$

Using this transformation, scale differences and attributes often differing in the order of magnitude were eliminated (Meloun and Militky, 2004). The original data set was reduced using correlation analysis

$$s_{xy} = \frac{\sum_{i=1}^{n}(x_i - \overline{x})(y_i - \overline{y})}{n-1} \quad (2)$$

and variation coefficients

$$cv = \frac{\sigma}{\mu} \quad (3)$$

to exclude redundancies between variables and their interconnectivity.

2) The cluster analysis was applied to the standardized data. The purpose of clustering the data, also known as cluster analysis, is to discover natural grouping(s) of a set of patterns, points, or objects (Jain, 2010). Initially, hierarchical cluster analysis was applied in order to determine the most suitable number of clusters. Ward´s method was used, also referredto as the incremental sum of squares methodthatisbasedonwithinthecluster distances and the between the cluster distances (Ward, 1963), the aim of which is to minimize cluster heterogeneity. The intra-cluster variance (VSS) is given by the correlation:

$$VSS = \sum_{j=1}^{m}\sum_{i=1}^{k}(x_{ij} - \overline{x_j})^2 \quad (4)$$

$$\overline{x_j} = \frac{1}{k}\sum_{i=1}^{k} x_{ij} \quad (5)$$

3) Subsequently, the non-hierarchical clustering method based on Euclidean distance was used using K-means clustering.

In order to determine the number of clusters, the elbow rule method was used (Kodinariya and Makwana, 2013).

$$d_E(x_k, x_1) = \sqrt{\sum_{j=1}^{m}(x_{kj} - x_{ij})^2} \quad (6)$$

K-means clustering is a frequently used method in order to automatically partition a dataset into k-groups. It proceeds by selecting k-initial cluster centres and then iteratively refining them as follows:

- Each instance is assigned to its closest cluster centre.
- Each cluster centre is updated to be the mean of its constituent instances (Wagstaff et al., 2001).

4) Afterward, a composite agriculture index for each country was constructed and compared with GDP per capita (PPP). The variables entering the composite indicator were selected based on the cluster analysed. All the variables would be given equal weight (OECD, 2008; Saisana and Saltelli, 2011; Sharpe and Andrews, 2012).

In order to verify the correlation between the composite agriculture indicator and GDP, correlation coefficient will be used and the final value will be tested.

Results and discussion

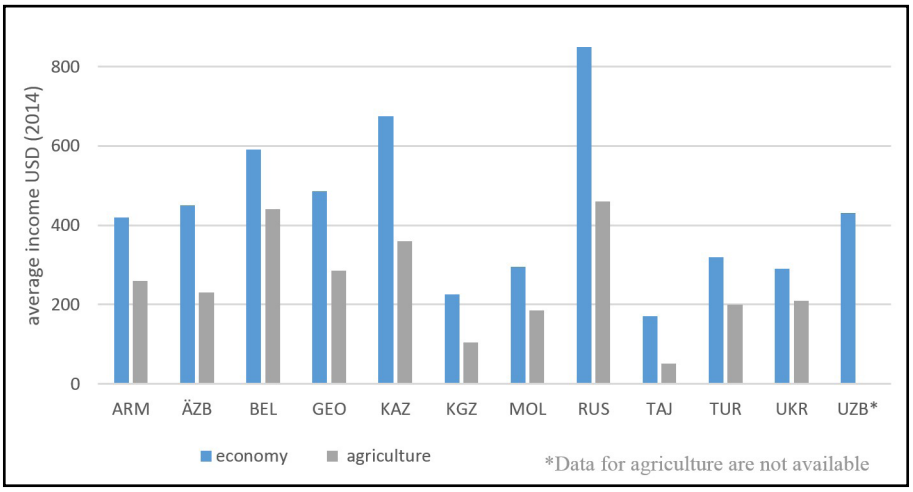
The status of agriculture in the economies of the post-Soviet republics

The dissolution of the Soviet Union led to significant socio-economic changes which had a profound impact on agricultural economics of these countries including a considerable decline in the contribution of agriculture to GDP or overall employment. Table 1 provides basic characteristics of agriculture in the post-Soviet republics. Regarding agriculture of the post-Soviet republics, their most distinct feature is considerable heterogeneity and asymmetry between individual states. There are significant differences between the monitored countries related to the economic potential of agriculture, which is connected with basic production factors. There are considerable differences between the share of workers in agriculture, contribution of agriculture to GDP or labour productivity in agriculture.

Country	Agricultural land (km2)	Share of agricultural land on total area (%)	Share of workers in agriculture (%)	Arable land (ha)	Proportion of arable land on total area (%)
AZE	47 683.00	57.68	37.70	1 896 800	22.94
ARM	16 830.00	59.11	38.90	448 400	15.74
BLR	87 960.00	43.34	10.50	5 522 000	27.21
GEO	24 650.00	35.47	53.40	400 000	5.75
KAZ	2 079 750.00	77.07	31.00	22 900 000	8.48
KGZ	105 913.00	55.22	34.00	1 276 600	6.65
MDA	24 600.00	74.86	26.39	1 814 000	55.20
RUS	2 143 500.00	13.08	9.69	119 750 000	7.31
TJK	48 750.00	34.83	66.50	860 000	6.14
TKM	338 380.00	72.00	48.40	1 940 000	4.10
UZB	266 900.00	62.74	63.90	4 350 000	10.22
UKR	412 970.00	71.28	17.20	32 518 000	56.13

Source: own processing based on statistical data from WB, ILO, CIS and Eurasian Development Bank

Table 1: Basic agricultural indicators of post-Soviet countries (2013).



Source: own processing based on the data from CIS and national statistical institutes

Figure 1: Income of workers in agriculture.

The total population of the post-Soviet republics approaches 287 million. More than one third of the population lives in rural areas. However, this proportion fluctuates when comparing the countries as well as within individual states. Tajikistan reaches the highest levels with more than 70% of its population living in rural areas; on the contrary, in Belarus and Ukraine, the number slightly exceeds 20%.

20% of the population in the monitored countries work in agriculture, which amounts to almost 19 million people. Again, there are significant differences. Georgia reaches the highest levels, the Russian Federation and Belarus the lowest. Contribution of agriculture to GDP reaches 12.5%. In 2014, this amounted to almost 63 billion USD.

In 2014, the income of workers in agriculture reached half of the average monthly income in the monitored countries (graph 1). The Russian Federation and Belarus traditionally reach the highest average levels of income. Conversely, Tajikistan long-term reaches the lowest income levels, amounting to approximately 50 USD in 2014. The majority of the monitored countries also show trade deficit in agricultural and food products.

In the monitored period, a significant change has been detected in how important each sector of the national economy is in terms of its contribution

to overall economic performance. The majority of the post-Soviet countries follow the trend evident in the developed countries where the importance of the role of agriculture in national economy has been undermined. In the monitored period, the contribution of agriculture to GDP has decreased by 7 p.p., whereas in 2000 the contribution of the primary sector to GDP was almost 22%, in 2013 mere 13%.

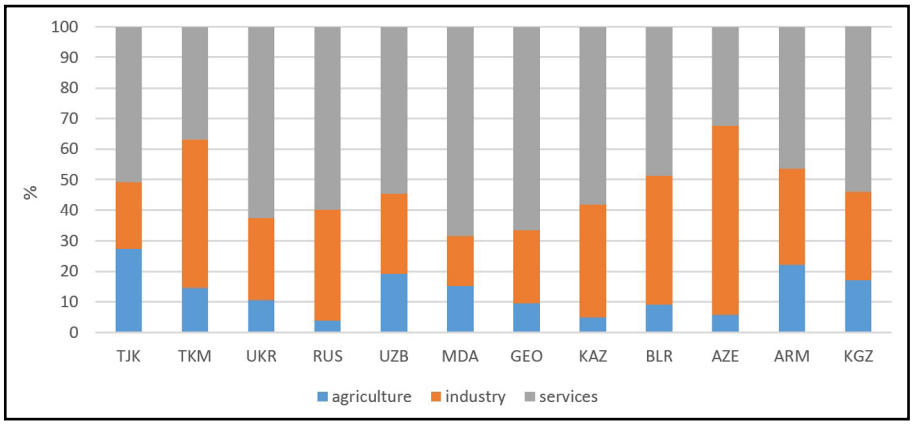
However, when comparing contribution of added value of each sector of the national economy to GDP, a significant difference between the monitored countries is evident. The highest contribution of agriculture can be seen in Tajikistan, where agriculture comprised 27.4% of its GDP in 2013. Armenia follows with 21.9% and Uzbekistan with 19.1 %. More than 10% of agriculture value added in GDP is also recorded in Kyrgyzstan, Moldova, Turkmenistan and Ukraine, with Russia (3.99%), Kazakhstan (4.92%) and Azerbaijan (5.66%) occupying the opposite end.

In 2000, Kyrgyzstan reached the highest share of agriculture value added in GDP – more than 35%. Uzbekistan also demonstrated high levels (34.5 %). All the countries showed a declining tendency in the monitored period. However, this tendency was discontinued in 2009 when the importance of agriculture started growing again in five of the monitored countries (Tajikistan, Moldova, Armenia, Turkmenistan and Ukraine). Owing to this, there has also been a slight increase in the median level in the monitored countries. Since 2009, the remaining countries have been experiencing stagnating contribution. The most stable contribution can be seen in Russia; however, this reflects its low basis (6 %) in 2000.

Russia reaches the highest levels of agricultural production in absolute values, followed by Ukraine and Uzbekistan. Regarding the Russian Federation, the total value of agricultural production is almost double in comparison with that of Ukraine and quadruple in comparison with that of Uzbekistan. On the other hand, Armenia and mainly Georgia are countries with the lowest value of agricultural production.

However, when taking into account agricultural yield per area, the order will change. Belarus shows the highest values of agricultural production per area, followed by Armenia and Ukraine. Kazakhstan and Turkmenistan reach the lowest values. Regarding the number of workers, Belarus is the most efficient, followed by Russia and Uzbekistan. Azerbaijan and Tajikistan reach the lowest values.

When taking into account the plant production only, the order of the countries with the highest value of production in absolute figures is the same. In terms of the area unit, Moldova and Ukraine reach the highest level of effectiveness. On the contrary, Kyrgyzstan, Turkmenistan and Kazakhstan reach very low levels of yield per area unit. This is the result of the way these countries are managed, with extensive agriculture mainly. When taking into account the worker in agriculture, Belarus, Russia and Ukraine show the highest levels of productivity. Again, this reflects the management style as well as their focus on different types of commodities. Animal production represents an important part of the agrarian sector in the monitored countries. Belarus, Russia and Turkmenistan reach the highest levels of productivity. Conversely, the lowest levels of productivity are evident in Tajikistan.



Source: own processing based on WB

Figure 2: Contribution of individual sectors of national economy to GDP.

Similarities between economic indicators of Eurasian countries in agricultural production

Using the basic indicators characterizing the economic situation in agriculture (that is the average contribution of agriculture to GDP and the share of workers in agriculture in the total number of employees), the countries can be divided into four groups, plus Tajikistan. The first group contains Russia, Belarus and Ukraine. The share of workers in agriculture as well as the contribution of agriculture to GDP in these countries is low. The highest added value per worker in agriculture is created in Belarus. The second group of the countries consists of Kazakhstan and Azerbaijan. Both countries show low contribution of agriculture to GDP; at the same time, this sector is relatively important in terms of employment. This is also strongly influenced by the proportion of agricultural population which is relatively high, reaching 40 – 60%. Another group of countries where agriculture represents an important source of employment is comprised of Turkmenistan and Georgia. Armenia, Moldova, Kyrgyzstan and Uzbekistan represent a heterogeneous group of countries. These countries reach higher contribution of agriculture to GDP, and at the same time a high share of employment in GDP. The lowest share of rural population in this case can be seen in Armenia, which also shows the highest added value per worker. At the same time, however, agriculture represents an important source of employment for almost 40% of workers. Regarding the post-Soviet republics, Tajikistan is an extreme example by reaching almost a 70% share of employment and at the same time more than 25% contribution to GDP.

When applying the cluster analysis to the above variables (contribution of agriculture to GDP, the share of employment in agriculture, agriculture value added per worker and the share of rural population), while assuming 4 clusters, we will obtain the following groups of countries.

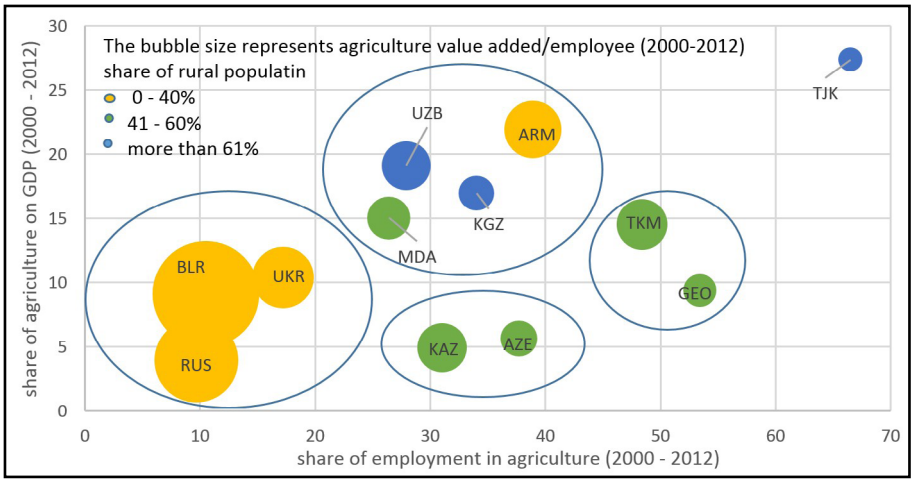
Cluster	Country	Characteristics
1	Armenia, Turkmenistan,	High employment and higher productivity
2	Azerbaijan, Georgia, Kazakhstan, Moldova, Ukraine,	High employment in agriculture and low productivity
3	Belarus, Russia,	High productivity countries
4	Kyrgyzstan, Tajikistan, Uzbekistan.	Rural countries

Source: own processing based on statistical data from WB, ILO, CIS and Eurasian Development Bank

Table 2: division of the countries into individual groups.

The first and the second cluster show the closest similarities, whereas the third and the fourth almost none. Agricultural production per worker is the most important variable in clustering, the share of rural population and contribution of agriculture to GDP follow. The share of workers in agriculture in the total number of employees is least significant.

Armenia and Turkmenistan show considerable contribution of agriculture to GDP and reach lower labour productivity levels. The contribution of agriculture to GDP in the second group of countries reaches maximum 15%. Regarding this indicator, they are closest to Russia and Belarus, which comprise the third group of countries. These reach the highest levels of labour productivity and lowest contribution of agriculture to GDP,



Source: own processing based on statistical data from WB, ILO, CIS and Eurasian Development Bank

Figure 3: Economic indicators in agriculture of post-Soviet republics.

and at the same time show a low share of rural population and workers in agriculture. The last group of countries is characterized by high proportions of rural population.

Agricultural index

Based on these four basic indicators for the status of agriculture within the national economy, the agriculture index was created.

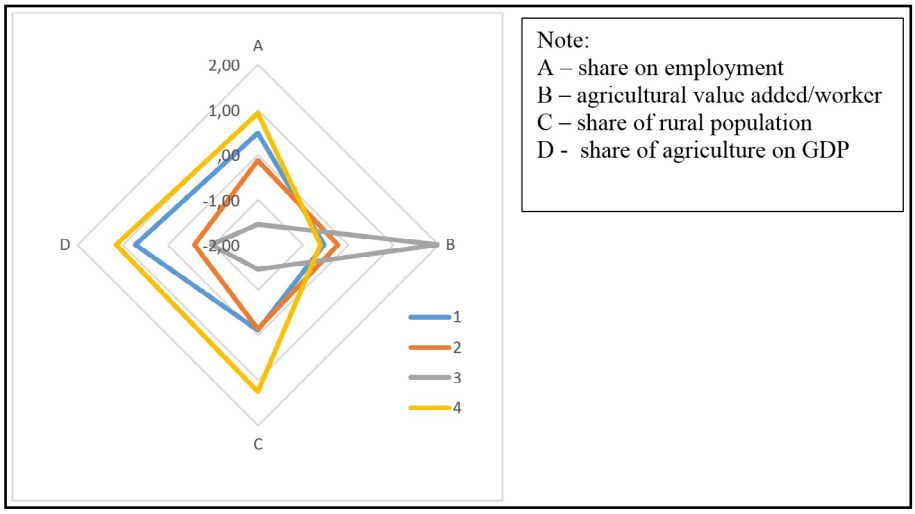
$$AI = 1/4\ AGRGDP + 1/4\ AGREMPL + 1/4 AGRVA + 1/4\ RURP \quad (7)$$

Where:

AI – agriculture index,
AGRGDP – the share of agriculture on GDP,
AGREMPL – the share of employment in agriculture,
AGRVA – agriculture value added per worker and
RURP – the share of rural population.

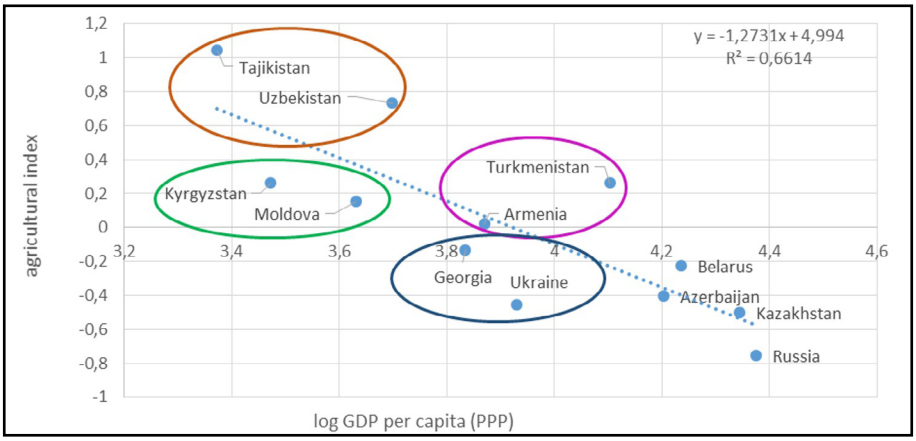
In the case of the monitored countries, the agricultural index reaches its highest values in Tajikistan or Uzbekistan. Conversely, the Russian Federation or Kazakhstan show the lowest values. It might be concluded that the higher the agricultural index, the lower the GDP level per capita (PPP) in the monitored countries. This also corresponds with the negative value of the correlation coefficient -0.813. The correlation is significant at the 0.01 level. Due to the fact that the coefficient value is higher than 0.7, the degree of interdependence is high.

As is also evident in the case of the post-Soviet republics, the trend connected with the decreasing importance of agriculture in GDP can be seen. Based on the analysis, it can be concluded



Source: own processing based on statistical data from WB, ILO, CIS and Eurasian Development Bank

Figure 4: Average values of individual clusters.



Source: own processing based on statistical data from WB, ILO, CIS and Eurasian Development Bank.

Figure 5: Relation between agricultural index and log GDP per capita (PPP).

that there are sub-clusters within agriculture of the post-Soviet countries, which follow a similar tendency. Out of all the monitored countries, Tajikistan or Uzbekistan are most dependent on agricultural production and their GDP per capita has long-term been low. On the contrary, Russia or Belarus are countries with lower contribution of agriculture to GDP (Ishchukova and Smutka 2013) and higher GDP per capita. At the same time, they are countries which have managed to sustain their food security, and therefore increased their self-sufficiency (Maitah and Smutka 2016). Ukraine occupies a special position in this regard which has been experiencing political instability since the so called Orange revolution that also strongly influences the country's economic situation. In this regard, however, Lerman (2009) points out that agricultural development of these countries is strongly influenced by political factors.

Nevertheless, it might be stated that economic differences within each country are closely connected with the change in the structure of the economy, in which dependence on agrarian sector, while labour productivity is stagnating, hinders economic development. This has also been confirmed by Caselli and Coleman II (2001) and Awokuse and Xie (2015). On the other hand, the total increase in the productivity factor in agriculture has been 1.5% higher than in non-agricultural business (Christiaensen, Demery and Kuhl, 2010).

Conclusion

The position of agriculture has witnessed a significant decline between 2000–2008 and then on the ground of the economic crisis it has been growing since 2009. Agriculture of the post-Soviet republics is very diverse, and we can find countries with high labour productivity among them (Belarus) or countries with a considerable number of employees and with the low level of productivity. The share of rural population fluctuate between 20% in Ukraine and Belarus and 70 % in Tajikistan. At average 20% of the overall population work in agriculture. The income gap between agriculture and other sectors of the economy exists in all countries. Majority of the countries also have trade deficit with agricultural products. Tajikistan has the highest contribution of agriculture on GDP (27%) compare to Russia (4 %).

The countries can be divided into four basic groups which differ in individual economic characteristics of the agricultural sector. Based on the analysis, it might be concluded that there are significant differences between Eurasian countries and the so called sub-clubs are created as part of cooperation.

In the case of the post-Soviet republics, a statistically important negative relation between the agriculture index value (contribution of agriculture to GDP, the share of employment in agriculture, agriculture value added per worker and the share of rural population) and low GDP per capita (PPP) can be verified. At the same time, it might be stated that the countries with a high value of agriculture index reach low values of GDP per capita.

As it is evident from the previous chapters, the post-Soviet republics are rather heterogeneous when taking into account agricultural variables. This offers them great potential for future co-operation. However, some of these countries (Tajikistan, Uzbekistan) can still be considered as predominantly agricultural with high contribution of agriculture to GDP. In addition, they have not undergone economic transition. Belarus, Kazakhstan and Russia should be able to supply some of the other countries with agricultural products. Ukraine also shows great potential; however, its "military conflict" with the separatists and the dispute over Crimea with Russia is problematic and hinders progress.

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APPENDIX 1 Variables entering the analysis

Agricultural Products, Total (share on total merchandise trade (%)

Agricultural land (% of land area)

Agriculture (PIN/worker in agriculture

Agriculture value added per worker (constant 2005 US$)

Agriculture, value added (% of GDP)

Arable land (% of agricultural land area)

Arable land (% of land area)

Average alleviation above the level

Barley Yield (Hg/Ha)

Beef and Buffalo Meat

Beverages Tobacco (share on total agricultural trade (%)

Cereals, Total

Cereals, Total (PIN/worker in agriculture

Crops (PIN/worker in agriculture

Crude Materials -Ex2 (share on total agricultural trade (%)

Dairy Products Eggs (share on total agricultural trade (%)

Eggs Primary

Employment in agriculture (% of total employment)

Employment in agriculture (% of total population)

Food (PIN/worker in agriculture

Food and Animals (share on total agricultural trade (%)

Food and Animals (share on total agricultural trade (%)

Forest area (% of land area)

Fruit + Vegetables (share on total agricultural trade (%)

Industry, value added (% of GDP)

Land under cereal production (% of arable land)

Livestock (PIN/worker in agriculture

Maize Yield (Hg/Ha)

Meat and Meat Preparations (share on total agricultural trade (%)

Meat indigenous, cattle and buffalo

Meat, Poultry

Milk, Total

Nitrogen + Phosphate Fertilizers (N+P205 total nutrients)

Nitrogen Fertilizers (N total nutrients)

Non Food (PIN/worker in agriculture)

Oats Yield (Hg/Ha)

Permanent cropland (% of land area)

Permanent crops % of Agricultural Area

Permanent meadows and pastures % of Agricultural Area

Phosphate Fertilizers (P205 total nutrients)/ha

Rural population (% of total population)

Services, etc., value added (% of GDP)

Sheep and Goat Meat kg/per capita/year

Total area equipped for irrigation % of Agricultural Area

Wheat Yield (Hg/Ha)

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Oil Prices, Exchange Rate and Prices for Agricultural Commodities: Empirical Evidence from Russia

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Abstract

In this paper, we investigate long and short-term impact of changes in oil prices and the exchange rate on prices of seven groups of agricultural products in Russia (buckwheat, grain crops, potatoes, oat, wheat, rye, barley). In this paper, Granger causality approach is applied to test long-run interlinkages with monthly data from January 1999 to October 2015. For testing the response of agricultural prices to sudden shocks in oil prices and exchange rate in the short run, we use impulse-response techniques. The results of impulse response analysis show that agricultural prices are not particularly sensitive to changes in oil prices and the exchange rate of Russian ruble in the short term, except for imported commodities. In the long run, Granger causal relationship between agricultural prices and oil prices is missing, and with exchange rate is observed only in case of imported agricultural goods.

Keywords

Agricultural commodity, world oil prices, exchange rate, Granger causality test, impulse response analysis.

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Introduction

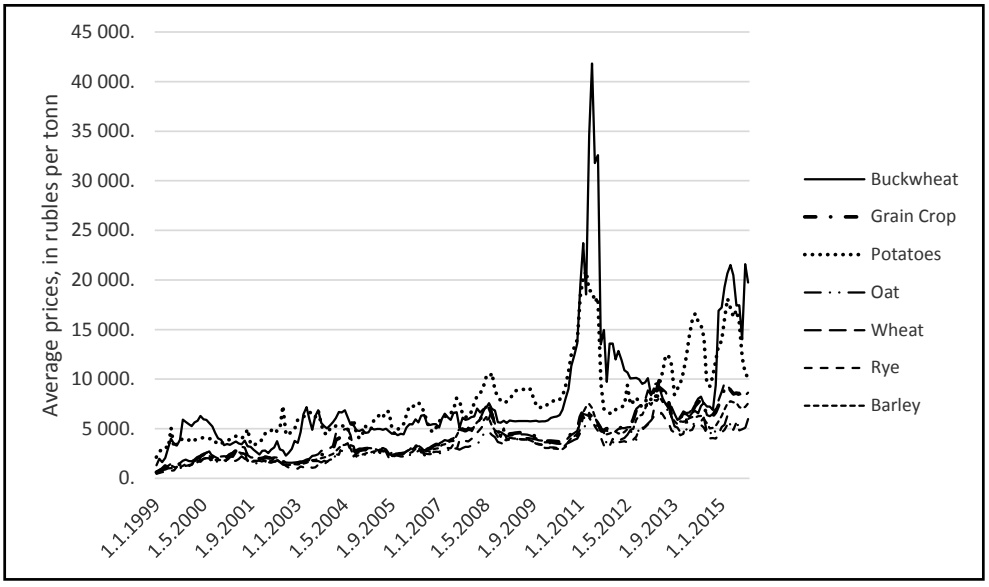
1. Russian agricultural market: current state

Due to technological development, and slow population growth in the world, the prediction of Paul Samuelson about large-scale food crisis did not come true. During the 1990s and the first half of the 2000s a large proportion of agricultural prices remained relatively stable. However, due to natural disasters, catastrophes and other technological and environmental factors, agricultural prices have increased substantially. The prices for such agricultural commodities as grain crops and wheat has doubled in the past few years. According to data provided by the IMF, the IMF's index of internationally traded agricultural products increased by 130% from January 2002 to June 2008 and 56% from January 2007 to June 2008 (Keith, 2008).

Russia is a major producer and consumer of a wide range of agricultural products. As one of the important players in the global markets of energy and agricultural products, Russia is very sensitive to changes in the prices of agricultural products, not to mention the oil prices. The sharp rise in prices of some crops, not to mention the general trend of rising prices in the agro-industry in the world markets, was due to a lack of supply and high production costs. (Figure 1).

For example, the price of buckwheat reached in June 2008 long-term peak and amounted to nearly 7,600 rubles per tonne. Compared with the previous year, the growth amounted to almost 30%. In the period from 2010 to 2012, the average price of buckwheat in Russia amounted to 25 000. A similar trend of rising prices of agricultural products is inherent to other cultures. Although the peak of growth of prices for buckwheat and wheat beginning in 2010s passed, the price growth is gradually recovering and gaining momentum. Frequent oscillations in agricultural prices have an impact on many other groups of the consumer goods. So, for example, price of pork in Russia during the boom years rose by 45% in 2008 and 82% in the period of 2010-2012. Rising grain prices pushed up the cost of pork production in terms of costs for fattening (Federal Service of State Statistics of Russia).

So, the rise in prices on world agricultural markets leads to disruption of the economic balance, balance in many countries, with particular impact on developing countries. On the one hand, high food



Source: Federal Service of State Statistics of Russia.

Figure 1. Price dynamics of main agricultural commodities in Russia (RR/ton)

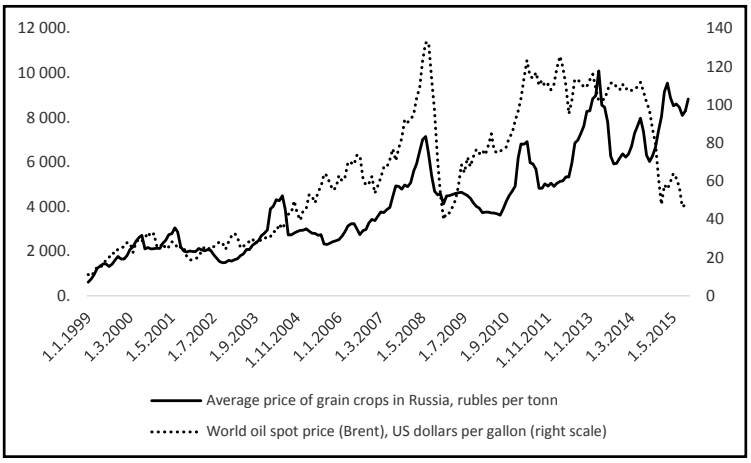
prices improve economic condition of exporting countries, positively affecting the balance of payments, as in the case of the USA, Canada and partly Russia. On the other hand, the number of countries - net importers of agricultural products is three times more than the number of countries net exporters (von Braun, 2008). As a consequence, importers, suffered significant losses during crises. The amount of expenses and crisis payments from the authorities has been substantially increased to cover cyclical effects.

Thus, the rise in world food prices is not only good for the exporting countries, but also is a curse. A rise in global prices is pushing manufacturers to increase prices in domestic markets, thereby putting pressure on the household sector. Thus, according to the Food and Agriculture Organization (FAO), developing countries dependent on agricultural imports, are forced to pay additional costs in the amount of 324 billion US dollars in connection with growth of world prices for food (FAOSTAT, 2015). In terms of sustainable growth trend of food prices, authorities of many countries are asking themselves a question about the factors influencing formation of tendency to their growth.

For example, Abbott, et al. (2008) put forward an idea that there were three main variables, which are also recognized by most economists, namely the abundance of demand, the U.S. dollar and the dependence of agriculture from energy industry. Among these three determinants, it is believed that the increased energy prices play a decisive role and affect food prices through direct and indirect channels. World oil prices skyrocketed to 140 us dollars per barrel by the end of the 2000s with about 20 dollars per barrel in the late 1990s (Figure 2).

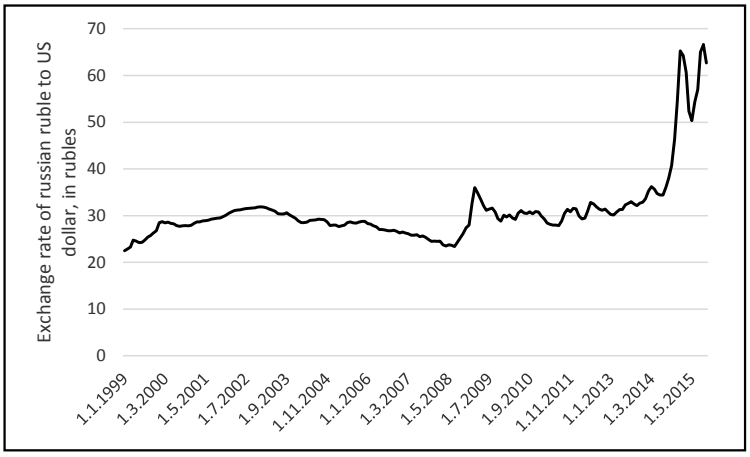
Hanson et al (1993) conducted a study on the linkages between energy and agricultural prices in importing countries, using model of input-output, and found that an increase in oil prices increases the cost of crops. The increase in oil prices leads to an increase in costs in the fixed capital, and also creates an additional shed in transportation costs. On the other hand, the sharp rise in oil prices stimulates ethanol production - the main substitute of oil. Then the expansion of demand for biofuels causes higher agricultural prices. Many countries start stimulating and supporting programs for production of ethanol, which indirectly increases demand for agricultural products. For example, according to the Renewable Fuels Association, USA, as the largest producer of ethanol, has allocated around 25% of crops for its production, thereby increasing the growth of prices for the crop. Moreover, Harri et al. (2009) found that because most oil transactions is held in U.S. dollars, and the price of agricultural commodities on domestic markets is established in national currency, another indirect channel for growth in the price of food is the exchange rate of the national currency (Figure 3).

Impairment or strengthening of the national currency affects the export price and the price of the purchase from the exporting countries.



Source: Federal Service of State Statistics of Russia.

Figure 2: Prices of international crude oil (US dollar/barrel) and wheat (Russian rubles/ton).



Source: Bank of Russia

Figure 3: Exchange rate of Russian ruble to US dollar.

For example, the devaluation of the Russian ruble will make agricultural products cheaper in comparison with other countries-exporters in the short term. As equilibrium restores, new equilibrium price level will be set at a higher level on the national market. Conversely, the strengthening of the Russian ruble will make the agricultural products more expensive, than in other countries, thereby reducing demand for products from Russia. The reduction of domestic demand in turn will bring the prices to a new equilibrium level.

Thus, it can be assumed that the existing knowledge about direct and indirect channels of influence of oil prices on agricultural prices in developing countries is uncertain and depends on many factors. In this article, we will discuss direct and indirect channels of transmission from oil prices to agricultural prices in the short and long term. When choosing agricultural variables for analysis we agree with the view of Baffes (2007), according to which prices of individual agricultural goods is preferable to using an average of prices for all agricultural products. We apply Granger causality test and impulse response analysis to test long run and short run effects respectively. Understanding of the relationships between oil prices and domestic agricultural prices will allow the national authorities of countries, both exporters and importers of agricultural products to establish optimal monetary and sectoral policies to support agro sector. A sufficient level of production and supply of food is the key and guarantee of food security. Major manufacturers and farmers will then be able to adjust their operating policies and expectations, thereby reducing exposure to risks from changes in the volume of demand and fluctuations in the exchange rate.

Given the above, the aim of this study is to determine elasticity of prices for a group of agricultural commodities in Russia to shocks in oil prices and exchange rate of the national currency in the short and long run.

2. Literature review

The apparent coincidence of the parallel growth of oil prices and agricultural prices has attracted attention of many researchers worldwide. As a rule, most of their attention was paid to either the study of the relationship between agricultural prices and biofuel, or fluctuations in the exchange rate.

In some outstanding works, indicate the relationship between crude oil prices and agricultural prices. Esmaeili and Shokoohi (2011) found that oil prices have an indirect effect on agricultural prices. Campiche et al. (2007) investigated the co-variability between crude oil prices and a number of agricultural crops during the period from 2003 to 2007. Diagnostics through Johansen cointegration test allowed making a conclusion about the absence of cointegration for the period from 2003 to 2005. However, the prices of grain and soybeans were in cointegration with oil prices in the period from 2006 to 2007. Shocks in oil prices can explain only a small proportion of changes in agricultural prices to food crisis in 2006-2007, while in the post-crisis period, the role of oil prices as the explanatory variable increases (Wang et al., 2014). Nazlioglu (2011) found the existence of a stable causal relationship between oil and grain prices. In a similar study, Yu et al. (2006) analyzed the relationship between oil prices and vegetable products. The results of the Johansen cointegration test showed that the impact of oil prices on prices of agricultural goods is statistically insignificant for the studied period.

In the study, Baffes (2007) argues that there is a relationship between oil prices and 35 international agricultural traded goods for the period from 1960 to 2005. After determining the regression equation, the author claims that if oil prices remain high for some time, an agricultural boom is likely to last longer than in the absence of growth in oil prices. In addition, Baffes suggested to use individual prices for agricultural products in order to optimize the quality of regression models. Xiaodong Du et al. (2010) found that shocks in oil prices lead to a spike in agricultural prices due to increased linkages between the agricultural and energy sectors. The authors of this study used weekly prices of futures for oil, grain and wheat from 1998 to 2009 and applied a Bayesian Markov Monte Carlo method.

The last two studies speak in favor of the existence of significant correlation between agricultural and oil prices. However, a number of researchers come to alternate conclusions. For example, Zhang and Reed (2008) found that changes of agricultural prices in China are not the result of changes in world oil prices.

In addition, it should be noted that there are alternative linkages between oil prices and agricultural prices. So, Abbot et. al (2008) suggested that an increase in the current account leads to a depreciation of the US dollar, making exports more attractive than imports (exchange rate channel).

Currently, given the scale of international trade, the exchange rate is perhaps a key factor in determining the macroeconomic situation, not to mention attractiveness of the national economy. However, decades ago, the role of exchange rate in domestic markets for obvious reasons was underestimated. And it was not until 1974, when the brilliant work of Schuh (1974) on the role of exchange rate in agricultural trade has appeared. In this study, the author assumed that the overvalued dollar has reduced exports, due to the appearance of additional costs in importing countries. Kost (1976) conducted a study of theoretical bases used to assess the impact of exchange rate changes on commodities' trade volumes in the national economy. At the end, he came to conclusion that there are limits to how price and volume can change in response to changes in the exchange rate. At the same time, Vellianitis-Fidas (1976) conducted a cross-sectional study using stepwise ordinary least squares (OLS) method using data of different time periods. Kost (1976) and Vellianitis-Fidas (1976) in the end came to conclusion that the depreciation of the US dollar was not the cause of high prices in 1972-1973. Chambers (1981) used regression analysis in order to test Granger causality between money supply and agricultural exports and lending rates. The results of the study were in line with other authors, and showed that the money supply (the value of the U.S. dollar) plays a role in the volume of agricultural trade.

On contrary, Batten and Belongia (1984) defended the view that the exchange rate is insignificant and plays no special role. In their opinion, the cornerstone of demand for exports is the changing income of households in the importing countries. Chambers (1984) developed a theoretical model to assess short-term effects of changes in monetary policy on the agricultural sector. He

also developed a VAR model for the resolution of statistical problems with the calculations. Koo (2009) investigated reasons for the decline of food prices using the method proposed by Toda and Yamamoto (1996) - Granger causality test. The authors concluded that agricultural prices are influenced by exchange rate and oil prices through various channels, which is confirmed by previous empirical studies of the Abbot et al. (2008).

Given the above, it should be noted that the history of the development of views on the question of relationship between agricultural prices, oil prices and exchange rate is quite long, and opinions are sometimes are diametrically opposed. With this in mind, the authors present a review of relevant literature in Table 1.

Materials and methods

1. Research methods

In this section, we provide an empirical strategy for achieving the above-mentioned goals of the study. In first place, we have to choose the best type of model for regression analysis –VECM model or unrestricted VAR model. For determining an appropriate type of the model, one should identify whether the variables used in the study are stationary at first difference and cointegrated.

In order to resolve the problem of non-stationarity of the data, all sampled time series are tested for the presence of unit root using traditional advanced Dickey-Fuller test (ADF test). The required number of lags is determined by information criteria of Akaike and Schwartzman:

$$\Delta y_t = \delta + \beta_t + \pi y_{t-1} + \sum_{j=1}^{p} c_j \Delta y_{t-j} + \epsilon_t$$

where δ – constant, t – trend value, y_t – dependent variable (e.g., exchange rate), ϵ_t – white noise term; null hypothesis (H_0) is $\pi = 0$ (presence of unit root), aleternative (H_1) - $\pi < 0$ (stationarity).

Secondly, if the condition of stationarity I(0) at first difference is obtained in all the variables used in this study, it is necessary to verify the presence of cointegrating equations in order to identify presence or absence of the relationship between each resulting and dependent variables in the long run.

To test for presence of cointegration we apply the Johansen test using non-stationary time series (values in levels). If between variables does exist a cointegration, the first-best solution would be using VECM model. An optimal number of lags according to Akaike information criterion for providing Johansen test is determined in VAR space. To conduct Johansen test, we estimate a VAR model of the following type:

Author	Commodity	Method	Exchange rate – role
Johnson, Grennes and Thursby (1977)	Wheat	Deterministic short run forecasting model	important
Chambers and Just (1979)	General agriculture	Critique of exchange rate treatment	somewhat important
Collins, Meyers and Bredahl (1980)	Wheat, corn, soybeans and cotton	Simple analytic method	overly restricted in models
Chambers and Just (1989)	Wheat, corn, soybeans	Dynamic three stage least squares	important
Chambers and Just (1981)	Agricultural vs non-agricultural sector	Vector auto-regression	important in the short run
Bessler (1984)	Brazilian agricultural prices	Vector auto- regression	important
Batten and Belongia (1986)	General agriculture	Standard expression for export determination	not important
Orden and Fackler (1989)	General agriculture	Non-recursive structurally identified model	inconclusive
Robertson and Orden (1990)	Agricultural prices	Vector auto-regression and Vector Error Correction	play a role
Henry, Peterson, Bessler and Farris (1993)	Beef cattle	Time series based on Bayesian VAR	important
Babula,Ruppel and Bessler (1995)	Corn	Both structural econometric models and time series methods	not important
Vellianitis-Fidas (1976)	General agriculture	Ordinary Least Squares and Time Series	not important in 1972–1973

Source: own elaboration

Table 1: Summary of relevant literature.

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \epsilon_t$$

in which each component of y_t is non-reposeful series and it is integrated of order 1. x_t is a fixed exogenous vector, indicating the constant term, trend term and other certain terms. εt is a disturbance vector of k dimension.

We can rewrite this model as:

$$\Delta y_t = \prod y_{t-1} + \sum_{i=1}^{p-1} V_i \Delta y_{t-1} + Bx_t + \epsilon_t$$

where:

$$\prod = \sum_{i=1}^{p} A_i - I, \qquad \bigvee_i = - \sum_{j=i+1}^{p} A_j$$

if the coefficient matrix ∏ has reduced rank $r < k$, then there exist k x r matrices α and β each with rank r such that ∏ = αβ' and $\beta' y_t$ is I(0). r is the number of cointegrating relations (the cointegrating rank) and each column of β is the cointegrating vector. The elements of α are known as the adjustment parameters in the VEC model. Johansen's method is to estimate ∏ matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of ∏.

In case of absence of cointegration between the sampled variables, a more appropriate method of regression analysis is the use of unrestricted VAR model:

$$Yi_t = a_0 + a_1 Y_{t-1} + \ldots\ldots + a_p Y_{t-p} + b_1 X_{t-1} + \ldots\ldots + b_p X_{t-p} + u_t$$

where Y_t presents price value of agricultural commodity i (resulting variable) at period t, X_t presents price value of oil or value of national currency's exchange rate (explanatory variable).

Providing regression analysis of the sampled variables by modeling VAR allow us to determine the existence of substantial and statistically significant dependence not only on the values of other variables in the sample, but also dependence on previous values of the variable.

However, VAR model must meet the requirements of serial correlation's absence, homoscedasticity of the residuals and to meet the requirement of stability. Only in this case the results can be considered true.

The last stage to determine the relationship and its direction is the use of Granger causality test. So, rejection of the null hypothesis of Granger test (H0), according to which:

$b_1 = b_2 = \ldots\ldots = b_p = 0,$

in favor of the alternative hypothesis (H1) suggests that changes in oil prices or exchange rate of national currency granger cause changes in prices of agricultural commodities.

If unrestricted VAR model is appropriate for testing the variables of the study, one could also use impulse response analysis, providing information about sensitivity and elasticity of analyzed variables in the short-run.

2. Materials and data processing

The basis of statistical data for the study are monthly world oil prices, value of exchange rate of the Russian ruble/USD and monthly domestic prices of buckwheat, barley, potatoes, wheat, oats, rye and grain crops for the period from January 1999 to October 2015. The choice of this time span is due to the relative stability of agricultural prices during the 1990s. Since the end of 1990s, agricultural prices began to grow at a significant pace. In this study, we are interested in whether shocks in oil prices and dynamics of the exchange rate are able to explain the upward trend in agricultural prices.

Variable "oil prices" represents the average monthly spot prices for crude oil (Brent) in Europe. Data is obtained from the statistical database of the US Energy Information Administration (EIA). Variable "exchange rate" is the value of the Russian ruble to the US dollar at the beginning of each month. Data is obtained from the statistical database of the Bank of Russia. Data on monthly prices for agricultural goods is obtained from the database of the Federal Service of State Statistics of Russia (www.gks.ru).

To conduct time-series analysis, all variables were transformed into logarithms. To evaluate variables we use the method of descriptive statistics. To identify and formally assess the relationship between variables, we use simple correlation analysis. To study sensitivity of agricultural commodities' prices to shocks in oil prices and the exchange rate of the ruble in short-and long-run, we turn to regression analysis, which involves the construction of VAR model of certain type based on stationary time series, testing the model for heteroscedasticity of the residuals, autocorrelation as well as stability. Based on the model, we measure elasticity of variables in the short and long run by applying Granger causality test, as well as using impulse response analysis.

Results and discussion

Descriptive statistics for variables are presented in Table 2. According to data of descriptive statistics, the exchange rate has the minimum values of the average, median, maximum, and standard deviation (0.1926). In the case of oil prices, the standard deviation from the trend (0.6136) represents the maximum value of the entire sample. Specific behavior of the exchange rate and low volatility relative to other variables is because that throughout the 2000s in Russia the exchange rate was under the control of monetary authorities and restrained within the legislative boundaries. In this regard, significant exchange rate fluctuations were excluded. The transition in recent years to the regime of free exchange rate undoubtedly has increased the volatility. In contrast, oil prices are characterized by the maximum value of the standard deviation, which suggests significant volatility. The same is true for the prices of agricultural goods. This feature is explained by the fact that oil prices are set on the world market and represent the ratio of supply and demand, as well as their dynamics.

L in each name of the variables denotes the logarithm (i.e. LB - logarithm of prices for barley; LBW - logarithm of prices for buckwheat; LCO - logarithm of prices for crude oil; LER - logarithm of exchange rate; LG - logarithm of prices for grain crops; LO - logarithm of prices for oat; LP - logarithm of prices for potatoes; LR - logarithm of prices for rye; LW – logarithm of prices for wheat).

If we turn to the results from simple correlation analysis (Table 3), we can detect a number of significant, at first glance, correlations. First, there is a significant linear relationship between the prices of various agricultural products. For example, the correlation between barley and wheat tends to 1 (0.981), and the correlation between barley and grain crops is 0.989. Thus, a sudden shock in the price of one commodity can lead to changes in the price of other goods, traded on the market.

The results of correlation analysis also show the presence of a linear relationship between the prices of agricultural goods and oil prices. For example, it can be considered a strong correlation between oil prices and the prices of rye and oat (0.863 and 0.883, respectively). However, this correlation may be misleading and the results cannot be considered fully reliable because of serial correlation issue.

The picture with the exchange rate looks not so clear. The degree of linear correlation between exchange rate and prices of agricultural products can be considered, at best, medium (0.3-0.5). This speaks in favor of the absence of a significant dependence of agricultural prices from exchange rate fluctuations. The reasons for this correlation may be the fact that Russia is a major international agricultural exporter. Therefore, shocks to exchange rate do not have a significant impact on domestic prices. However, it is important to remember that Russia is not a net exporter. The import channel affects a number of agricultural products included in the sample. In case of crop failure or inadequate supply the share of import of certain goods increases (for example, in the case of buckwheat).

Since the way of stochastic is different at each time point of the non-stationary series, general stochastic of the series is hard to capture. There is also the probability of obtaining spurious regression.

Thus, to resolve the problem with the nonstationarity of time series, it is necessary to test for the presence

	LB	LBW	LCO	LER	LG	LO	LP	LR	LW
Mean	8.0819	8.7486	3.9815	3.4116	8.1997	7.9640	8.8345	7.9493	8.2168
Median	8.0674	8.6807	4.0920	3.3783	8.2471	8.0287	8.8222	8.0392	8.2405
Maximum	9.0092	10.641	4.8882	4.1986	9.2189	8.8643	9.9473	8.8422	9.1712
Minimum	6.2429	7.1714	2.3292	3.1130	6.4164	6.4923	7.6680	6.1408	6.4149
Std. Dev.	0.5746	0.5602	0.6163	0.1926	0.5580	0.5212	0.4639	0.5594	0.5489
Skewness	-0.4004	0.6585	-0.4017	2.2891	-0.3011	-0.3813	0.3260	-0.7634	-0.2854
Kurtosis	1.6513	2.2492	1.0860	2.3298	1.5584	1.3646	1.6622	1.1751	1.6676
Probability	1632.5	1767.2	804.27	689.14	1656.3	1608.7	1784.5	1605.7	1659.8
Sum	66.375	63.083	76.362	7.4592	62.604	54.606	43.264	62.912	60.574
Sum Sq. Dev.	66.37523	63.08330	76.36233	7.459206	62.60486	54.60605	43.26464	62.91200	60.57406
Observations	202	202	202	202	202	202	202	202	202

Source: own processing

Table 2: Descriptive statistics.

Variable	LB	LBW	LCO	LER	LG	LO	LP	LR	LW
LB	1.000								
LBW	0.775	1.000							
LCO	0.866	0.667	1.000						
LER	0.423	0.479	0.122	1.000					
LG	0.989	0.769	0.838	0.470	1.000				
LO	0.965	0.759	0.883	0.436	0.964	1.000			
LP	0.840	0.795	0.756	0.502	0.832	0.865	1.000		
LR	0.961	0.708	0.863	0.339	0.956	0.954	0.789	1.000	
LW	0.981	0.750	0.816	0.476	0.996	0.949	0.814	0.946	1.000

Source: own processing

Table 3. Correlation matrix

	ADF		PP	
	Statistic	Prob.**	Statistic	Prob.**
Levels				
Intercept	8.4421	0.9392	7.9174	0.9021
Intercept and trend	7.3459	0.3187	5.4482	0.3685
First-difference				
Intercept	770.82	0.0000**	745.54	0.0000**
Intercept and trend	749.75	0.0000**	720.58	0.0000**

Note: ** denotes statistical significance at the 5% level of significance
Source: own processing

Table 4: Results of the group unit root test.

Hypothesized No. of CE(s	Eigenvalue	Trace Statistics	0.05 Critical Value	Prob.**
None	0.289	145.381	197.371	0.346
At most 1	0.236	127.868	159.530	0.203
At most 2	0.168	124.665	125.615	0.177
At most 3	0.153	88.343	95.754	0.145
At most 4	0.111	55.555	69.819	0.396
At most 5	0.085	32.328	47.856	0.594
At most 6	0.057	14.812	29.797	0.792
At most 7	0.014	3.109	15.495	0.962
At most 8	0.002	0.342	3.841	0.559

Note: Trace statistics indicate no cointegrating equations at the 0.05 level.
* denotes statistical significance at the 5% level of significance
Source: own processing

Table 5: Results of Johansen co-integration test.

of unit root. The results of ADF and Phillipes-Perron tests are presented in Table 4. The results show that the maximum order of integration is 1 (d = 1). This means that the first-differenced variables with constant and trend are stationary.

Once we have determined that all variables are stationary at first difference we can present Johansen cointegration test for determining the appropriate type of regression model to use in the study. For Johansen test we use non-stationary data to check for presence of relationship between sampled variables.

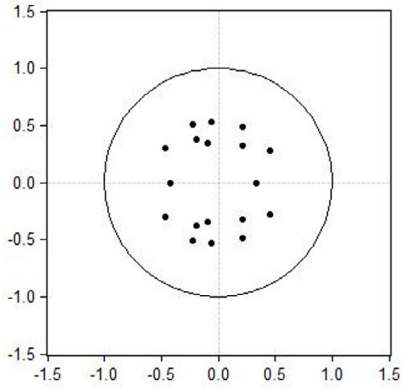
As can be seen from the results of the Johansen test (Table 5), cointegrating equations between variables have not been revealed. For all null hypotheses of no existence of cointegrating equations, values of trace statistics are less than critical values and p-values are more than 5 percent, and that allows us to accept the null hypothesis of no cointegration between variables. In other words, based on results

of this test, using VECM model would be incorrect way of providing analysis, which leads us to the necessity of using an unrestricted VAR model.

Building a VAR model involves determining the optimal number of lags. In our case, the Akaike information criterion equals 2. Consequently, we built a model based on the use of time lag of 2 months to determine the relationship in the short term.

The model is used to determine the level of sensitivity of control variables (prices for agricultural goods) to shocks in oil prices and the exchange rate. For these goals, we apply pairwise Granger causality test and impulse response analysis.

The results of the diagnostic testing of the model for heteroscedasticity of residuals, autocorrelation, serial cross-correlation, and stability are presented in Figure 4 and Table 5. As can be seen from Table 5, the model is stable, heteroscedasticity and serial correlation of residuals in the model are absent. For testing sensitivity of agricultural prices to shocks in oil prices and exchange rate, we use impulse response function. Since the inverse roots are all depicted in the unit circle (Figure 4), we can say that the VAR model is stable and does not affect the standard deviation in impulse response function.



Source: own processing

Figure 4: Inverse roots of AR characteristic polynomial.

Granger causality test confirms the presence of a number of long-term relationships between the variables. Thus, in contrast to simple correlation analysis, Granger test (Table 7) shows the presence

Type of test	**Results**		
VAR Residual Serial Correlation LM Test	Lags	LM-Stat	P-value
	1	100.1202	0.0736**
	2	92.8017	0.1743**
Stability condition test	All roots lie within the circle. VAR satisfies stability condition.		
Heteroscedasticity (White test)	0.1497*		
VAR Residual Cross Correlation Test	No autocorrelation in the residuals		

Note: **denotes acceptance of null hypothesis (Ho: there is no serial correlation).
* denotes acceptance of null hypothesis of homoscedasticity.
Source: own processing

Table 6: Results of unrestricted VAR model diagnostic testing

Variable	LB	LBW	LCO	LER	LG	LO	LP	LR	LW
LB		0.221	0.305	1.868	0.576	2.127	0.336	0.586	0.991
LBW	2.203		3.959	10.879*	1.136	0.159	1.704	0.463	1.285
LCO	1.066	0.626		2.241	0.005	3.148	2.618	2.534	0.626
LER	5.279	2.669	4.318		2.369	1.070	1.398	0.575	4.672
LG	11.718*	0.340	0.985	3.822		0.087	0.447	1.627	6.809*
LO	16.743*	0.267	3.190	0.433	0.909		5.978*	11.380*	0.749
LP	4.108	1.633	0.021	0.581	2.117	1.307		1.660	1.363
LR	9.509*	1.190	3.127	0.232	2.565	0.535	0.496		5.847*
LW	9.438*	0.639	0.545	1.550	0.384	0.365	0.450	3.447	

Note: * denotes statistical significance at the 5% level of significance and rejection of null hypothesis of no Granger causality.
Source: own processing

Table 7: Results of long-run Granger causality test.

of a long-term relationship between the exchange rate and the prices of buckwheat. At the same time, the Granger causality between exchange rate and other agricultural commodities is missing. This result is explained by the fact that for most of agricultural products, Russia is a net exporter and the channel of exchange rate has no significant impact on prices in the agro-industry. In the case of buckwheat, Russia is both a producer and importer. In case of droughts, crop failures, artificial panics in the agricultural market ("Buckwheat mania" of 2010-2011, crop failure of 2013), as well as increasing production costs and restriction of free pricing, lead to a loss of competitiveness of domestic producers. In 2014-2015, significant role in increasing domestic prices has played a sharp and strong depreciation of the ruble.

The absence of Granger causality from oil prices to agricultural commodities is also due to the exporting status of Russia. No need for import of crude oil reduces sensitivity of domestic agricultural price fluctuations to the world market.

Thus, in the group of agricultural commodities, on which Russia is a net exporter, sensitivity to shocks in oil prices and exchange rate tends to zero. For those agricultural goods that are imported (e.g. buckwheat), the channel of the exchange rate manifests itself in the long run.

To assess the link between agricultural prices and oil prices and exchange rate in the short term, we turn to impulse response analysis. This technique allows us to assess sensitivity of control variables to shocks in oil prices and exchange rate in the short run on the basis of the constructed VAR model. The results of impulse response analysis are presented in Figures 5-6.

The results of impulse-response analysis confirm the overall results of the Granger test. In the short term and in the long-term sensitivity of buckwheat prices to shocks in the exchange rate is manifested. In other cases, statistically significant elasticity could not be detected. Thus, the results of impulse response function show a statistically significant sensitivity of prices for buckwheat to changes in the exchange rate of the national currency of Russia in the short term. Judging by the results, the shock (in one standard deviation) on the currency market leads to an increase

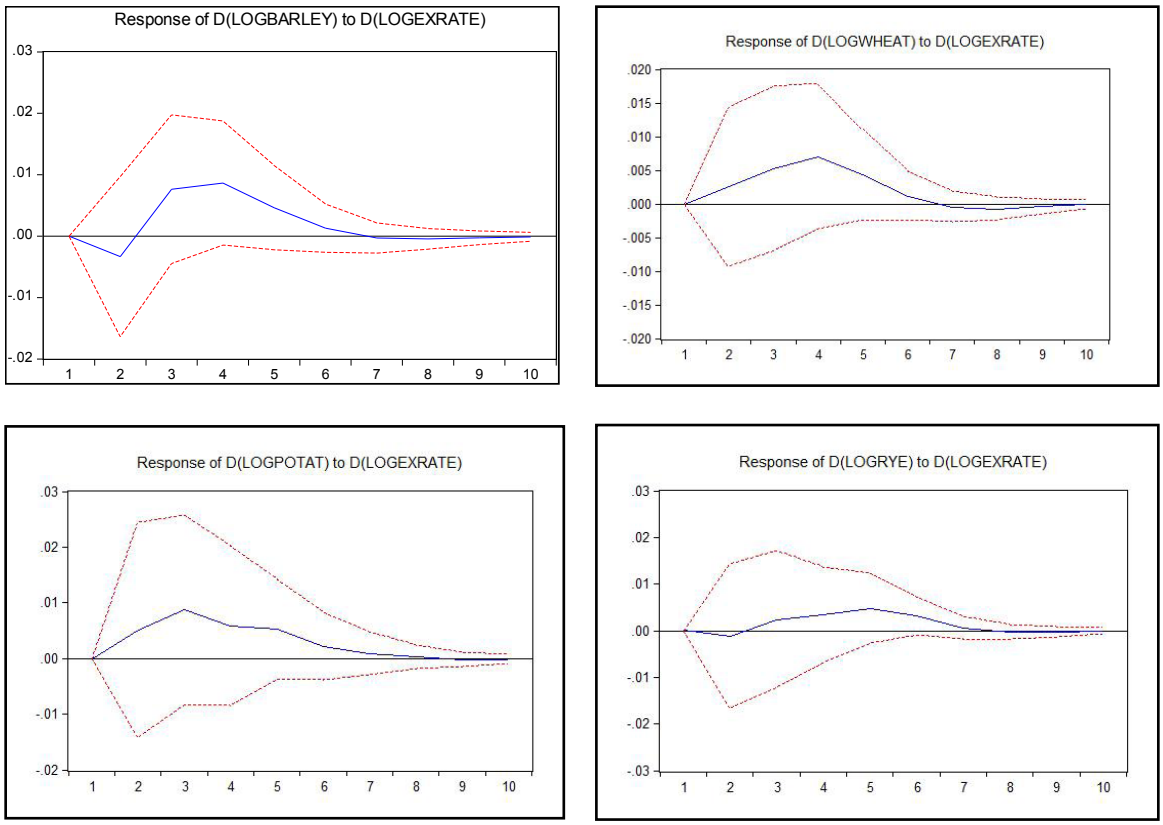


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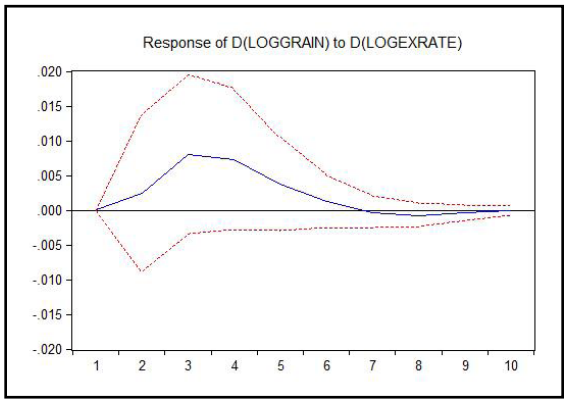
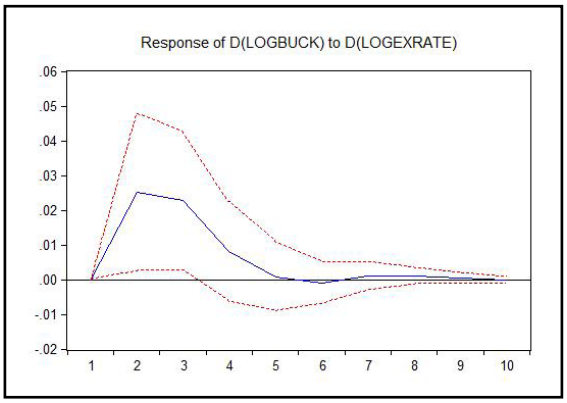
Figure 5: Response to one-standard deviation of the exchange rate.





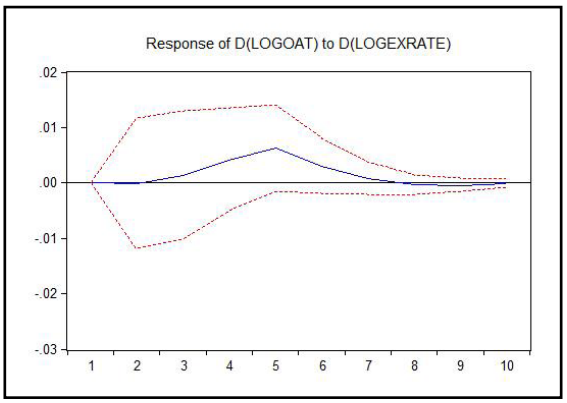


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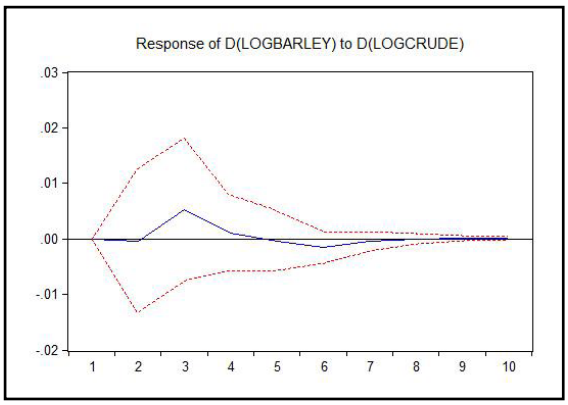
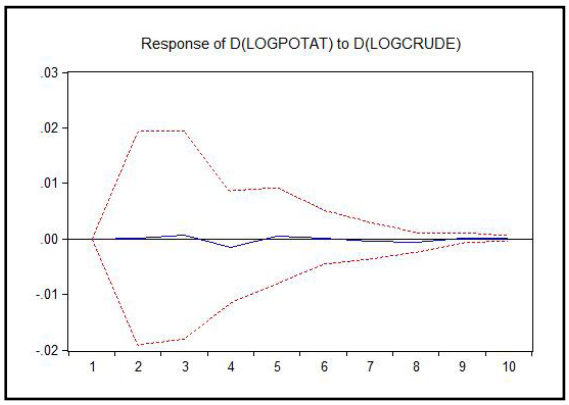
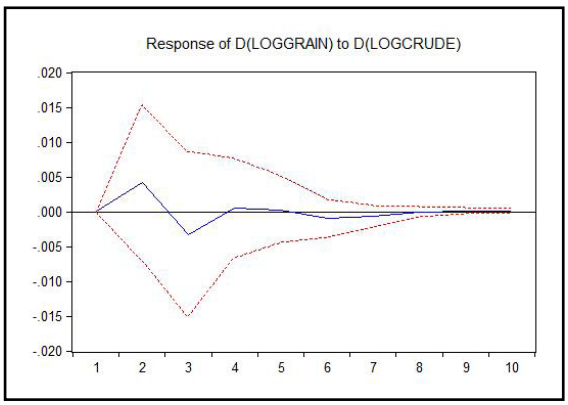
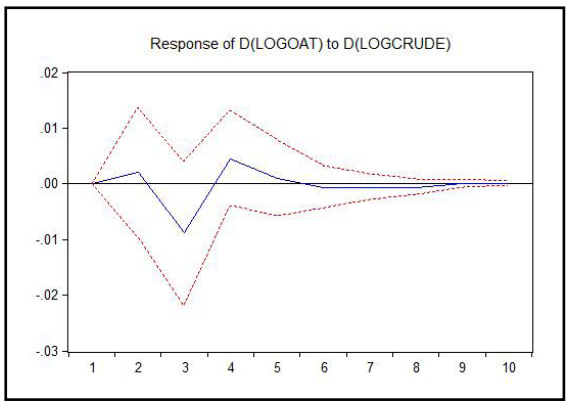
Figure 5: Response to one-standard deviation of the exchange rate. (continuation)



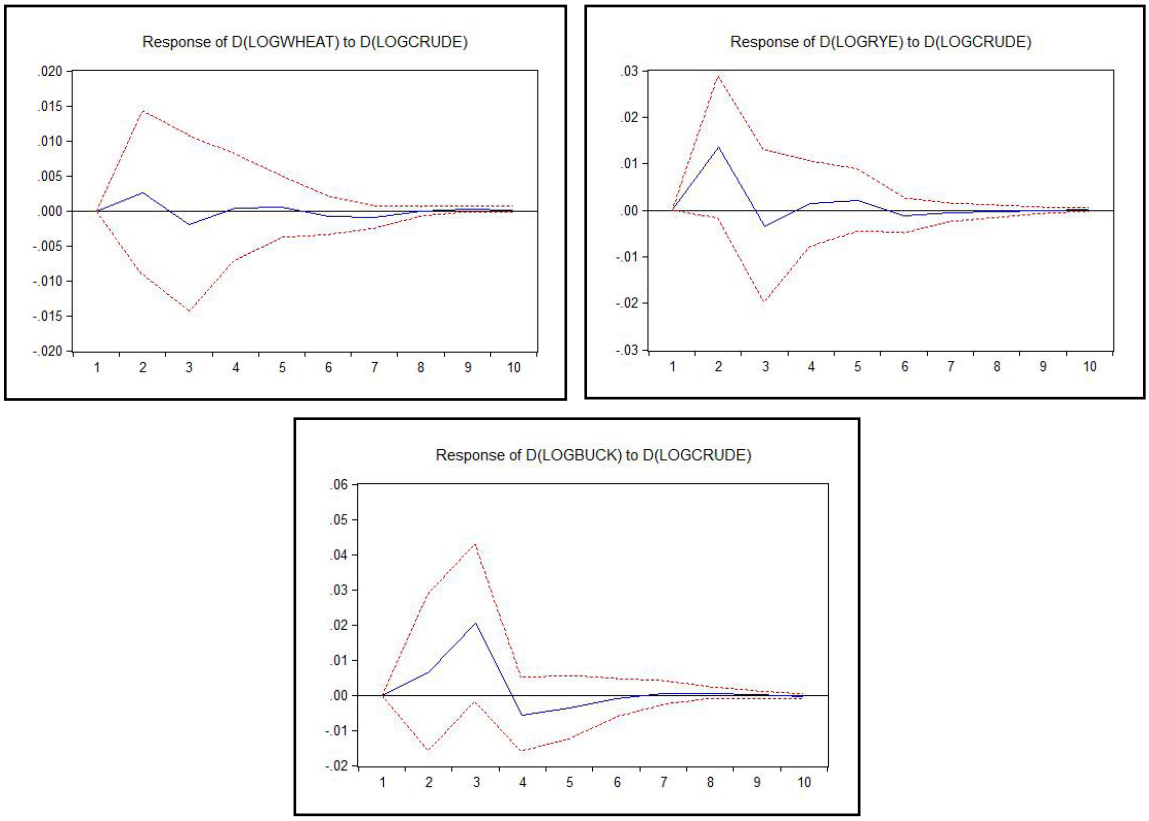






Source: own processing

Figure 6: Response to one-standard deviation of world oil price.



Source: own processing

Figure 6: Response to one-standard deviation of world oil price (continuation).

in output prices for buckwheat on the domestic market within a maximum of three months from the moment of shock occurrence. This result suggests the necessity of taking into account the relationships between production, planning, selling prices, as well as developing mechanisms of currency risk hedging in the agricultural industry. In addition, recognizing sensitivity in the prices of buckwheat to shocks on the foreign exchange market speaks in favor of increasing domestic production and enhancing national food security as well as developing mechanisms mitigating realization of currency risk in relations with trade partners. The lack of sensitivity of agricultural prices to changes in oil prices are explained by the exporting status of Russia. The availability of domestic energy resources allows to protect domestic agricultural prices from fluctuations in the world oil market.

Conclusion

This study focuses on the analysis of relationships and determining sensitivity of agricultural prices to oil prices and exchange rate. The definition of the character of interrelations in the national economy is important to ensure macro-economic wellbeing and food security. A clear understanding of the links between agricultural prices, oil prices and the exchange rate is a key prerequisite for the formation of optimal monetary and fiscal policy. Analyzing sensitivity of Russian agricultural market to shocks in world oil prices and exchange rate, we come to conclusion that the status of an exporter of agricultural products significantly protects the national economy from the effects of adverse shocks.

However, at the same time, changes in oil prices and exchange rate are not sufficient to explain an increase in domestic agricultural prices, which could be the subject of further research.

In the case of importer's status (for Russia - import of buckwheat), sensitivity to exogenous shocks of exchange rate (under condition of free market pricing) increases dramatically, which creates a threat to food security and welfare of the population. Thus, an additional argument is given to the position according to which the transmission channel of exchange rate plays a significant role in pricing mechanism of agricultural products.

At the same time, there are a number of other channels that have potential to impact domestic

prices for agricultural products. One of the key in our opinion may be growing demand for fertilizers and technologies for agricultural sector. Transmission of currency risk in domestic agricultural market may be found through increasing demand in raw materials.

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Welfare Analysis of Lifting the GM Ban in Russia

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Abstract

Use of genetically modified crops is prohibited in Russia, however, Russian politicians are currently discussing this technology. This article evaluates the potential welfare effects of adopting genetically modified crops in Russia, focusing on the potential benefits to Russian producers who adopt herbicide tolerant corn and soybeans. Calculations are based on supply and demand functions of current market situations and their potential shifts. The results quantify the potential monetary gains from open markets to genetic engineering technology and explain the potential additional costs related to technology adoption.

Keywords

Welfare analysis, GM, corn, soybeans, Russia

Chetvertakov, S. (2016) "Welfare Analysis of Lifting the GM Ban in Russia", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 2, pp. 49-56. ISSN 1804-1930. DOI: 10.7160/aol.2016.080204.

Introduction

The battle of sanctions that began in 2014 between the Russian Federation and its some trade partners resulted in constraints for the entire Russian economy, and it especially affected the agricultural sector. Maintenance of economy required from the government initiation of anti-crisis activity to stabilize the economy (Gov (b), 2015), but they were unsuccessful in controlling the weakening economy. The national currency fell and the Central Bank raised the interest rate. Higher interest rates and the growing inflation rate demanded changes to the current level of agricultural subsidies (Gov (a), 2015). In the face of government financial constraints, which are the results of sanctions on Russia, an important question can be raised: what alternative sources can be used to support agricultural producers?

Widespread innovations such as genetically modified seeds cannot be applied legally in Russia, despite demand for this technology from the production sector. In 2012, a law that would open the gate for genetically modified (GM) crops was proposed (MEDRF, 2012), but did not pass. Political discussion regarding adoption of GM seeds inclines to the position of GM opponents and Russian policy-makers, employing the argument of unpredictable outcomes for human health and the environment, kept GM seeds out of Russia (Lenta, 2015; Kommersant, 2015). In Russia and other countries that prohibit the production of GM crops, there is particular interest in economic compensation for the welfare losses resulting from these market constraints (Moschini et. al., 2000).

The possible effects of GM crop adoption have been calculated for many regions and different crops (Trigo and Cap, 2004; Raney, 2006). Brookes and Barfoot (2014) argue that the main reason for the current adoption of GM herbicide tolerant (HT) crops has been lower production costs. Although there is some evidence of a yield advantage (Brookes and Barfoot, 2014), this effect cannot be generalized (Finger et al., 2011).

Potential welfare effects of GM seed adoption in the Russian economy have not been studied. This paper estimates the welfare changes of Russian producers in the case of access to GM seeds. The specific focus of the study is HT corn and soybeans.

Particular interest in substituting GM corn and soybeans for conventional varieties stems from the fast acreage expansion of these crops and their growing importance in Russian agriculture. The average annual growth rate (2000-2013) for both crops was 10.2%[1] across Russia. In this same period, average annual growth rates reached 17.3% and 32.8% for corn and soybeans, respectively, in the Central Federal District, one of country's main agricultural regions.

Insect resistant corn was also considered

[1] Own calculation based on official statistics from UniSis database, 2015.

for the study, but there is a relative lack of necessary data. First of all, the effects of insect resistant corn use depend significantly on pest infestation levels (Baute et. al., 2002). Some regional studies (Potemkina and Lastushkina, 2006; Serapionov and Frolov, 2008) do not track pest infestation levels in corn growing regions. Secondly, few studies include economic performance figures of farms using Bt corn (Finger et al., 2011), making economic analysis difficult. Finally, there is also considerable ambiguity about the yield effects of using Bt corn (Finger et al., 2011). All of these make estimating the welfare effects of Bt corn in Russia difficult.

This paper is organized as follows: the second section describes and discusses methods which will be used in the paper; the third section provides the results. The discussion regarding the pitfalls of the GM legislation and conclusion will finalize the paper.

Materials and methods

Russian corn and soybean market models are assumed to take the following functional forms, following the linear supply and demand equations:

$$D(Q) = P = a_0 + a_1 Q^d \quad (1)$$

$$S(Q) = P = b_0 + b_1 Q^s \quad (2)$$

The starting point of model construction is estimating the current situation. Calculation of the demand and supply equations requires initial data that was taken from three sources: production and trade data (total production, consumption, exports, imports, etc.) for 2013/2014 growing season[2] come from the USDA database (2015); Russian corn and soy supply and demand elasticities come from the FAPRI Elasticity Database (2015); the average prices in Russia for the selected season were gathered (and then converted to US dollars) from UniSis database (2015).

1. Corn

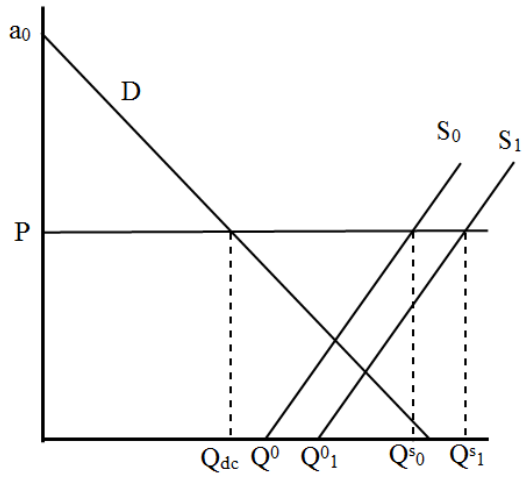
Corn balance in 2013/2014 was as follows: total supply[3] was Q^s_0 = 11,642 mln. metric tons (MT), total demand (consumption) Q_{dc} = 7,500 mln. MT and net export 4,142 mln. MT. Supply elasticity (area) is equal to e_s = 0.31. Average price for the season was P = $173.56 per MT. There are two demand elasticities based on the two uses of corn for animal feed and human consumption. As the majority of the total consumption (88%) is used for animal feeding, the author employs the elasticity relative to this use, which is equal to e_d = -0.2. It is also possible to calculate one demand elasticity based on the two uses or apply other solutions, but as will be explained later, demand elasticity does not influence the consumer welfare alteration.

Given the above values, it is possible to derive the four unknowns in the supply and demand equations:

$$a_1 = \left(\frac{1}{e_d}\right) \times \left(\frac{P}{Q_{dc}}\right) \quad (3)$$

$$a_0 = P - a_1 Q^d \quad (4)$$

Substituting b_0 and b_1 for a_0 and a_1, respectively, the necessary parameters for the supply function are also calculated. The demand and supply curves are drawn in Figure 1. Further calculations reveal the x-intercept of the supply function S_0 and horizontal axis, which is Q_0 equal to 8,033 mln. MT. Lifting the GM ban will lead to cost savings, which will shift the supply curve S_0 downward to S_1.



Source: own processing

Figure 1. Corn market in 2013/2014

In this paper the author applies a small-country assumption: such that Russian production and trade policies does not affect the world market price. Therefore, the world demand for Russian corn is perfectly elastic and as long as domestic market is a world price taker, domestic consumer's welfare does not change due to the supply shift. However, there is another way of modelling the market. Moschini et al. (2000) employed

[2] The local marketing year for Russia for corn and soybeans is October 2013 to September 2014

[3] Calculated as the sum of beginning stocks and production less ending stocks.

a partial equilibrium model by measuring demand elasticities of importing countries. This method was not used because of two limitations:

1. The lack of quantity and destination data of corn exports (the UN Comtrade Database (2015) was considered as the source of such information, but was rejected due to limitations explained on their webpage).
2. Russia exports a negligible amount of corn relative to the world market and thus a slight increment of export quantities does not influence the world market.

One of the key challenges is quantifying the cost savings from the adoption of GM crops. Climate conditions do not influence on the economic performance of GM crops in comparison to conventional (Finger et al., 2011), which seems logic as trading by GM seeds and treatment materials companies adjust prices to the potential farmer's return. Hence, climate conditions are not considered to have an effect on crop production costs, and therefore, cost-savings resulting from use of GM or conventional seeds.

The paper from Brookes and Barfoot (2014) presents a summary of economic impacts of GM crops over many countries. Income benefits resulting from both lower input costs (cost savings) as well as yield gains will be considered in this study. Although Finger et al. (2011) argue that yield increase of GM crops cannot be generalized, this factor cannot be ignored. Therefore, yield gains are included in the calculation of the monetary benefits of GM use, but conventional and GM crop yields were assumed to be the same for the calculation. Different benefit level will reflect the sensitivity of the welfare in depends to the average farm benefit, which differs from year to year due to fluctuation in price of herbicide, seed cost, cost of technology and yield. The lowest ($1 per hectare in South Africa) and the highest ($90 per hectare in Argentina) values of the farm income benefit (after deduction of cost of technology) will be the limits.

Welfare effects of open access to GM seeds in Russia compared to the current situation can be measured as geometric areas. Current consumer surplus CSA is the area below the demand curve D and above the price P:

$$CS^A = \frac{1}{2}(a_0 - P) \times Q_{dc} \quad (5)$$

Current producer surplus PS^A can be measured as the area above the current supply curve S_0 and below the price P:

$$PS^A = (Q^0 \times P) + \frac{1}{2}\left(\left(Q_0^S - Q^0\right) \times P\right) = 0.5P(Q_0^S + Q^0) \quad (6)$$

After potential change in the Russian legislation the supply curve will move downward, increasing producer surplus. This amount will be calculated as income benefit per ha divided by the actual yield (5.01 MT per ha). This figure will reflect the income benefit per metric ton basis. The new supply curve function will be:

$$S_1(Q) = P = b_0 - c + b_1 Q_1^s \quad (7)$$

where c is the amount of income benefits in US dollars per metric ton and Q^S_1 is a new supplied amount.

New producer surplus PS^N can be calculated as:

$$PS^N = (Q_1^0 \times P) + \frac{1}{2}\left(Q_1^S - Q_1^0\right) \times P) = 0.5P(Q_1^S + Q_1^0) \quad (8)$$

2. Soybeans

Unlike corn, soy is a scarce commodity in Russia and the domestic production provides only half of the total domestic consumption. Total domestic supply[4] of soybeans in 2013/2014 was Q^{sd}_0 = 1,453 mln. MT, net import 1,907 mln. MT and the total domestic consumption Q_{dc} = 3,360 mln. MT. Supply elasticity (area) is not specified for Russia in the FAPRI database, so the elasticity for CIS[5] countries is used, which is e_s = 0.42. Average price for the marketing season is P = $504.97 per MT. Demand represents two components: feed demand and demand for crushing, and there is absence of consolidated demand elasticity for beans. Author uses Moschini et al. (2000) calculations of bean elasticity for the rest of the world, which is e_d = -0.4. However, as in the case of corn, the small country assumption will be applied and consumer welfare will not change due to the supply move.

Exploiting equations (3) and (4), it is possible to calculate the supply and demand functions (figure 2). Further calculations are used to derive the crossing point of supply function S_0 and horizontal axis, which is Q_0 = 842.7 mln. MT.

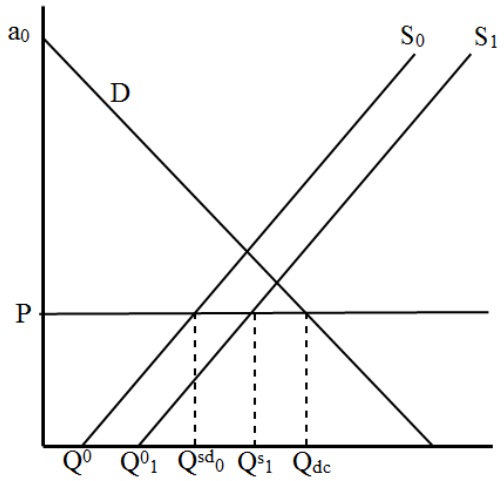
Net gains from planting GM herbicide tolerant soybeans are difficult to estimate as the effect of the following crop may also have an impact. A paper by Brookes and Barfoot (2014) simulate a range of possible net farm benefits from GM

[4] treated the same manner as corn supply

[5] The Commonwealth of Independent States

technology in several countries and different GM technologies. The minimum farm income benefit was observed in South Africa and equal to $4 per hectare (1st generation GM HT soybeans) and the highest was $149 in the US (2nd generation GM HT soybeans). This range of benefits will be used to calculate the potential welfare gain.

Equations 5-8 presented in the corn part can be employed to measure soybean welfare as well. Amount of the benefits per ton is calculated by dividing net gains from GM per hectare by the yield level of the selected season, which was 1.36 MT/ha.



Source: own processing

Figure 2. Soybean market in 2013/2014.

Results and discussion

1. Corn

First, consumer and producer surplus are calculated for the current situation of no access to GM seeds. Corn consumers have surplus equal to $3,254 mln., and corn producer surplus is $1,707 mln. Sequentially, by substituting income benefits into equation (7), and then subtracting current producer surplus from potential producer surplus, change in the producer welfare, ΔPS, is found. The results for selected amounts of income benefits per hectare relative to the potential adoption rate of GM corn in Russia are presented in Table 1. Adoption rate was applied to indicate the different welfare outcomes. Lifting the GM ban would not lead immediately to wide acceptance by farmers. The number of producers who will use GM seeds will affect the total producer surplus area.

Increase of producer surplus is a result of growth in supply. For example, with $30 per ha of income benefit and 100% technology adoption, producer supply will increase by 124.5 thousand MT (going to export) which leads to additional $21.6 mln. in producer surplus at a price of $173.56 per MT.

2. Soybeans

Russian soybean consumers benefit from the world market price as it is located below the domestic market price. Their current consumer surplus is equal to $4,242 mln., while producer surplus is only $580 mln. Possible welfare gains from access to GM HT soybeans are reflected in Table 2. Income benefits will slightly affect the quantity of soybeans produced domestically. With $50 per ha benefit from GM technology, soybean growers would be ready to increase soybean planting by 32,670 hectares, which leads to additional production of about 44.4 thousand MT (with yield 1.36 MT/ha). In such case Russian soybean producers would reap an additional $22 mln.

Income benefit per hectare	Adoption rate			
	25%	50%	75%	100%
$1	0.18	0.36	0.54	0.72
$10	1.8	3.6	5.4	7.2
$20	3.6	7.2	10.8	14.4
$30	5.4	10.8	16.2	21.6
$40	7.2	14.4	21.6	28.8
$50	9.0	18.0	27.0	36.0
$60	10.8	21.6	32.4	43.2
$70	12.6	25.2	37.8	50.4
$80	14.4	28.8	43.2	57.6
$90	16.2	32.4	48.6	64.8

Source: own processing

Table 1. Estimated impact on producer's welfare with GM HT corn application in Russia (Millions of USD).

Income benefit per hectare	Adoption rate			
	25%	50%	75%	100%
$4	0.45	0.90	1.35	1.79
$20	2.24	4.49	6.73	8.97
$35	3.93	7.85	11.78	15.71
$50	5.61	11.22	16.83	22.44
$65	7.29	14.58	21.88	29.17
$80	8.97	17.95	26.92	35.90
$95	10.66	21.31	31.97	42.63
$110	12.34	24.68	37.02	49.36
$125	14.02	28.04	42.07	56.09
$140	15.71	31.41	47.12	62.82
$149	16.71	33.43	50.14	66.86

Source: own processing

Table 2. Estimated impact on producer's welfare with GM HT soybeans application in Russia (Millions of USD).

3. Discussion

Creation of a law to allow GM seeds and products to enter the market is not the only issue. Policymakers should also think about the procedure of admittance such products to allow producers to reap aforementioned benefits and guarantee food safety for consumers.

Around the world, current legislative practices with regard to GM products can be differentiated between two, rather extreme principles: substantial equivalence principle that treats GM as conventional food technology (OECD, 1992), as is applied in the U.S.; and precautionary principle that says in the case of a lack of scientific evidence it is better to ban a product that could be safe than accept one that could be dangerous (McGarity, 2001), as is applied in Europe. Most countries' legislation with respect to GM food falls between these two extremes (Chen, 2006). The precautionary principle hinders European growers to use GM technology, but this could change in the near future with extend of GM use in the Regulation on Genetically Modified food and feed (EC, 2015).

The author believes that politicians should construct rules with respect to GM technologies in a way to provide the necessary information to consumers and at the same time does not unequally disadvantage producers who wish to use GM or conventional products. The public is very sensitive to such issues and would rather avoid GM products. In this case labeling will play the major role.

With regards to labeling, studies reveal that when GM labeling is voluntary or mandatory, the outcome is equal (Bansal and Gruère, 2010). In the case of the type of labeling, rules should transparently define which products can be assigned as GM. Three categories of such products have to be determined:

1. GM food for direct consumption;
2. Food for animal feed that is later converted to other type of products;
3. GM food that is processed and can be sold for direct consumption or for use in production of other products.

Common practices of labeling the aforementioned categories are: GM food for direct consumption is labeled as being a GM food. Japan offers a good example of labeling the second and third categories: "Exempted processed foods are products such as those in which recombinant DNA or proteins produced by such DNA are finally eliminated or broken down…" (FAQ, 2003). In other words, if DNA of genetically modified product is broken such product should not be labeled as GM. With regards to the third category, Chinese law requires labeling products as GM if the share of GM ingredients is more than 5% (Chen, 2006).

Definition of GM foods can be adjusted with legislation. But should non-GM food be labelled as well? This question is more difficult. In the case of Switzerland, 'GMO-free' labeling is prohibited because it is difficult to guarantee 0% GMO in the food (Regulation, 1997). This point is valid given the difficulty of separating GM and non-GM products during planting, transportation, and processing.

The aforementioned legislative practices can be adapted to the Russian case as well. Proper labeling of GM products will provide sufficient information to consumers, while not harming producers of GM products.

Government policy in regards to handling and storage of GM products will impact the welfare effect from the technology. Additional costs will rise with the necessity to document, verify and separate transport and storage facilities for GM and non-GM products. However, the size of such additional costs depends on the crop, volume and the threshold level of contamination accepted (Stone et al., 2002).

Many authors have estimated such costs. For example, Buckwell et al. (1999) find that for the US market with tolerance level of GM residues of 1%, additional costs were approximately 10% of farm gate prices. With this same tolerance level in Russia, it would require almost $87 per ha of corn and $68.7 per ha of soybeans. Interpreting these results, costs for GM corn handling are higher than most values of income benefits per ha seen in Table 1, which means that considering the handling and storage costs of GM HT corn can result in welfare losses. For soybeans additional costs are in the middle range of income benefits from the GM technology (Table 2), and so large welfare gains can occur. Aforementioned costs are calculated for the first period of GM introduction. Over time costs are expected to fall as procedures improve (Buckwell et al., 1999).

Another source (Leading Dog Consulting, 2001) presents an estimation from Australia, where additional costs for testing technology, segregation and identification systems will increase by 10-15% through the supply chain. Vandenberg et al. (2000) used a linear programming approach to evaluate different scenarios of segregation for existing GM corn and soybeans on the market and found that the total costs of the supply chain will increase in the range by 3-9%. The European Commission (2000) estimated the costs will increase by 6-17% of the farm gate price.

Estimations of additional costs related to GM crop treatment vary and depend on the particular country case and chosen policy applied to the GM products. These estimations demand careful calculation as the additional costs in the supply chain can potentially cancel out the producers' welfare increase from the cost-saving technology.

The state can support farmers not only by subsidies, but opportunity to produce cheaper and, therefore, larger quantity of products and reap higher profits with GM introduction. Unlike subsidies, which are a redirection of financial resources from other sectors, producers will gain from free access to GM products without large state expenses. Additional welfare gains will accelerate soy and corn production.

Conclusion

The paper presents the possible gains to Russian producers from opening the market to GM seeds, in particular HT corn and soybean seeds. The term "producer" in this context does not refer to only farmers. Farmers share total producer welfare with other players in the inputs market. Lifting the GM ban will lead to a multiplier effect that touches all related industries.

Allowing GM technologies will not only affect producers who choose to plant GM seeds, but conventional growers as well. Seed companies will have to decrease the price of conventional seeds to compete with the new product. The same direction of price policy will adhere to retail companies who sell herbicide products for treatment of conventional varieties.

This paper examined the direct monetary effects only. However, GM crops lead to other benefits as well: the reduced tillage with HT crops leads to less machinery costs and release of machines for other operations; reduction in the amount of crop protection (or change to a less dangerous class of chemicals), which leads to environmental and health benefits. In addition, an increase of soybean production will lead to higher self-sufficient levels for this crop, which is a very important issue for Russian politicians.

Lifting the GM ban in Russia may lead to a considerable increase in the welfare of producers. Only taking into account these two GM crops: corn and soy (assuming a 50% adoption rate and income benefits of $30 and $50 for corn and soy, respectively) results in income benefits equal to the current government subsidies for purchasing elite seeds (MCX, 2015).

The author does not intend to declare unambiguously that lifting the ban on GM products only yields benefits. Introduction of GM products will require developing and applying an identification and labeling system for GM and non-GM products, which can outweigh potential benefits. Environmental and health issues, as well as possible changes in the influence and market shares of multinational seed companies, should also be considered carefully. A comprehensive analysis of all pros and cons should be done as soon as possible so that Russia does not lose out on the potential welfare gains that are partly discussed in this paper.

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Serbian Large Agribusiness Corporations Knocking at the Door of E-Agribusiness Revolution

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Abstract

Transformation of large agribusiness corporations in Serbia is at its beginning. Institutional investors are taking control of these firms through foreign direct investments. Corporate reorganization of agribusinesses starts up by introducing efficient management, information technology, Net and e-commerce. IT environment generates a new business model, which creates connections in Serbia between the large agribusinesses, business processes and IT. The market of agricultural production in Serbia is rapidly changing and adapting itself to the global trends, mainly to the Internet economy. The speed of transactions and volume of information is increasing dramatically. It is important to explain the basic economic principles at macro and micro levels. Such revolutionary changes affect the operations and management of agribusiness on the Internet and outside of it. The purpose of this work is to stimulate further research in these processes, and to use the acquired knowledge as a tool for efficient corporate agribusiness management.

Keywords

Serbia, e-agribusiness, information technology.

Ljutić, B. Ž., Đurđević, D., Đorđević, Z. and Damnjanović, A. (2016) "Serbian Large Agribusiness Corporations Knocking at the Door of E-Agribusiness Revolution", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 2, pp. 57-65. ISSN 1804-1930, DOI: 10.7160/aol.2016.080205.

Introduction

The main reason for realization of the research is the emergence of the e-commerce in Serbian large agribusiness corporation. The use and perceptions of the development of the Internet and e-commerce in Serbian agribusiness corporations is evident in the media, it has not been tackled as an important scientific research area. We have conducted a questionnaire survey by contacting few large agribusiness corporations, survey of the available data at websites at the public domain. Basic aim of ours research was to start-up research in this area, and to stimulate other researchers, also to review the pertinent literature dominantly from the most developed agribusiness systems and markets, since this area is not covered in the published papers in Serbia not only in the agribusiness but also in the others sectors of the national economy.

Ownership transformation and introduction of new management methods within the big industrial farms, that later became the largest leading agribusiness corporations was a slow process. Socialist farms, cooperatives and agribusiness combined farms were important, while small private farms were dominant, but at the same time not so efficient model of food production in the late 1980s in Yugoslavia, and later on in Serbia. First discussions and paper publications were influenced by the foundation monograph in financial planning in agribusiness, as the key to better and more efficient money management (Schneeberger and Osburn, 1977), as well as by recent analysis of bank finances for agribusiness in open market economy (Joshi and Prasad, 2012). The capital requirements of farms, ranches, small and medium agribusiness required specially prepared management, later on established as farm agribusiness management. More elaborate and comprehensive systems approach to modern agricultural management was the reflection of structured and well balanced

approach to a trend of larger commercial farms in the USA. This dramatic shift has introduced a requirement for capable, educated operators and farm managers, decision-making skills, based on the corporate financial management principles and doctrine. Initial surveys of e-commerce practices, done by large number of researches, at the beginning were narrowly focused on the industrial and commercial businesses, in order to determine the level of participation in e-commerce and benefits of those activities. One of the pioneering studies on the role of Internet and e-commerce early adoption by agricultural input firms showed that agribusiness companies in the USA were using e-commerce more with their suppliers than with their customers, envisaging that the e-commerce capabilities in agribusiness industry will remain highly diverse in future, as this really happened at the end of the first decade of the 21st century (Henderson, Dooley and Akridge, 2004).

New agribusiness management tools and principles were established to solve complex large-farm operational and strategic development goals and problems (Schneeberger and Osburn, 1983), as a foundation for strategic agribusiness management planning for food chains, centred around gigantic agribusiness corporations (Fava Neves, 2007). Efficient methodological approach to the creation and publication of so called "integrated or unified" reports which include the aspects of environmental, social responsibility, as well as corporate governance reporting of the large agribusiness corporations, adequate to the circumstances in Serbia, as a specific road map, are set as an acceptable proposal. Logical and consequential progress to foundation of the basic principles of agribusiness management was created a few years later as the definition of the agribusiness system at the national level in the USA, as well as of the role of agribusiness manager and corporate planning function, while the focus on applied food economics, at the beginning of the 21st century, intertwined with the agribusiness management and agricultural economics (Beirleing, Schneeberger and Osburn, 1983, 2013), with significant advances in the field of organizational economics in agribusiness (Cook and Barry, 2004). This methodological approach, based on the establishment of the new research and professional field in agro economics we may call "Bible", since it is more than the globally spread standard in high quality textbooks and leading research articles in the USA and all around the world. Colleges, universities, faculties, associations of farm producers and ranchers are using this approach more than any other, according to the number of the footnotes quoted. Bierlein, Schneeberger and Osburn embedded the development of marketing plan and consumer demand within the corporate planning function, forecasting the role of budgeting function. Within the organization they stressed importance of the organized agribusiness for success, especially cooperative large agribusiness farms, which are similar to modern agribusiness corporations in Serbia. The controlling function stresses the element of organized production, based on the sound economic principles, cost management control, financial statement analysis, accounting information systems, capital budgeting. The e-commerce has the strongest, everlasting and increasing impact on the corporate function of the agro-food marketing, generated almost a decade ago as a marketing tool, with an emphasis on agro and organic food, now adopted by the large corporate leaders (Baourakis, Kourgiantakis and Migdalas 2002). Next and promising step is a very fast development of e-commerce personalization, a process easily available to many online vendors. Large agribusiness corporations could be the leaders of this process (Kaptein and Parvinen, 2015).

The corporate directing function is based on the sound supervision mechanisms, staffing the organization with adequate human resources, while the concluding part of this approach has been narrowly focused on the use of IT for better management, and on evaluation of the operating agribusiness. Profound agricultural price and trade policy reforms in developing countries as a whole, and especially in transition economies like Serbian, require efficient agribusiness corporate sector in Serbia, embodied in large agroindustrial corporations (Anderson, Krueger, Schiff and Valdés, 2009). Contemporary development of information technology and commerce through the Internet has been widespread in the EU, and these trends are also reflected in Serbian agribusiness large corporations, mostly local branches of the EU counterparts (Strzebicki, 2014), since they increasingly use electronic commerce. Only a few domestic market leaders, like MK Komerc and PKB Corporation, use electronic commerce, since they form very significant food supply chains on the Serbian market. At Belgrade Stock Exchange only five companies are listed at the primary market as primary issuers (Ljutic, Jankovic and Vlasic, 2012). Out of these mentioned group only one is in the agribusiness sector, Sojaprotein, Becej, which has been covered in our direct survey, since that data on the e-agribusiness are not publicized

at the stock market web site (Belgrade Stock Market, 2016).

Agricultural markets in Serbia are under the direct influence of the neighbouring countries, mostly the EU members (e.g. Croatia, Slovenia, Austria, Hungary, Bulgaria, Romania, Greece, etc.) Information technology is playing a crucial, dynamic and strong role in business operations and strategy of agribusiness firms and farms in Serbia, regardless of their size, which proves that firms increasingly use e-commerce online tools and techniques (Manouselis, Konstantas, Palavitsinis, Costupoulou and Sideridis, 2009). Also, the necessity of reengineering and refactoring of business processes should be taken into account, with a clear goal to improve the operational efficiency and effectiveness of the e-commerce applications, taking into account the software life cycle, since the few corporate largest agribusiness leaders in Serbia are really making the first inroad steps into e-commerce, creating software solutions which are not best today, but could be improved in the next few years (Distante, Garrido, Camelier-Carvajal, Giandini and Rossi, 2014).

In Serbia this approach was accepted, additionally elaborated and in part adjusted to the local institutions, with a vision to influence reforms and changes in the farming and primary agriculture, taking into account present dilemma on the pace of the reform strategy (Schneeberger, Osborn and Ljutić, 1995). Serbia could learn a lot from the China's gradualist approach to reform strategy, while the speed of transition process in Serbian farming sector was much faster compared to China's, and the state farming sector has been melted down and totally privatized, mostly by the foreign institutional investors and large domestic ones (Benzinger, 1998). New possibilities are opened for the credit capacity of local banks, for the role of specialized financial institutions in agriculture production, model of financial management in corporate agribusiness, for definition of managerial goals, short term bank loans, working capital management and working capital loans in agriculture. This approach has established the role of micro finance function at the level of SME, large industrial farms and corporate agribusinesses, mainly in the food processing and marketing. The systems approach to farm production, as well as to SME and large agribusiness established firmly the theoretical approach and practical models of modern agribusiness management in Serbia, based on the pioneering works of Schneeberger and Osburn, from the early 1960s in the USA, just as corporate agribusiness planning as a way of feasibility assessment and project enterprise financing are also based on their works (Ljutić, Schneeberger and Osburn, 2003), (Fante, Giovannucci and Hanway, 2007). The authors have further developed the framework embracing the role of internal and external audit, marginal analysis, costs of farm ownership, of management control problems and early warning diagnostics, while at the same time complex approach to business planning has been covered. The aspects of agribusiness marketing management, investment analysis and decision making process have been also included, but still with a strong focus on micro-finance and agricultural banking. The concluding research in these series of monographs has been refocused on the area of agriculture finance, based on the sound micro and macro concepts in finance, with an agricultural policy goal to restructure productive agriculture business performance through the improved financing model (Ljutić, Schneeberger and Osburn, 2006), while re-engineering of agriculture has been an initial step to improve performance of agribusinesses through financing (Mafinisebi, Oguntade, Mafinisebi O., 2010). The authors have defined the position and role of agriculture finance in the institutional environment, comparatively in the USA and Serbia, as well as the significant aspects of the financial stress in agriculture, present even now in 2015/16, almost ten years later, but now as a fully-fledged and deepening financial crisis. The principles of agriculture finance are based on the doctrine of agribusiness management at farms and in corporations, on vital financial management function, business monitoring at the farm level, on the foundation of the contemporary enterprise resource planning (ERP) in agribusiness which incorporates the e-commerce and e-agribusiness as well. Micro financial planning is a base for documented corporate decision making, for improved business organization and resource management, for the use of capital and credit planning. Corporate finance function in the agribusiness firm is stressing the role of external equity, and also the management check-up list for the large agro industrial projects in construction and exploitation. Financial markets, intermediaries and institutions which are serving production agriculture and agribusiness in Serbia even today present a strategic map and creative vision for the much needed reforms and unavoidable necessity to create an adequate infrastructure. As Serbian agriproduct markets are integrating into the EU and global market structures transaction costs do increase, e.g. legal and negotiating costs, which is something that large agribusiness

corporations must control and manage effectively in order to reduce drastically their total business costs (Fomina and Fomin 2011).

From E-commerce to E-agribusiness

Electronic commerce (E-commerce, E-business) came like a surfing wave, with the Internet revolution and economy, but after the initial expansion most of the bubble Internet firms disappeared while the E-commerce stayed as the proven approach and concept of electronic applications. Commercial ties between the individual participants and corporate firms are made on the new form of the market, so called "virtual or internet market". E-commerce model should be also based on the business process management in agribusiness, and on the application of the business continuity standards, taking into account the dominant role of the information and computer technology in the corporate performance.

Leading global agribusinesses, even regional and local market leaders are fast adopting innovative internet strategies, causing long-lasting strategic changes in the supply-chain networks, changes that we are not fully aware of at this moment (Henderson, Dooley, Akridge and Carere, 2005). Analysis of introduction and application of the management information system (MIS) or so called "business informatics" in agribusiness enterprises in the Czech Republic revealed the facts that SMEs farm owners dominantly apply information systems technology as a technological approach and solution, using accounting centred information systems, software for primary agriculture and cattle breeding, and the same trend is probably acceptable for the large agribusinesses in Serbia.

The revolutionary breakthrough has many advantages over the classic business market model, like:

- Access to large, and very often to a global market
- Business costs reduction;
- Easy accessibility to all resources and information.

For the large agribusiness corporations in Serbia the physical frontiers, customs and duties, visible and invisible barriers, shall be very soon almost non-existing, since all the hidden monopolies and production control shall be transferred from the state owned enterprises onto private international agribusiness corporations, which naturally and traditionally do not care about the limitations, borders and restrictions. For e-commerce oriented large agribusinesses in Serbia mobile data technologies are "sine qua non", but not on the open base, since the European project called "Farm-Oriented Open Data in Europe" (FOODIE) shall be implemented in the EU in the period 2014-17, addressing the open data security issues, with a goal to improve the efficiency of transportation in primary agriculture, the path Serbia could replicate, based on the EU countries experience and know-how. E-agribusiness does not require employment of additional human resources, and hire of office premises, while operating around the clock. E-agribusiness means the implementation of the E-business concept and it is a model for Agribusiness Corporation functioning, but our personal opinion is that only medium sized agribusiness firms could apply it. Our preliminary research shows that in Serbia there is not any empirical analysis of the success determinants regarding food and agribusiness e-commerce firms, but the model developed by the group of authors (Montealegre, Thompson and Eales, 2007) could be easily and almost without any adaptation applied in Serbia, as the supply chains are not consistently applying the e-commerce approach. For example, the PKB Corporation, from Belgrade, is using that approach to transform important farming and ranching business processes, with the ever increasing application of the Internet technologies and computer networks. PKB Corporation has developed a strong conceptual dynamic model of E-agribusiness based on:

- E-business strategy, as a part of strategic and operational business planning process;
- Operational application of the E-agribusiness in everyday business transactions and decision making process.

PKB Corporation has envisaged the business strategy as well as E-agribusiness, as the processes which join all the business functions and operations, with the ultimate goal to satisfy the clients' needs fully, while achieving the long term strategic goal of the increase of the corporation value. Elements of E-agribusiness strategy include the E-philosophy concept, E-marketing, business strategy and planning, IT and communication infrastructure, while the farm production includes E-farming production, E-technology, E-distribution, E-security (physical and IT infrastructure). While waiting for the new owner the PKB Corporation is considering to introduce business intelligence, customer relationship management (most of the elements are operational nowadays

but the process is not completed), ERP (significant parts of the ERP systems are implemented, like the accounting, corporate finance, human resources, business information, e-mail and data exchange, etc., but the system needs a full integration and some minor, necessary elements). Great potential is hidden into the open data and open formats, but our latest research is pointing out that further research studies are necessary (Vostrovsky, Tyrychtr and Ulman, 2015).

The intrinsic meaning of the term agribusiness incorporates large-scale corporate farms with industrial background, vertically integrated food production, e.g. corporate farming on a large scale as a contrast to smaller family farms. The core of the agribusiness is integrative in itself (e.g. collective business activities focused on the food production and the final consumption), incorporating the concept of agricultural production and final distribution to consumers. E-commerce is the natural embodiment of this concept and efficient environment for generation of new employment and income.

Materials and methods

In this research we have applied the standard multi-question, multi-criteria survey, covering ten agribusiness corporations in Serbia, while two of them are the corporate groups based on the Law of Accountancy and Auditing in Serbia and Standard Statistical Classification, EU Stat Standards. These two corporate groups are Victoria Group with ten companies within the Group, and MK Group consisted of seventeen independent companies. The survey covered thirty companies, and some individual companies within the two corporate groups are included separately taking into account the specifics of their operation closely related to agribusiness, the websites for the agribusiness groups, group member companies with dominant agribusiness operations, and other large corporations in the agribusiness sector of Serbia.

Results and discussion

Our research shows that the studies of managerial structure and E-agribusiness in Serbia do not exist. Large agribusiness firms are not present as publicly traded firms on the A-list of the Belgrade Stock Exchange, so all the privatization from now on shall probably take a form of direct buy-out or acquisitions. Our preliminary study was focused on the two leading corporations, one still state owned, PKB Corporation and the other is MK Group, Novi Sad, Serbia. We have taken into account the impact of the global and the national financial crisis, while aspiring to emphasize the impact of still invisible but strong E-agribusiness phenomena in corporate sector in Serbia.

All the websites as a feature found at the agribusiness company website provide background information about the group and/or company, as well as industrial standard technical information about the products sold. Half of the agribusiness corporations in the sample provide link to other data and information sources at home or abroad. Only 10 % of agribusiness corporations provide a dealer directory with information where the products are sold, and there is a large room for improvement of the web page features in this area. Password protected areas which are only accessible to registered users are utilized by the 40 %, and we could expect increase of usage along the parallel development in the whole IT sector of Serbia in using this IT solution. The provision of pricing information at the websites about the products sold is only 30 %, that is signalling that the dissemination of price information is still in its starting phase. It is surprising, despite our and the general expectation that the online communities and social networks like chat rooms, bulletin boards, and other forms of online communication are not present at all with 0 % at the sample. The online ordering with the using of traditional means of payment are present at the 30 % of the firms, but the other 30 % of the firms allow online ordering and payment, and two indicators should be observed in parallel, as a sing of significant improvement and the orientation of the large agribusiness in Serbia to make a significant step towards a full transformation to online ordering and payment.

When we are talking about the perceptions of the agribusiness firm managers about the Internet and e-commerce in our survey conducted May 25-30th, 2016, 30 % percent of managers thinks that the e-commerce will fundamentally change the way they do business, which is an indicator that the whole top management structure did not accept the idea and goal at full. Even less they are convinced that the emergence of e-commerce shall greatly reduce the role of local dealers in their industry in the next three years, only 10 % of them, but this low estimate should be considered as a clear warning that the whole process is taking a slow pace. It is evident that only 20 % of managers have perception

Web Page Features for Firms with a Website, 2016 Survey	Percent of Firms (N=30)*
Feature Found on Company Web Page	
Provided background information about the company	100 %
Provided technical information about products sold	100 %
Provided links to other data/information sources	50 %
Provided a dealer directory (information where products are sold)	10 %
Included password protected areas, only accessible to registered members	40 %
Included areas with content customized to different audiences or individuals	60 %
Provided pricing information about products sold	30 %
Included online communities (e.g., chat rooms, bulletin boards, etc.)	0 %
Allowed for online ordering, but using traditional means of payment	30 %
Allowed for online ordering and payment	30 %
Perceptions of Agribusiness Firm Managers About the Internet and e-Commerce, 2016 Surveys	
Description	
Perceptions about e-Commerce:	
E-commerce will fundamentally change the way we do business in our industry in the next three years	30 %
The emergence of e-commerce will greatly reduce the role for local dealers in our industry in the next three years	10 %
E-commerce will improve my company's ability to manage inventory levels in the next three years	20 %
Perceptions about the Internet:	
Information about increasingly complex products is difficult to provide over the Internet.	50 %
Farmers are unwilling to buy products on the Internet	100 %
Personal relationships with customers are difficult to develop over the Internet	50 %
Distribution (logistics) issues will limit sale of my industry's products over the Internet	30 %
The Internet allows our company to expand into additional markets	100 %
The Internet is useful for education and training	100 %
The Internet is a critical tool for research in my business	50 %
Characteristics of Survey Respondents, 2016.	
Type of Firm:	
Crop	90 %
Livestock	50 %
Crop and Livestock	40 %
Other: Lending, Consulting, Marketing	40 %
Channel Position of the Firm:	
Manufacturer	70 %
Distributor	90 %
Dealer	60 %
Multi-channel Position	0 %
Other: Financial and Consulting	40 %
Ownership Structure of the Firm:	
A Cooperative	0 %
Privately Owned	80 %
Publicly Held	20 %
Other	0 %
Scope of the Operating Unit's Distribution of Products/Services:	
Local	100 %
State-wide	100 %
Regional	80 %
International	70 %
Total Gross Annual Sales of Your Company:	
Less than $10 million	10 %
$10 million to $49 million	20 %
$50 million to $99 million	20 %
$100 million to $499 million	50 %

*Notes: Victoria group a.d. - www.victoriagroup.rs, No of members: 10; MK Group, www.mkgroup.rs, No of members: 17; Delhaize Serbia d.o.o. - www.maxi.rs, No of members: 1; Meat Industry Carnex - www.carnex.rs, No of members: 1; Žito-Bačka d.o.o - www.zitobacka.com, No of members: 1; Sojaprotein - www.sojaprotein.rs, No of members: 1; IDEA d.d. - www.idea.rs, No of members: 1; Sunoko d.o.o. - www.sunoko.rs, No of members: 1; PTP DIS DOO - www.dis.rs, No of members: 1; Veterinarski zavod Subotica - www.vetzavod.com, No of members: 1.
Source: own processing

Table 1: Features Found on Company Web Page, 2016 Surveys.

that the e-commerce will improve the corporate capacity to effectively manage inventory levels in the next three years. Perceptions about the Internet use are generally better, with 50 % of respondents considering that the information about increasingly complex products is difficult to provide over the Internet, and rightly that the Serbian farmers are unwilling to buy products on the Internet, something 100 % of the surveyed managers have agreed upon. Half of the managers have a perception that the personal relationship with customers are difficult to develop over the Internet, while even only 30 % are convinced that the distribution and logistics related issues will limit the sale of their products over the Internet. It is very high perception, in both cases with 100% percent of participants are expecting that the Internet will allow their company to expand to additional markets and at the same time that the Internet is useful for education and training, while only 50 % of managers treat the Internet as a critical tool for research in business.

Firms characteristics of the 2016 sample survey respondents is crop 90 %, livestock 50 %, crop and livestock 40 % and other (e.g. lending, consulting, marketing) is also 40 %. Channel position of the firms is manufacturing 70 %, distributor 90 %, dealer 60 %, multi-channel 0 %, and other (financial and consulting) 40 %. Ownership structure is cooperatives 0 %, privately owned companies 80 %, publicly held 20 %, and other 0 %. Scope of operating unit's distribution of products/services is local 100 %, state-wide in Serbia 100 %, regional 80 % and international 70 %. Gross annuals sale of total company sales are less than $10 million 10 %, from $10 to $49 million 20 %, from $50 to $99 million 20 %, and from $100 million to $499 million 50 %, based on the official date of the Serbian Business Entity Register – Companies, Data Search (SBRA, 2016).

We have compared our study with the results of the e-business in Croatian agribusiness sector (Tomic, Cerjak and Hadelan, 2012). The authors studied representation of the e-business among Croatian agribusiness sector as a whole, not narrowly focusing as our study only on large agribusiness corporations as market leaders and promoters of change and progress. The study sample included 142 business entities, engaged in agricultural, farming and agribusiness activities, dominantly in primary agriculture (110). The majority of the sample had less than 15 employees (51,4 %), while at the other extreme were 4,2 % with more than 500 employees. Agribusinesses with Total Gross Annual Sales over 5.000.000 Croatian Kunas (e.g. 700.00 Euros at prevailing exchange rate at the time of survey). General conclusion of this survey that the firms use Internet banking (85,7 %), to communicate with suppliers and clients (74,6 %), while 56,5 % are using Internet as a marketing research tool and 48,5 % for the purchase of input materials. The results of this research provide directions for further research of the development of the e-business in large agribusiness corporations in Serbia and impact on the whole agricultural sector.

Conclusion

The leading agribusiness corporations are consciously (MK Group) or unconsciously (PKB Corporation) applying and introducing the elements of E-agribusiness which, in turn, in the long term, improve the performances of agribusiness firms, based on their business model and forecasting expectations. The top management teams are still not engaged in monitoring the positive and negative effects of the E-commerce development on the business performance. Top management strategies related to the development and expansion of the E-agribusiness for the large corporations (PKB, MK) understand an inevitable step forward towards increased profits. For example, the MK ZAGA is an E-agribusiness model, based on the ERP approach, which enables the farm production to become a profitable, highly organized business, but it is still in its initial developmental phase. Based on the initial feedback information from respondents from agribusiness firms and their top managers we expect that initial results of this research shall steer up further discussion and research in this field.

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Agricultural Production and Trade Structure Profile in Democratic Republic of Congo (DRC)

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Abstract

The African region represents the weak point of the world economy. Many African countries have still not finished the process of transforming their economy. Agriculture represents only a minor portion of their economies' performance – however it is still a key sector of the economy (especially considering the number of people working in agriculture or people representing the agricultural population). The agricultural sector in many sub-Saharan countries is extremely sensitive and its stability affects the stability of the whole region. A very good example representing sub-Saharan Africa is the Democratic Republic of Congo (DRC). It is a country with a lot of potential, but it is classified among the poorest countries in the world. Its economy is extremely weak (despite its significant share in total GDP formation value), and underdeveloped. The share of agriculture in total GDP formation is over 42.5%. The number of people living in rural areas represents over 45 million out of a total of 75 million. The number of people working in agriculture is over 60% of the total economically active population. The economy of the country is extremely poor and fragile, mainly because of political instability. The aim of this paper is firstly to specify the position of agriculture in the DRC economy, and also to specify the production and trade commodity structure in relation to other African countries. The paper's ambition is to identify the most perspective commodities (groups of commodities), both for production and also for trade, and to recommend such a production and trade profile which would allow the DRC the possibility of improving its competitiveness - not only in relation to other African countries, but also in relation to the global market. The production and trade commodity structures are analysed through the application of the BCG method and competitiveness analysis. In relation to these objectives, the paper provides the following conclusions. The position of agriculture in the DRC economy is stable one. Furthermore, agriculture probably represents the most stable part of the DRC economy. According to the portfolio and competitiveness analyses, the most important commodity items for the DRC are the following: Rice paddy, Maize, and Cassava. The most competitive trade items are particularly Coffee, Tea, and Cocoa, and Sugar Raw centrifugal. The most notable weakness of DRC agriculture is the production of Wheat, Beverages, Poultry Meat, and Fixed Vegetable Oils.

Keywords

WDRC, Africa, agriculture, production, trade, competitiveness, structure, comparison, value, development, trend, modified BCG matrix.

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Introduction

Africa is a continent which consists of 54 states including some island states belonging to Africa (UN, 2011). The African population currently exceeds cc 1.2 billion inhabitants representing over 15% of the world's population. Population growth in the Africa region is (regarding the time series) a very dynamic indicator (Jeníček, 2011). Compared to other world regions, the African population is fast growing (Jeníček, 2010). From 1961 till 2015, it has grown from about 293 million to the current cc 1.2 billion. That means, an annual growth achieved cc 2.6 % in average; this represents an increase of 15 million a year (on average). A peak of the population growth was achieved in the 1970s and 80s, when the annual growth exceeded 2.8 % (maximum 2.85 % in 1982). In absolute terms, however, the peak of the population growth has come in the current

decade, despite the decline in incremental growth (Jeníček, 2010). An annual increase of population by 2.1 % in years 2014/2015 has turned into a decline in the relative growth rate; nevertheless an absolute increment has reached its historical highest value, represented by 24 million people. Such development far exceeds the population development in other continents. Another African specific is economic development (Ajakaiye and Ncube, 2010). Regardless of the amount of mineral resources and strong population basis, Africa is the poorest region (continent) of the global economy (Ahmed and Suardi, 2009). The total GDP value has been standing at a very low level in the long-term; expressed on per capita basis, the figures are remaining far below the world average. (Fosu, 2001). Currently, the value of African GDP reaches about USD 2.45 trillion which is a long way from results achieved in other regions (the value of world GDP has achieved USD 78 trillion in 2015). Taking into account the above mentioned share of Africa in the world population, and in the value of global product (about 3.1 %), essential abnormalities of economic development will appear. It should also be stressed that backwardness concerns not only the total GDP, but also GDP expressed on a per capita basis. While the average annual world GDP per capita reaches over USD 10 thousand, in the case of Africa, the value stands at around USD 2000. In this respect, it should be stressed that there are significant differences among African countries in terms of average levels of GDP per capita. While Equatorial Guinea has reached the GDP per capita of USD 18,389 in 2014, Democratic Republic Congo, in contrary, only USD 437 in the same year. Taking into account the more than 50 countries of African continent, only four of them exceed the average world GDP per capita. More than forty countries do not touch the level of USD 5,000 per capita, whilst 21 even reach the level of USD 1,000 (World Bank, 2016).

From an economic, cultural, social, as well as demographic perspective, Africa is far from being a homogenous continent (Fosu, 2003). Neither is the distribution of the GDP and population spread evenly. The African continent can be thus divided into several parts. From an economic point of view, it is reasonable to divide it into two main parts: North Africa and sub-Saharan Africa. North Africa, which consists of countries adjacent to the Mediterranean Sea, has undergone a different evolution. It has had historical ties mainly to Europe unlike the other African regions; its structure of population and related cultural, social, and other aspects varies significantly (Kuna, 2010). The population of North Africa is dominated by Arabs, whereas sub-Saharan Africa by the black population. About 200 million people live in North Africa, which is about one fifth of the total African population; over 900 million people are estimated to live in sub-Sahara.

A significant difference between the two parts of Africa lies in their economic performance. While the countries of North Africa generate about one third of the total African GDP (approximately USD 800 billion), the remaining two thirds (about USD 1.6 trillion) have their origin in the sub-Saharan region. There are also noticeable differences in the average GDP per capita between both regions (Akokpari, 2001).

The sub-Saharan Region is also characterised by the highest percentage of the population living below the poverty line. Currently, about 40 % of the sub-Saharan population lives on less than USD 1.25 per day (World Bank, 2016). This is reflected in a high rate of malnutrition (Wodon and Zaman, 2010). Almost 200 million inhabitants of the region were confronted with malnutrition in the years 2009–2010. It should be underlined that the problem of malnutrition is a long-term problem of Africa (Kuna, 2010; FAO, 2010).

A very specific problem of Africa is its' economy structure (Jeníček, 2011). Africa is still heavily dependent on its agricultural sector performance. However within the world economy, GDP structure has almost finished the transformation process (over 70% is generated by services, cc 20% is represented by industry and less than 5% is represented by agriculture), in Africa – especially in its Sub-Saharan part the share of agriculture in total GDP formation is between 15 – 20%. Even more, there are countries where the share of agriculture in total GDP formation is even higher than 30%, and agriculture provides job opportunities for over 50% of population (Hopkins, 2014).

A very specific case in Africa is represented by the largest Sub-Saharan country and the fourth most populous African country – the Democratic Republic of Congo. DRC is a very specific country especially because of its population growth, increasing demand for food, very limited economy performance, and low level of society and political stability. We decided to choose this country as a very good object to analyse the extremes of African agriculture.

The Democratic Republic of Congo (DRC) is

a country located in the centre of the African continent. The total area of the country is about 2,344,840 km^2 (Global EDGE, 2014). The total agricultural area is about 260,000 km^2. The agricultural area is very limited in comparison to the total country size, and the size of arable land is even lower: only about 70,000 km^2. For historical reasons, the economy of DRC is extremely underdeveloped, and its performance is extremely low. Since its independence in 1960, the DRC went through numerous political and economic crises affecting its growth in general, particularly its economy and its agricultural production. These political issues caused many armed conflicts that mostly ended up with different sorts of wars (Ministry of Agriculture of DRC, 2012).

The structure of DRC's economy is dominated by primary sector performance. Agriculture is keeping a really dominant role. The share of agriculture in total GDP is estimated to be about 30-40%. However, the share of agriculture in total GDP formation is very high, and agricultural production growth is very limited despite the significant population growth. In the period from 1960 to 2015, the DRC recorded population growth from about 15 million people to more than 77 million. The current inter-annual population growth is about three times higher in comparison to the country's real agricultural production growth, and two times higher in comparison to the country's total real GDP growth (The World Bank, 2016). The DRC is in a very complicated situation, as its process of economy transformation is still not finished. According to the most pessimistic material, published by USAID in 2015, agriculture accounts for 42.5 percent of the DRC's gross domestic product, employs 62 percent of its men and 84 percent of its women, and is the country's most promising foundation for establishing food security and sustainable, equitable economic development. For the last four years, the DRC has been ranked first on the Global Hunger Index, while agricultural production has fallen by 40 percent since 1990. The average daily food consumption is estimated at less than 1,500 kilocalories per person, below the minimum of 1,800 per person required to maintain good health (USAID, 2015). However, the data provided by other institutions (e.g. FAO, WB or IMF) are not so pessimistic – though it is still true that the DRC is heavily dependent on the performance of the agricultural sector. The prosperity of the agricultural sector must be understood to be a key determinant in reducing poverty and stabilizing society. Agriculture is also the most stable sector of the DRC economy. It was "somehow" able to survive the period of civil wars and while the other economy sectors collapsed – agriculture is still working – but its effectivity is very limited.

There is no easy way for the DRC to solve its economy problems. The only way is to reduce its dependency on agriculture and to increase its agricultural sector performance and effectiveness. The next step is to encourage the growth of industry and the service sectors (Jeníček, 2010).

According to USAID, the only way to stabilise the DRC is to reduce poverty, to increase agricultural productivity, to improve market stability, and to encourage environmental sustainability. USAID proposed an integrated approach to stabilise the situation. The idea of this approach is to change the current agricultural production structure, to increase the productivity of the agricultural sector, and to reduce the number of farms operating in the DRC (USAID, 2015).

Agriculture as a key economy sector is a part of the huge development agenda introduced by the DRC government in recent years. That agenda is based on the following action plan.

For the period 2013 – 2020 the following five priorities areas were identified and programmes developed (DRC, NAIP, 2014):

Programme 1: Promote sustainable agricultural sectors, first and foremost food value chains, and develop agribusiness in order to improve the income of farmers and other operators in the sector;

Programme 2: Improve the management within the food and nutrition security and strategic reserves;

Programme 3: Develop and disseminate research products to users and improve the professional competence of the various actors;

Programme 4: Improving agricultural governance, promoting the integration of gender in the implementation of the Plan and the overall strengthening of sector-related human and institutional capacities;

Programme 5: Reduce vulnerability in the agriculture sector to climate change.

The strategic approach for the implementation of the NAIP is based on a number of principles for action (DRC, NAIP, 2014):

1) The inclusion and accountability of all public and private stakeholders involved in agricultural and rural development;

2) Valuation of the comparative advantages of each province through the implementation of Provincial Agricultural Investment Plans whose development will be the responsibility of provincial authorities;
3) The establishment of Centres of Agricultural Enterprise (PEA) in order to boost the different sectors;
4) Mainstreaming gender aspects and good governance across all of the planned interventions;
5) Promoting and facilitating capacity building among all public and private stakeholders to enable them to perform their respective roles more effectively and efficiently; and
6) Focusing on the enhancement of agricultural productivity in a sustainable manner that also respects relevant environmental and social constraints.

To summarise the above mentioned text it is necessary to highlight the following: Agriculture is one of the most important drivers affecting the current economy development in the DRC. The share of services and industry in national economy formation is much lower that is typical for the other Sub-Saharan countries. Agriculture in the DRC must be understood as being a pillar of economy and society. Agriculture is considered to be the only safe pillar in their lives. However, agriculture in the DRC is very important, it is underdeveloped, and the living standards of people working in agriculture and their families is very limited. Their production performance is very low and their labour effectiveness is extremely low. The DRC suffers not only because of its limited agricultural production and agricultural sector's performance and productivity. It is also suffering because of its limited ability to compete with other countries both within the region and also outside. Agricultural production in the DRC is not as heterogeneous as is typical for other African countries. The DRC is heavily dependent on global agricultural price fluctuations, weather conditions and especially its' constantly increasing population. Population must be understood not only as a source of demand, it must be also understood as a source of many problems – thinking here about the structure and size of individual agricultural companies/farms. Despite the fact that in the past the DRC was considered as being a net exporter of agrarian products, nowadays the situation has changed. The DRC has lost its position of being a net exporting country, and it is now heavily dependent on imports. The DRC is losing not only its ability to produce enough food and to satisfy local demand, it is also losing its competitiveness. Competitiveness is disappearing not only at the level of inter-regional trade, it is also disappearing at the level of inter-regional trade. The situation is becoming more and more complicated, and the government is not able to solve the situation. The results is the crisis in the DRC economy and society. The proposed paper is focused on DRC agriculture. The main idea is to identify its structure (at the level of production and trade performance), and also to identify the main changes affecting its development (Maitah et al., 2014; Toth et al., 2014; Mikhalkina et al., 2015).

The aim of this paper is firstly to specify the position of agriculture in the DRC economy, and also to specify the production and trade commodity structure in relation to other African countries. The paper's ambition is to identify the most perspective commodities (groups of commodities) both for production and also for trade, and to recommend such a production and trade profile which would provide the DRC with the possibility to improve its competitiveness not only in relation to other African countries, but also in relation to the global market. The production and trade commodity structures are analysed through the application of the BCG method and competitiveness analysis.

Materials and methods

The paper is based on secondary data provided by UN Comtrade, FAOSTAT, World Bank and IMF. The analysed time period is from 2004 to 2012 (this time period was chosen because of data availability – 2012 is the last year providing stable agricultural data in the case of all above mentioned databases). The paper is based on the application of standard statistical approaches and other methods (basic index, chain-index etc.). The paper is part of long term research published by one of the authors (Smutka). The paper is based on facts and findings already published in Smutka, Tomšík, (2011); Maitah and Urbankova, 2015; Maitah and Smutka, (2012); Tomšík and Smutka (2013); Smutka and Tomšík (2014). The agricultural sector performance is analysed through the gross agricultural production, and the agricultural sector's added value (as a part of GDP formation (Fuchs, 2013)).

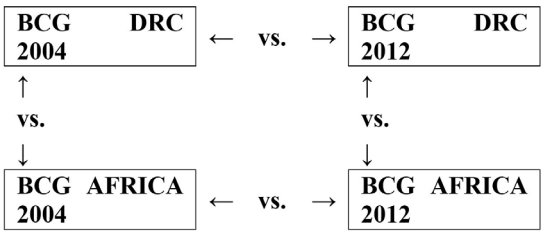
This paper is focused especially on the study of the production and trade portfolio of the country compared to the production and trade situation of Africa as a region. However, before doing

a modified BCG matrix (Smutka, 2011) analysis, the paper compares data for the year 2004 and 2012 of both the studied regions and identifies the 10 most important items (for commodity structure analyses, the standard FAO methodology is applied – for details see FAOSTAT) with regard to production, import and export. This identification is very important as it provides the data for the modified BCG matrix creation, and also for competitiveness analyses

The paper has analyses the full range of DRC agrarian production and import and export structure. The data are in 1000 I$ (constant 2011, prices - for international dollar methodology see details provided by WB (2016)), and they can be found in the appendix of the paper. In relation to the above mentioned objectives, the paper identifies 10 the most important products or groups of products produced or traded in the DRC in 2004 and 2012, and the specified production structure is compared to the production structure development typical for the African region. The idea is to identify differences/similarities existing between the DRC and the rest of the African region.

Using the production, import and export data collected from the above analysis, a modified BCG matrix is done to determine which products should be abandoned as they are unproductive (miserable dogs), which ones request more funding as they show a big income potential (stars), which ones request less funding and income collection due to maturity (dairy cows), which ones are in the starting mode where the DRC should pay more attention as they are not sure whether to grow or to die (question-marks).

The analysis of the BCG has been processed as in Figure 1:



Source: FAOSTAT, own processing, 2016

Figure 1: BCG analysis model DRC versus Africa (2004 and 2012).

The BCG matrix (Palia A et al. 2002) originates from the consultancy firm Boston Consulting Group. This is an important marketing tool which allows users to concentrate their capabilities (finance, human resources, etc.) to develop only those products that are important and beneficial to them. More specifically, this matrix determines which products are in each of the following four categories:

- Question-marks: these are the products which are at the beginning of their life cycle. They can become promising products which are then converted into stars or they might not succeed and turn to miserable dogs. The BCG matrix user should be very careful while dealing with these products.
- Stars: these products have a market share which is considerable and they are growing quickly. They deserve more funding to return more revenue.
- Dairy cows: these products need less funding as they are in the mature stage. There is a need to collect maximum revenue from these products as they will not grow any more, though they still have a high market share. They will eventually turn into miserable dogs. The income collected can then be used to finance the stars and the question-marks if needed.
- Miserable dogs: these products have slow growth and low market share. They should be abandoned.

The modified BCG matrix is based on:

- Rate of growth (value of production, export value and import value)
- Relative share (the share in total agricultural production value, export value and import value)

The rate growth is calculated as the Geometric mean

$$\left(\prod_{i=1}^{n} a_i\right)^{1/n} = \sqrt[n]{a_1, a_2, \dots a_n} = \textbf{GEOMEAN}$$

The geometric mean is an average that is used to indicate the central tendency value of a set of numbers by using the product of their values. For this paper, the geometric mean will be used to define the average of the rate of market growth and of the relative market share.

The agricultural market in the DRC is an extremely concentrated one. To analyse production and trade commodity concentration we decided to apply the Herfindahl-Hirschman index (HHI) (Hirschman, 1964). This index is usually applied to analyse the level of market concentration at the level of individual companies sales as a part of total sales

realized within the market. We decided to apply that index to analyse the level of production and trade concentration/diversification. The HHI is calculated for production value, export value and also import value performance (in 1000 I$, 2011 constant prices).

HHI is used to measure the commodity concentration within the market. The index ranges from 0 (no concentration) to 10,000 (absolute level of concentration) (Hirschman, 1964). The index is calculated by squaring the value of individual commodities within the market (production, export, import) and adding the resulting numbers together:

HHI = s1^2 + s2^2 + s3^2 + ... + sn^2,

where s1 is the value of selected commodities production, export or import value and „n" represents the whole set of commodities. This article uses the HHI classification defined by the US Department of Justice. If the HHI is lower than 0.01 (or 100), the market concentration is low. HHI ranging from 0.01 and 0.15 (100 and 1,500 respectively) indicates that the market is not concentrated. The values of HHI from 0.15 to 0.25 (1,500 and 2,500 respectively) reveal significant level of concentration and HHI above 0.25 (2,500) indicates a highly concentrated market (when considering the level of production, export or import commodity structure concentration). If an HHI is close to 1 (10,000), it suggests a dominancy of only one commodity.

A part of this paper is also the competitiveness analysis based on an application of the Lafay index (LFI). The Lafay index (Lafay, 1992) has the ability to prove the existence of bilateral comparative advantages existing between one country (in our case the DRC) and its trade partner or partners. The LFI helps one to understand how the comparative advantages have developed over time and to compare its strengths for individual products and product groups in individual regions and countries.

For a given country *i*, and for any given product *j*, the Lafay index is defined as:

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

In this equation, x_j^i and m_j^i represent exports and imports of product *j* of country *i*, towards and from a particular region or the rest of the world, respectively, and *N* is the number of items. Positive values of the Lafay index indicate the existence of comparative advantages in a given item; the larger the value the higher the degree of specialization. (Zaghini, 2003).

Results and discussion

The agricultural sector of the DRC is changing its character very slowly. Its production structure is based especially on cheap low added-value commodities. The majority of domestic production is not even gained through the market, as it is consumed by the farmers. The extreme level of poverty does not provide any possibility to many people than to produce high volume commodities to feed themselves and their families. It is the reason why the production structure is so limited. Another reason is the effort of government to encourage the farming of cash crops. The main idea is to improve the farmers' income. However, too high a level of cash crops production is also negative for many reasons. The country is focused only on a few commodities. Those commodities are extremely specific and their price fluctuates widely. The result of cash crops farming is an even higher agricultural sector and market destabilization. The country is becoming more and more dependent on bulk commodities imports, and income from cash crops are not able to cover the constantly increasing imports.

Commercial agriculture in the country is relatively limited as most producers are small-scale farmers and subsistence food producers, because of the deterioration of the market infrastructure caused by war. The main agricultural products in terms of volume and value are: cassava, plantains, game meat, maize, groundnuts, rice, mangoes, and mangosteens. The main agricultural exports in terms of value are unmanufactured tobacco, green coffee, sugar raw centrifugal, wheat bran, and natural dry rubber. The main agricultural imports in terms of value are wheat, maize, wheat flour, palm oil and chicken meat (PNIA, 2014).

Agricultural production is changing rapidly in the DRC. Individual changes are affected by re-structuring the DRC economy. Only in the period 2004 – 2012 (last available verified data), the agriculture sector recorded the following changes affecting its production and also trade portfolio. In the analysed time period the value of agricultural production increased from cc 3.7 billion I$ up to cc 4.1 I$. The average inter-annual production growth rate recorded the value of 1.1%. The production profile

significantly changed. The changes are apparent especially if we compare the DRC production profile development to the African region production profile development.

While the African production profile is quite heterogeneous (see Table ANNEX 1), the DRC production profile is very limited (Table 1). About 80% of the production profile is represented by only a few commodities. About fifteen commodities represented in 2004 cc 80% of the production profile, whilst in 2012 the 80% of production profile was made up of about 20 commodities.

If we compare the African portfolio and the DRC production portfolio we can see that the DRC situation is extremely limited. Only three commodity items represent over 50% of total production performance. Such trade structure makes the DRC extremely vulnerable if any crises or price fluctuation were to appear. The limited production heterogeneity also makes the DRC extremely dependent on exports and imports. In comparison to other African countries the DRC commodity profile is extremely narrow. In 2004 46 production items represented 80% of African production value performance in the DRC, the same 80% was reached by only 16 items. Later in 2012 the situation became a little bit better, but still the DRC is a long way from the majority of African countries. About 80% of production profile is based on only 20 items, while the average for the whole African region is about 50 items.

Another significant problem affecting production performance is the limited production rate of the DRC in comparison to the rest of Africa. While in Africa the production growth is between 2% and 3% a year, in the DRC it is only cc 1% (while the human population growth rate is over 3%).

The main pillars of the DRC production volume, and value profile in particular, are the low added-value commodities such as cassava, plantains, game meat and groundnuts, maize and palm oil. Despite huge effort by local farmers, the government, and also external (foreign) partners, the DRC is not able to change its production profile and the situation is even worsening - especially

BCG production for DRC 2004			**BCG production for DRC 2012**		
Products	Value in 1000 I$	% of the total (3730021,91)	Products	Value in 1000 I$	% of the total (4338591,34)
Cassava	1561776	41.87%	Cassava	1671408	38.52%
Plantains	247626	6.64%	Plantains	278718	6.42%
Meat, game	191557	5.14%	Meat, game	250225	5.77%
Groundnuts, with shell	164148	4.40%	Maize	194789	4.49%
Maize	163627	4.39%	Groundnuts, with shell	167555	3.86%
Bananas	88282.9	2.37%	Oil, palm	128559	2.96%
Rice, paddy	87814.1	2.35%	Rice, paddy	97531	2.25%
Oil, palm	76135	2.04%	Bananas	90685.2	2.09%
Beans, dry	65756.5	1.76%	Beans, dry	75174.4	1.73%
Papayas	60754.1	1.63%	Papayas	65275.2	1.50%
Pineapples	55643.8	1.49%	Sugar cane	64032.2	1.48%
Sugar cane	50915.4	1.37%	Pineapples	58434.4	1.35%
Meat indigenous, goat	44258.5	1.19%	Avocados	48507.2	1.12%
Avocados	42818	1.15%	Meat indigenous, goat	45077.5	1.04%
Meat indigenous, pig	36599.9	0.98%	Pulses, nes	40853.3	0.94%
Oranges	34794.2	0.93%	Meat indigenous, pig	38389.6	0.88%
Total	2972507	79.69%	Oranges	35173	0.81%
			Coffee, green	34916.7	0.80%
			Meat indigenous. cattle	30366.5	0.70%
			Cow peas, dry	26862.6	0.62%
			Melon seed	26663.2	0.61%
			Total	3469196	80%

Source: FAOSTAT, own processing, 2016

Table 1: DRC agricultural production structure.

because of the constantly running process of reducing the average farm size.

DRC agrarian trade

In the past the DRC was considered to be a very strong agricultural production exporter. Over the last four decades, however, development trends have turned the country into a net importing country, suffering because of the steadily-growing negative trade balance value. Only in period 2004 – 2012 the value of imports increased by cc 800 million I$, while the value of exports increased by only cc 46 million I$. The DRC is more and more dependent on imports of many commodity items, including also those items which can be produced even in sufficient quantity directly in the DRC. Details related to DRC agrarian trade performance can be seen in Table 2.

DRC import

The agrarian import commodity profile for the DRC is illustrated through the following Table 3. At the foot of Table 3 it can be seen that import commodity profile is even more heterogeneous in comparison to production profile and the inter-annual growth rate of import value profile is much higher in comparison to production value growth. The structure, and especially the growth rate of import value in DRC, is extremely different when compared to other African countries (see the ANNEX 2). The growth rate of import value makes from DRC one of the most import-dependent countries in Africa, and it is possible to expect that the situation will become even more critical in the near future – especially because of the constantly growing demand, and also because of possible climate changes.

The main items representing the majority of imports value are the following: wheat, poultry meat, palm oil, sugar, rice and milk. Those items represent nearly 50% of all imports. The DRC is becoming less and less self-sufficient, especially in the basic agricultural commodities necessary to feed the population. While Africa as a region is becoming more dependent on imports of semi-finalised or already finalised agricultural products, the DRC is more and more dependent on import of unprocessed commodities.

If we focus our attention especially on changes in commodity structure – it is possible to observe that import value growth is especially related to commodities for human feeding. This applies in particular to such commodities as wheat (+221%), poultry meat (+269%), plant oil (+1100%), milk (+150%), sugar (+150%) etc. Imports are more oriented on bulk commodities.

DRC export

Exports from the DRC (Table 4) are extremely limited. The value (per capita) and inter-annual growth rate are below the regional average. The commodity structure is extremely concentrated onto only a few items representing the majority of export performance. As already mentioned, before the current export performance was only 46 million I$ and 80% of trade performance was represented by only 10 items. Agrarian export commodity structure is based especially on tobacco, green coffee, rubber, cocoa, palm oil kernel and palm oil. During approximately the last ten years, the export structure has changed slightly. It is possible to see the reduction of maize, sugar and wheat exports – commodities necessary for population feeding. On the other hand exports now are more focused on cash crops commodities in particular. These commodities are profitable, but on the other hand, the high attention on cash crops commodities makes the DRC economy and agriculture even more dependent on the external environment. The high orientation on cash crops is

Import Value (1000 I$)										
item	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Growth rate**
Agricult. Products	328 808	433 581	452 890	650 355	655 909	801 458	996 727	1 007 293	1 108 127	1 164 008
Export Value (1000 I$)										
item	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Growth rate**
Agricult. Products	21 561	38 368	33 918	39 474	41 997	59 214	61 559	78 127	68 380	1 155 201
Trade Balance Value (1000 I$)										
item	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Growth rate**
Agricult. Products	-307 247	-395 213	-418 972	-610 881	-613 912	-742 244	-935 168	-929 166	-1 039 747	XX

Source: FAOSTAT, own processing, 2016

Table 2: DRC Agricultural trade development.

BCG production for DRC 2004			BCG production for DRC 2012		
Products	Value in 1000 I$	% of the total (433581,00)	Products	Value in 1000 I$	% of the total (1172019,00)
Rice	59764	13.78%	Wheat	147942	12.62%
Wheat	46057	10.62%	Poultry Meat	117568	10.03%
Meat. chicken	31831	7.34%	Oil. palm	102000	8.70%
Milk. whole dried	28042	6.47%	Beverages	61587	5.25%
Flour. maize	23000	5.30%	Sweeteners and Honey	61150	5.22%
Sugar Raw Centrifugal	19089	4.40%	Rice	53381	4.55%
Cigarettes	16708	3.85%	Oil. olive residues	41765	3.56%
Pulses	13385	3.09%	Milk Dry	36289	3.10%
Malt	7940	1.83%	Milk. whole dried	34905	2.98%
Oil. palm	7730	1.78%	Sugar refined	29483	2.52%
Oil. rapeseed	7600	1.75%	Malt	26788	2.29%
Beans. dry	6800	1.57%	Pigmeat	22467	1.92%
Meat. cattle	6500	1.50%	Tobacco	21646	1.85%
Tomatoes. paste	6265	1.44%	Meat. turkey	20611	1.76%
Oil. sunflower	4700	1.08%	Pulses	18580	1.59%
Eggs. hen. in shell	3613	0.83%	Rapeseed	17400	1.48%
Beverages. distilled alcoholic	3495	0.81%	Oil. rapeseed	17400	1.48%
Margarine. short	3037	0.70%	Meat. pig	12266	1.05%
Peas. dry	3000	0.69%	Beans. dry	11813	1.01%
Cheese and Curd	1650	0.38%	Cotton lint	8700	0.74%
Beverages. non- alcoholic	1634	0.38%	Peas. dry	6452	0.55%
Onions. dry	1452	0.33%	Oil. soybean	5600	0.48%
Onions	1452	0.33%	Maize	4427	0.38%
Flour. potatoes	1400	0.32%	Butter	4169	0.36%
Pigmeat	1226	0.28%	Cheese and Curd	3582	0.31%
Butter	1221	0.28%	Garlic	3565	0.30%
Tea	1188	0.27%	Margarine. short	3138	0.27%
Total	309779	71.45%	Total	922010	76.34%

Source: FAOSTAT, own processing, 2016

Table 3: DRC: Agrarian import commodity structure.

BCG production for DRC 2004			BCG production for DRC 2012		
Products	Value in 1000 I$	% of the total (38368.00)	Products	Value in 1000 I$	% of the total (45931.00)
Tobacco. unmanufactured	9988	26.03%	Coffee. green	13732	29.90%
Coffee. green	7387	19.25%	Rubber natural dry	7651	16.66%
Sugar Raw Centrifugal	3737	9.74%	Natural Rubber	7651	16.66%
Maize	1598	4.16%	Tobacco	3621	7.88%
Cocoa. beans	1387	3.61%	Cocoa. beans	2302	5.01%
Bran. wheat	1259	3.28%	Oil. palm kernel	950	2.07%
Rubber natural dry	1094	2.85%	Oil. palm	315	0.69%
Total	26450.00	68.94%	Total	36640.00	79%

Source: FAOSTAT, own processing, 2016

Table 4: DRC: Agrarian export commodity structure.

destructive – especially for two reasons. The DRC must import more "conventional" commodities, because it is not possible to feed people with cash crops. The second problem is too high sensitivity of DRC exports and agricultural sector performance in relation to regional and global prices. The commodity structure of DRC exports is extremely different in comparison to other regions and also in relation to the African region (see the Table ANNEX 3).

If we compare the DRC and the African regions' export portfolios, we can see that the DRC is extremely focused on cash crops commodities. While the African region's exports are based on about 100 commodities representing cc 75% of African exports (without DRC), the export structure of the DRC is based (as mentioned above) on cc ten aggregations representing almost 80% of exports value. The paper shows that in 2004 the DRC had 7 products representing 69 % of its total exports. The following list represents the important products in both portfolios in 2004 even though the % value added is not the same:

i. Maize: 4.16 (DRC) compared to 0.99 (Africa)
ii. Sugar Raw Centrifugal: 9.74 (DRC) compared to 4.02 (Africa)
iii. Coffee, green: 19.25 (DRC) compared to 3.88 (Africa)
iv. Cocoa, beans: 3.61 (DRC) compared to 15.02 (Africa)
v. Tobacco, unmanufactured: 26.03 (DRC) compared to 4.49 (Africa)
vi. Rubber natural dry: 2.85 (DRC) compared to 1.72 (Africa)

The following list represents important products in both portfolios in 2012 even though the % value added is not the same:

i. Wheat: 0.25 (DRC) compared to 0.21 (Africa)
ii. Maize: 0.17 (DRC) compared to 2.2 (Africa)
iii. Oil, palm: 0.69 (DRC) compared to 1.09 (Africa)
iv. Oil, palm kernel: 2.07 (DRC) compared to 0.28 (Africa)
v. Coffee, green: 29.9 (DRC) compared to 5.05 (Africa)
vi. Cocoa, beans: 5.01 (DRC) compared to 12.42 (Africa)
vii. Tea: 0.41 (DRC) compared to 2.33 (Africa)
viii. Tobacco, unmanufactured: 7.88 (DRC) compared to 6.00 (Africa)
ix. Beverages: 0.08 (DRC) compared to 3.61 (Africa)

Agricultural production and trade segmentation structure analyses; modified BCG matrix applied

BCG quadrants for 2004 compared to 2012

In the above analysis, the paper identified which products are the most important for the production, import or export portfolios and how each of those portfolio structures changed between 2004 and 2012. Now the following study will make a deeper analysis of each product life cycle, as it is very important for determining business strategies. In this section a BCG matrix will determine the DRC's production and trade structure according to their perspectives for the development growth of future agricultural sectors. The following three sets of BCG matrixes provide an overview of the DRC agricultural production and trade structure. Each segment of the BCG matrix provides an overview about the past and the current situation of DRC agriculture. The idea is to identify the main segments representing the pillars of agricultural production, exports and imports activities. The idea is to identify the most perspective product groups representing the current strengths and future opportunities for DRC agriculture and trade, and on the other hand to identify those commodities representing the current weaknesses and future threats of DRC agricultural sector. The idea is to define some possible recommendations for future agricultural sector development.

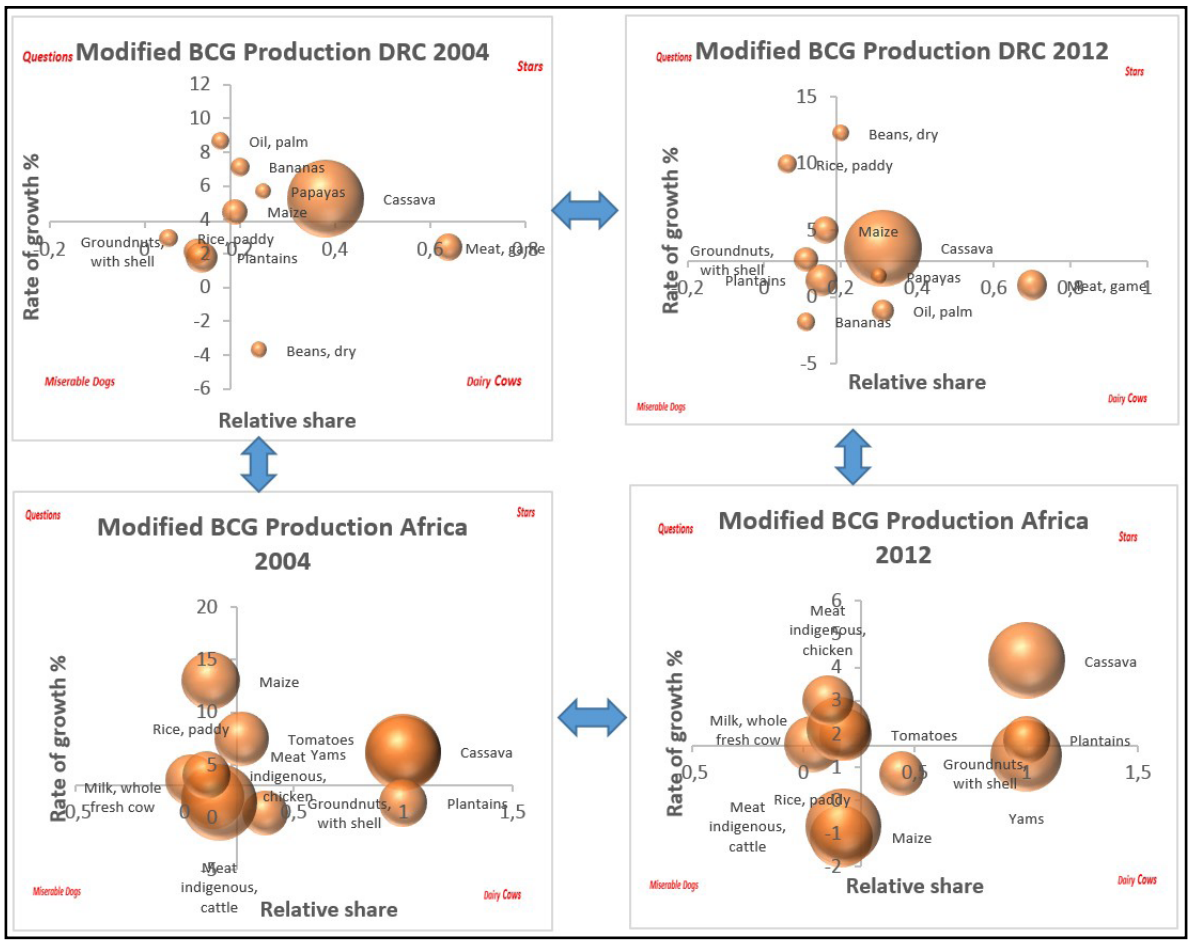
Production

The next part of the paper is focused on identification of production structure perspectives. The BCG matrix provides an opportunity to compare the commodity structure of the DRC agricultural production in 2004 and 2012, and it also provides an opportunity to compare the DRC to the rest of the African region. The BCG matrix provides a possibility to divide a commodity structure into four segments according to individual commodities' share in total production and inter-annual growth rate (for details – see the methodology). The results for DRC can be compared to the rest of the African region. On the basis of the BCG matrix it is possible to specify the following findings. The most perspective segment (stars) is represented by beans, maize cassava, the pillars of production performance are represented by papayas, palm oil, Game meat and bananas. The other commodities can be considered only as question-marks and even dogs – it means they are not perspective at all. The problem of the DRC compared to Africa as a region is the fact that while in Africa the commodity segments called stars and cash cows are improving their position within the commodity structure, in the DRC it is vice versa. Only a few commodity items can be considered as cash cow or even star. On the other hand the share of those commodities in production performance is increasing. The problem is that the production commodity structure is becoming less and less

heterogeneous, and the DRC is more and more dependent on only a few production items. The commodity segments stars and cash cows have been representing more than 70% of the production structure, and the share of those two items is constantly increasing. Such a trend would be without any doubts a positive one if the number of items within the cash cow and star segments would not be so low. (The following graph number 1 provides information about the DRC and the African BCG matrix structure development). The DRC stars segment recorded during the analysed time period only marginal changes its share and value changed from 52% and 1.95billion I$ to about 50% and almost 2 billion I$. While the value is the same, the number of items reduced. In the case of the cash-cow segment it is possible to see the growth of share and value from cc 7% (about 300 million I$) to more than 12% (cc 400 million I$). Question-marks and dogs have been keeping their share of about 40% in total production – but the number of items representing the dogs is constantly increasing. The problem of the DRC agricultural production is its constantly reducing heterogeneity of production profile. The DRC is becoming more and more specialised. Unfortunately the specialization process is focused especially on cash crops, and production stability is disappearing.

Import

While production volume and structure are worsening their position within the market, the import profile is becoming more and more important. In the past DRC import was more or less stabilized, however, nowadays its value and inter-annual growth are increasing. The majority of import items are represented by bulk commodities necessary to import for direct human feeding. While ten years ago the DRC was self-sufficient in many different items, nowadays it is not self-sufficient in any really important bulk agricultural commodity except for cassava. The inter-annual growth rate of import value is about ten-times higher compared to production



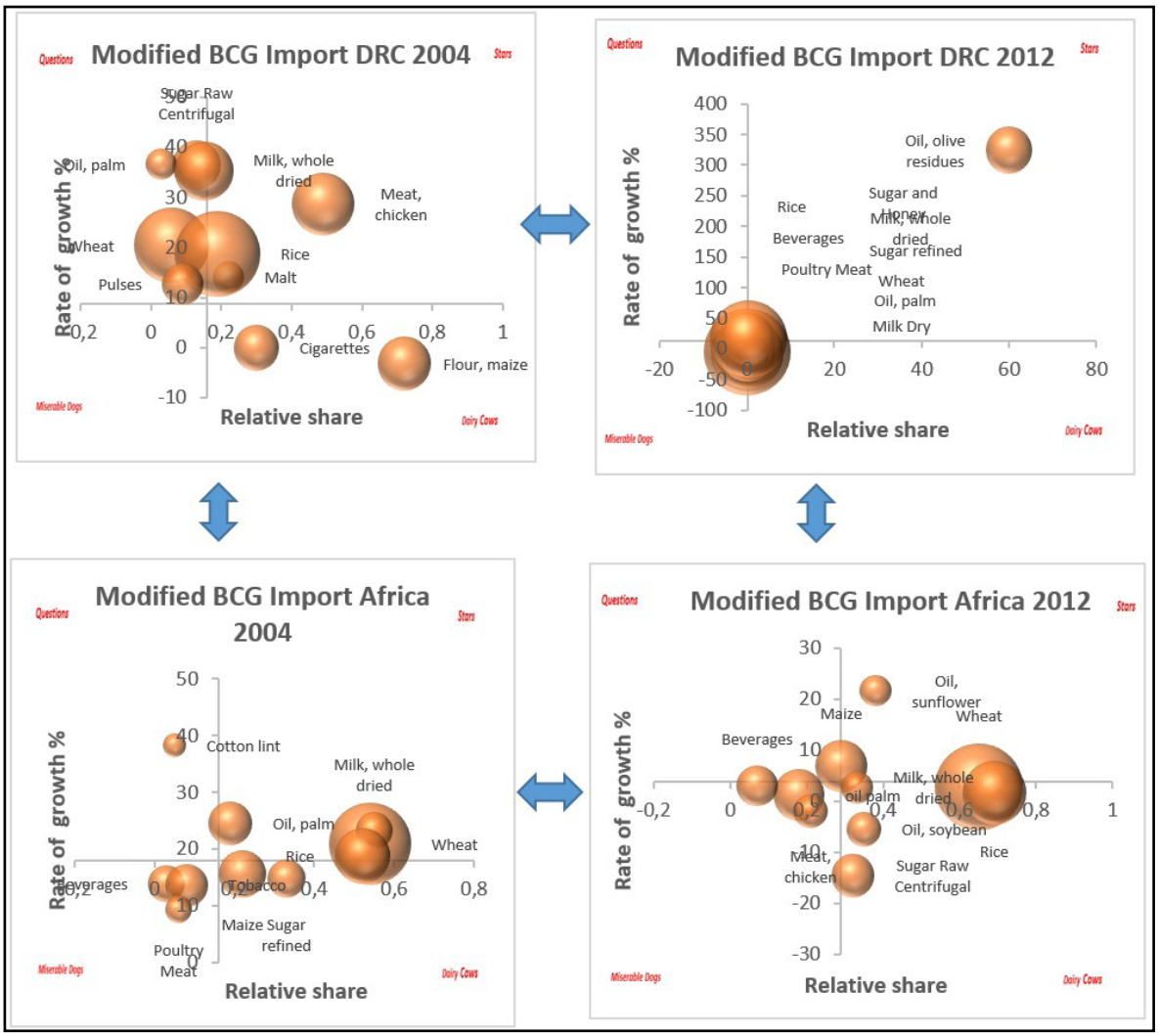
Source: FAOSTAT, own processing, 2016

Graph 1: BCG matrix production model - DRC versus Africa (2004 and 2012).

value growth. Many items, for example Milk, Meat, Rice, maize, Malt, Flour, Oil, Sugar, are being imported in larger amounts, because of lack of domestic production. The import structure is now completely destabilised – it means that the DRC is looking for a new market balance. Unfortunately the decision of farmers and also government to focus their attention on production of cash crops was not a very successful one, and the country is suffering. In comparison to the rest of the African region, the DRC represents a specific country. Its import structure development is completely different in comparison to the rest of the African region. The problem of the DRC is its limited ability to finish restructuring its agricultural sector and to make its production structure more heterogeneous. Another problem is the very limited farmers' ability to increase production performance and their production efficiency.

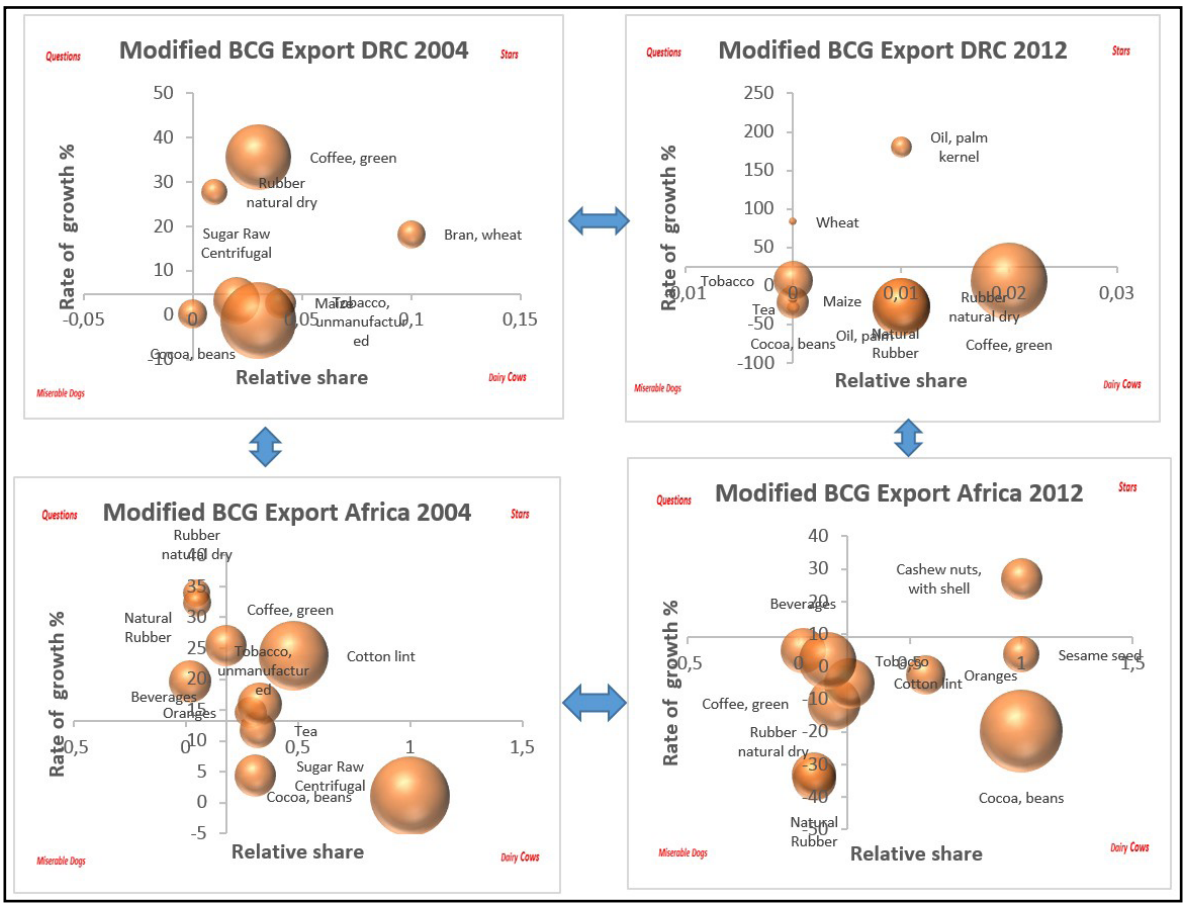
Export

The export profile of the DRC recorded during the analysed time period has an extremely specific development. The export structure was reduced to only a few commodity items. The majority of bulk commodities almost disappeared and the current export is based from over 70% on cash crops items. The ability of the DRC to export agricultural products is slowly dispersing. Nowadays, only palm oil kernel can be considered as a star - the rest of the cash-crops items have already lost their dynamics and their turned themselvesinto "cash cows". The export structure currently has almost no question-marks (the possible future export leaders) and the dynamics of cash cows is also diminishing. Nowadays the export structure is based only on maize, rubber, green coffee, cocoa, palm oil kernel and palm oil. Such a limited export



Source: FAOSTAT, own processing, 2016

Graph 2: BCG matrix import model - DRC versus Africa (2004 and 2012).



Source: FAOSTAT, own processing, 2016

Graph 3: BCG matrix export model - DRC compared to Africa (2004 and 2012).

profile represents a problem/barrier for the future agricultural sector transformation process. Again if we compare the export structure profile to the African region export profile, it is possible to see that the DRC is in stagnation, and its agricultural market is in crisis. Its ability to generate production for export is marginal (except for certain items) and it is possible to expect that export volume will be reduced even more, particularly because of internal market consumption growth.

Agricultural commodities production and trade concentration; HH index analysis

We have already mentioned that the commodity structure of agricultural production and exports are significantly concentrated in the DRC. The level of agricultural production commodity structure in the DRC is much higher in comparison to the African region. While the HH index for the African region proved an unconcentrated market, the same HHI calculated for the DRC proved the existence of a significant level of market concentration (for details see the Table 5). A similar result is also coming from the HHI analysis focused on agrarian export commodity concentration. In the case of agrarian exports, the level of commodity concentration in the DRC reached a much higher level in comparison to the African region. The HHI calculation proved the significant concentration of agrarian commodity structure in the DRC. Exports are highly specialised into only a few main commodities. While production and trade structures are quite concentrated in the DRC, the import commodity structure is unconcentrated. The value of the HH index calculated for the DRC is almost the same as the value of HH index calculated for Africa as whole region. The low level of import concentration explains the constantly increasing agrarian trade negative balance. The DRC has lost its self-sufficiency, the country is not able to satisfy the increasing demand for food from domestic sources, and the DRC is becoming more and more dependent on imports of many different commodities from other countries.

Production	2004	2005	2006	2007	2008	2009	2010	2011	2012
DRC	0.19	0.19	0.19	0.19	0.18	0.18	0.19	0.18	0.18
Africa	0.12	0.12	0.14	0.11	0.11	0.10	0.11	0.12	0.12
Export	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
DRC	0.29	0.19	0.17	0.21	0.23	0.20	0.21	0.16	0.16
Africa	0.05	0.05	0.04	0.04	0.03	0.03	0.04	0.04	0.04
Import	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
DRC	0.07	0.06	0.06	0.09	0.050	0.050	0.05	0.05	0.05
Africa	0.04	0.05	0.05	0.05	0.055	0.065	0.05	0.05	0.05

Source: FAOSTAT, own processing, 2016

Table 5: DRC: Agricultural market concentration (production, export and import commodity structure) – application of HH index (for details see methodology).

Competitiveness analysis based on application of the Lafay index (LFI) for the DRC

The last part of the paper is focused on an analysis of bilateral competitiveness of DRC agricultural trade. The existence of bilateral comparative advantage is analysed through the LFI index (for detail see methodology). The LFI analyses proved that agricultural and food export do not have comparative advantage as a whole group of products. Comparative advantage only exists in the case of a few commodities or commodity sub-groups from the DRC exports. Table 6 provides a brief overview related to the distribution of comparative advantage related to DRC agrarian trade. In 2004 the existence of comparative advantage was proved in the case of the following items: crude materials, coffee, tea, cocoa, tobacco, beverages, sugar, feeding stuff, natural rubber, bananas, plantains and oilseeds. In 2012 the comparative advantage was proved only in the case of tea, cocoa, coffee, crude materials, tobacco, natural rubber, feeding stuff, groundnuts and bananas and plantains. However these items represent the majority of DRC export performance, their share in total production volume and value is very limited and they do not represent the pillar of DRC agriculture.

The number of competitive items in the DRC is extremely small – both if we compare the DRC to the African region average, and also in relation to the global market. Furthermore, the DRC must face another problem, which is the constantly decreasing agricultural trade competitiveness. Just within the last decade the number of items having comparative advantage has decreased by more than 20%.

The weakness of DRC agricultural trade performance is its territorial structure. DRC has been suffering by limited intra-regional trade performance.

LFI	2004
Agricult.Products,Total + (Total)	**-944 873**
Food Excl Fish + (Total)	**-104 365**
Crude Materials -Ex2 + (Total)	4 284 168
Tea+Cocoa+Sp + (Total)	326 058
Tobacco + (Total)	3 252 651
Beverages+ (Total)	2 950 674
Coffee Green+Roast + (Total)	2 862 493
Sugar,Total (Raw Equiv.) + (Total)	0.708069
Fodder & Feeding stuff + (Total)	0.467592
Natural Rubber + (Total)	0.423714
Bananas and plantains + (Total)	0.005633
Oilseeds + (Total)	0.001451
LFI	2012
Food Excl Fish + (Total)	**-4.602997019**
Agricult.Products.Total + (Total)	**-9.476877536**
Tea+Cocoa+Sp + (Total)	5.668661194
Coffee Green+Roast + (Total)	2.477173779
Crude Materials -Ex2 + (Total)	2.016051798
Tobacco + (Total)	0.481661106
Natural Rubber + (Total)	0.419905462
Fodder & Feeding stuff + (Total)	0.355206283
Groundnuts Total Shelled + (Total)	0.007215298
Bananas and plantains + (Total)	0.002071607

Source: FAOSTAT, own processing, 2016

Table 6: DRC: Agrarian trade competitiveness analysis (LFI index).

On the other hand it is heavily dependent on inter-regional trade. The low intensity of intra-regional trade is not problem only for DRC, but it is the significant problem for the whole Africa as region. DRC agrarian trade is focused especially on European countries. Only in 2012 the European Union exported to DRC agricultural and foodstuff products in value about 258 mil. EUR and the value of imports coming from DRC to the EU was about 64 mil. EUR (European

Commission, 2016). European Union represented more than seventy percent of total DRC agricultural trade performance (both export and import). Such high level of trade territorial structure concentration makes DRC extremely vulnerable and sensitive in relation to any kind of global market shock.

Conclusion

The role of the agricultural sector in the DRC is an extremely important one. According to available data, the agricultural sector makes up 42% of the current GDP, and it provides job opportunities for about 60% of the total population. The agricultural sector in the DRC is in deep crisis. Its production and trade capacities are exhausted because of the instability over the last few decades. Production and trade performance are limited, and even more both production and also trade performance are not able to meet the demands of a constantly increasing population. DRC production growth is very limited and its inter-annual growth is even lower in comparison to population growth. The constantly increasing domestic demand for food products is also affecting the country's export capacities. The value and inter-annual growth rate of exports are stagnating and the country is becoming more and more dependent on imports. This results in a constantly increasing negative trade balance. The commodity structure of agricultural production is affected by two factors – the first one is the effort to feed the population, the second one is to increase farmers' income. But unfortunately both factors are negatively affecting the agricultural structure and volume performance. The need to feed their extremely poor population resulted in limited production structure, based especially on low price commodities available for the local population. The effort to increase farmers' income encouraged the growth of cash crops production – but cash crops are related to price fluctuation and too high a level of cash crops production, and trade makes the country extremely vulnerable. The DRC agricultural sector is underdeveloped not only in comparison to the developed or transitional countries, but the DRC is also underdeveloped in relation to majority of other African countries. Agrarian production and trade structure have been stagnating and the country is not able to start its agrarian sector transformation process.

The portfolio analysis proved that in 2004 the major part of the production of the DRC was held by only 16 commodities which represented 80 % (in comparison to 21 products in 2012) of the total production of the country. This should be compared to Africa as a region, which had a production portfolio of 46 products forming 80 % of its total production in 2004 (in comparison to 49 products in 2012). This production of the DRC represented only 2 % of the 80% production of Africa in both 2004 and 2012.

With regard to imports, the DRC had a portfolio of 27 products representing 71 % of its total import in 2004 (in comparison to 49 products representing 79 % in 2012). This should be compared to Africa, which had a portfolio of 106 products representing 69 % of its total import (in comparison to 126 products representing 71 % in 2012), and the imports of the DRC in both years represented 1.5 % of the African import portfolios. Concerning export portfolios, the DRC had a portfolio of 7 products representing 69 % of its total export in 2004 (in comparison to 11 products representing 80 % in 2012), compared to Africa which had a portfolio of 94 products representing 74 % of its total export (in comparison to 127 products representing 79 % in 2012). The export value of the DRC represented 0.2 % of the 74 % African export value in 2004 and 0.1 % of the 79 % African export value in 2012.

The competitiveness analysis proved the low ability of the DRC to compete in the global market. The number of competitive items is very low and the number is constantly decreasing. Currently there are only a few items which are still competitive: tea, cocoa, coffee, crude materials, tobacco, natural rubber, feeding stuff, groundnuts and bananas and plantains.

DRC agriculture is suffering especially because of low economy transformation level, and also because the position of agriculture within the economy is too strong. To improve the agricultural sector performance it is necessary to encourage the growth of the industrial and services sectors, in particular. It is necessary to move people outside of agriculture and to start agricultural sector transformation. Transformation must be based on massive capital inflow, reduction of farmers and number of farms, and increasing the average farm size. There are other recommendations but they will be the topic of another paper.

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Annex

Production Africa 2004			Production Africa 2012		
Products	**Value in 1000 I$**	**% of the total (165264156,75)**	**Products**	**Value in 1000 I$**	**% of the total (211916605.74)**
Meat indigenous, cattle	11816534	7.15%	Cassava	15295669	7.22%
Yams	11533146	6.98%	Meat indigenous, cattle	14707901	6.94%
Cassava	11506552	6.96%	Yams	13161599	6.21%
Milk, whole fresh cow	8190250	4.96%	Milk, whole fresh cow	10545387	4.98%
Maize	6745519	4.08%	Maize	9852304	4.65%
Tomatoes	5910214	3.58%	Rice, paddy	8024907	3.79%
Rice, paddy	5304311	3.21%	Tomatoes	6869076	3.24%
Plantains	4741332	2.87%	Meat indigenous, chicken	6487756	3.06%
Meat indigenous, chicken	4536602	2.75%	Plantains	5678493	2.68%
Groundnuts, with shell	4081870	2.47%	Groundnuts, with shell	5020202	2.37%
Meat indigenous, sheep	3706878	2.24%	Meat indigenous, sheep	4715636	2.23%
Wheat	3470393	2.10%	Bananas	4514060	2.13%
Bananas	3304518	2.00%	Wheat	3897878	1.84%
Sorghum	3217467	1.95%	Sorghum	3423242	1.62%
Sugar cane	2933201	1.77%	Cocoa, beans	3249059	1.53%
Cocoa, beans	2903240	1.76%	Meat indigenous, goat	3134487	1.48%
Cotton lint	2660611	1.61%	Beans, dry	3119763	1.47%
Millet	2542382	1.54%	Sugar cane	3096727	1.46%
Meat indigenous, goat	2510312	1.52%	Cow peas, dry	2699851	1.27%
Grapes	2194810	1.33%	Olives	2698933	1.27%
Meat, game	1961523	1.19%	Grapes	2458442	1.16%
Beans, dry	1843502	1.12%	Meat, game	2447516	1.15%
Eggs, hen, in shell	1830787	1.11%	Millet	2228461	1.05%
Olives	1692681	1.02%	Cotton lint	2163151	1.02%
Onions, dry	1410507	0.85%	Meat indigenous, pig	1922642	0.91%
Meat indigenous, pig	1357079	0.82%	Onions, dry	1888731	0.89%
Cow peas, dry	1314708	0.80%	Cashew nuts, with shell	1787045	0.84%
Dates	1199313	0.73%	Sesame seed	1758808	0.83%
Coffee, green	1140097	0.69%	Okra	1750505	0.83%
Milk, whole fresh goat	1130330	0.68%	Dates	1651379	0.78%
Oranges	1080684	0.65%	Oranges	1592641	0.75%
Okra	1066083	0.65%	Milk, whole fresh goat	1413367	0.67%
Sweet potatoes	1051769	0.64%	Sweet potatoes	1381129	0.65%
Cottonseed	1009430	0.61%	Pineapples	1183534	0.56%
Oil, palm	930103.1	0.56%	Coffee, green	1136866	0.54%
Cashew nuts, with shell	906347.2	0.55%	Meat indigenous, buffalo	1035988	0.49%
Milk, whole fresh buffalo	904149.2	0.55%	Milk, whole fresh buffalo	1022962	0.48%
Apples	865130.6	0.52%	Oil, palm	1022786	0.48%
Pineapples	809343.1	0.49%	Apples	1000774	0.47%
Barley	748382.9	0.45%	Cottonseed	915129.4	0.43%
Meat indigenous, buffalo	723296.7	0.44%	Tobacco, unmanufactured	909232.5	0.43%
Tobacco, unmanufactured	721796.1	0.44%	Meat indigenous, camel	908759.2	0.43%
Milk, whole fresh sheep	717714.6	0.43%	Milk, whole fresh camel	883920.3	0.42%
Sesame seed	695131.9	0.42%	Milk, whole fresh sheep	866841.4	0.41%
Milk, whole fresh camel	611454.8	0.37%	Barley	717134.4	0.34%
Tea	578761.2	0.35%	Almonds, with shell	706134.4	0.33%
Total	132110246	79.94%	Total	168975185	79.74%

Source: FAOSTAT, own processing, 2016

Table ANNEX 1: African countries agrarian production performance.

Production Africa 2004			Production Africa 2012		
Products	**Value in 1000 I$**	**% of the total (28954775,00)**	**Products**	**Value in 1000 I$**	**% of the total (84206265,00)**
Wheat	4695454	16.22%	Wheat	13736493	16.31%
Rice	2138297	7.38%	Rice	7385791	8.77%
Maize	1564525	5.40%	Maize	4903091	5.82%
Oil, palm	1337619	4.62%	Oil, palm	4717764	5.60%
Tobacco	1269573	4.38%	Sugar Raw Centrifugal	3328613	3.95%
Sugar refined	988226	3.41%	Beverages	2993008	3.55%
Milk, whole dried	974862	3.37%	Oil, soybean	2121032	2.52%
Beverages	952998	3.29%	Meat, chicken	2046217	2.43%
Poultry Meat	496328	1.71%	Milk, whole dried	1843419	2.19%
Cotton lint	369303	1.28%	Oil, sunflower	1782568	2.12%
Oil, sunflower	359291	1.24%	Soybeans	1365704	1.62%
Cattle	348068	1.20%	Tobacco, unmanufactured	1031337	1.22%
Tomatoes, paste	330585	1.14%	Tea	1022151	1.21%
Tea	262407	0.91%	Cattle	776900	0.92%
Soybeans	255543	0.88%	Coffee, green	715872	0.85%
Malt	226424	0.78%	Cheese and Curd	649223	0.77%
Coffee, green	213594	0.74%	Tomatoes, paste	621450	0.74%
Butter	182086	0.63%	Chocolate products nes	573333	0.68%
Sorghum	174985	0.60%	Malt	556645	0.66%
Potatoes	170667	0.59%	Apples	540218	0.64%
Beans, dry	166660	0.58%	Butter	518397	0.62%
Cheese, whole cow milk	163797	0.57%	Cheese, whole cow milk	500508	0.59%
Natural Rubber	146599	0.51%	Barley	484604	0.58%
Margarine, short	138948	0.48%	Pigmeat	440801	0.52%
Bananas	127633	0.44%	Potatoes	388007	0.46%
Rubber natural dry	123071	0.43%	Beans, dry	330298	0.39%
Barley	119168	0.41%	Rubber natural dry	305487	0.36%
Lentils	108082	0.37%	Cotton lint	303698	0.36%
Apples	101661	0.35%	Bananas	249387	0.30%
Meat Sheep Fresh	81833	0.28%	Sorghum	248597	0.30%
Tallow	81354	0.28%	Sheep	227443	0.27%
Peas, dry	68708	0.24%	Lentils	204127	0.24%
Meat, turkey	67810	0.23%	Eggs, hen, in shell	192646	0.23%
Meat, pig	57557	0.20%	Meat, turkey	177834	0.21%
Oil, rapeseed	55375	0.19%	Onions	159301	0.19%
Onions	54355	0.19%	Groundnuts, shelled	155346	0.18%
Oil, olive, virgin	54071	0.19%	Peas, dry	144263	0.17%
Eggs, hen, in shell	52537	0.18%	Chick peas	133552	0.16%
Chick peas	51947	0.18%	Onions, dry	129444	0.15%
Sesame seed	48024	0.17%	Dates	112752	0.13%
Goats	43317	0.15%	Oil, olive, virgin	102359	0.12%
Groundnuts, shelled	42928	0.15%	Spices, nes	99521	0.12%
Onions, dry	42828	0.15%	Beet pulp	96622	0.11%
Beet pulp	39549	0.14%	Almonds shelled	93153	0.11%
Oil, essential nes	36597	0.13%	Sesame seed	78527	0.09%
Sunflower seed	32180	0.11%	Cottonseed	77910	0.09%
Spices, nes	31810	0.11%	Oranges	76620	0.09%
Oranges	29916	0.10%	Anise, badian, fennel, coriander	76111	0.09%
Cocoa, beans	27941	0.10%	Horses	75812	0.09%
Pepper (piper spp,)	26799	0.09%	Whey, dry	70544	0.08%
Dates	23615	0.08%	Pepper (piper spp,)	64502	0.08%
Whey, dry	19680	0.07%	Goats	50180	0.06%
Garlic	15202	0.05%	Garlic	48930	0.06%
Flax fibre and tow	14593	0.05%	Coconuts, desiccated	46997	0.06%
Cider etc	13921	0.05%	Grapes	44661	0.05%
Total		69.07%	Total		71.45%

Source: FAOSTAT, own processing, 2016

Table ANNEX 1: African countries agrarian production performance.

Production Africa 2004			Production Africa 2012		
Products	**Value in 1000 I$**	**% of the total (20511945.00)**	**Products**	**Value in 1000 I$**	**% of the total (43224548.00)**
Cocoa, beans	3080101	15.02%	Cocoa, beans	5366600	12.42%
Cotton lint	2344091	11.43%	Tobacco	2594001	6.00%
Tobacco, unmanufactured	920365	4.49%	Coffee, green	2181749	5.05%
Beverages	852813	4.16%	Cotton lint	1969783	4.56%
Sugar Raw Centrifugal	823752	4.02%	Beverages	1559486	3.61%
Coffee, green	795171	3.88%	Natural Rubber	1482633	3.43%
Tea	624793	3.05%	Rubber natural dry	1433175	3.32%
Oranges	472587	2.30%	Cashew nuts, with shell	1332273	3.08%
Natural Rubber	369830	1.80%	Oranges	1175152	2.72%
Rubber natural dry	352794	1.72%	Sesame seed	1020856	2.36%
Grapes	315566	1.54%	Tea	1007380	2.33%
Sesame seed	278302	1.36%	Maize	950183	2.20%
Cashew nuts, with shell	276801	1.35%	Sugar Raw Centrifugal	864371	2.00%
Rice	270903	1.32%	Wine	764494	1.77%
Cattle	255552	1.25%	Grapes	706640	1.63%
Sheep	222880	1.09%	Pulses	588871	1.36%
Maize	203918	0.99%	Cheese and Curd	518261	1.20%
Apples	183491	0.89%	Sheep	483233	1.12%
Bananas	180848	0.88%	Tomatoes	474771	1.10%
Oil, palm	166961	0.81%	Oil, palm	472914	1.09%
Pineapples	127571	0.62%	Cattle	448221	1.04%
Beans, green	127305	0.62%	Oil, olive, virgin	415013	0.96%
Potatoes	114895	0.56%	Cheese, processed	386453	0.89%
Olives preserved	108641	0.53%	Apples	317653	0.73%
Dates	102840	0.50%	Beans, green	307657	0.71%
Pulses	96341	0.47%	Wool, greasy	291057	0.67%
Vanilla	89251	0.44%	Dates	284720	0.66%
Pears	80807	0.39%	Beans, dry	269980	0.62%
Cheese and Curd	80550	0.39%	Rice	265770	0.61%
Grapefruit (incl. pomelos)	80294	0.39%	Onions	249333	0.58%
Wool, greasy	76576	0.37%	Bananas	246532	0.57%
Onions	76015	0.37%	Onions, dry	240944	0.56%
Onions, dry	75294	0.37%	Cloves	233910	0.54%
Tomatoes	72090	0.35%	Oil, sunflower	209890	0.49%
Lemons and limes	66388	0.32%	Potatoes	192221	0.44%
Goats	64120	0.31%	Pears	161535	0.37%
Wheat	49707	0.24%	Goats	158878	0.37%
Cheese, processed	49294	0.24%	Groundnuts, shelled	140579	0.33%
Beans, dry	39987	0.19%	Lemons and limes	136712	0.32%
Plums and sloes	39701	0.19%	Cheese, whole cow milk	131808	0.30%
Oil, sunflower	37134	0.18%	Strawberries	128133	0.30%
Cloves	35839	0.17%	Oil, palm kernel	119765	0.28%
Oil, soybean	35726	0.17%	Grapefruit (inc. pomelos)	109821	0.25%
Groundnuts, shelled	35114	0.17%	Soybeans	105712	0.24%
Raisins	34542	0.17%	Peas, dry	97951	0.23%
Milk, whole dried	31487	0.15%	Chick peas	93006	0.22%
Meat, game	28065	0.14%	Wheat	92733	0.21%
Cottonseed	27808	0.14%	Beet pulp	80291	0.19%
Chillies and peppers, dry	27388	0.13%	Raisins	67494	0.16%
Chick peas	25695	0.13%	Avocados	65373	0.15%
Avocados	21577	0.11%	Plums and sloes	64832	0.15%
Eggs, hen, in shell	18903	0.09%	Milk, whole dried	63923	0.15%
Rubber, natural	16818	0.08%	Oil, olive residues	60553	0.14%
Spices, nes	15666	0.08%	Chillies and peppers, green	60511	0.14%
Chickens	15660	0.08%	Camels	58147	0.13%
Peas, dry	14764	0.07%	Peas, green	49952	0.12%
Peaches and nectarines	13707	0.07%	Peaches and nectarines	48791	0.11%
Strawberries	13281	0.06%	Spices, nes	48217	0.11%
Camels	13034	0.06%	Pumpkins, squash and gourds	43463	0.10%
Total	15264310	73.94%	Total	34211253	78.16%

Source: FAOSTAT, own processing, 2016

Table ANNEX 1: African countries agrarian production performance.

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The Analysis of the Age Structure of Regional Fixed Capital in the Agriculture

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Abstract

The paper deals with an estimate and analysis of the value of regional net fixed capital stock and the age structure of machinery and equipment in Czech agriculture. In order to perform such analysis, the official model of perpetual inventory method is transformed into the Markov chain model and applied on regional data separately. Regional net fixed capital stock is presented for the period of 2008-2013.

The development of the average age of machinery and equipment comprises a potential indicator of the modernisation process in the industry. The analysis of the age structure is based on the structure heterogeneity indicator. For these purposes, the real age structure in each Czech region is compared with the theoretical stable and stationary structure. Currently, the most heterogeneous age structure of machinery and equipment occurs in Prague and the Karlovy Vary region.

Keywords

Average age of assets, Markov chain, fixed capital stock, perpetual inventory method, regional capital stock.

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Introduction

Capital represents one of the most important factors of production in a national economy. However, expressing the value of capital goods relates to several issues which substantially affect the research activities and results. Moreover, even if the official estimate of the capital value is available, the official statistics may lack the necessary detail.

The first problem occurs with the most obvious form of capital – the book value. This indicator suits business practice sufficiently but does not work in an analysis of economic principles (Pigou, 1935). The book value represents an aggregate of historical prices (i.e. it sums prices from various periods without any revaluation) and depreciation arises mainly from current legislation and the owner's decision, whereas an asset with a zero book value could still prove productive and sellable, i.e. has a non-zero market value (Diewert, 2005; Hulten and Wykoff, 1996).

This problem of business bookkeeping data is accepted on the international level. Therefore, capital stock is measured by means of Perpetual Inventory Method (PIM) (OECD, 2009; United Nations et al., 2009). Although the Cambridge capital controversy (Robinson, 1953; Harrod and Sraffa, 1961) did not arrive at a completely clear solution and some authors consider the death of the main protagonists as the reason why the debate calmed down (Cohen and Harcourt, 2003), the international standards for measuring fixed capital are based mainly on the neoclassical capital theory (OECD, 2009).

Nowadays, fixed capital constitutes an integral part of national accounts statistics of developed countries in the form of various kinds of stock and flows computed via model computation. To solve the bookkeeping issues, the PIM model aggregates the flow of investment (gross fixed capital formation), which allows a survey on a regular basis. On the other hand, the outflows of depreciation and retirement must be modelled based on the real service life of assets. All assets are revaluated to basic year prices before their integration

into stock. (OECD, 2009)

Various studies employed capital indicators of Czech agriculture as an input variable. Despite the weaknesses of the book value, some authors (Kočišová, 2015; Nowak et al., 2015) prefer data from the Farm Accountancy Data Network (FADN) for all model variables, even for whole countries where the data on fixed capital exist in a required form. On one hand, using a single data source always represents an advantage. On the other hand, however, the used FADN database draws its numbers from bookkeeping data (European Commision, 2005). The FADN provides the data on fixed capital in replacement costs (European Commision, 2010). The replacement value is obtained from the index revaluation according to the estimation of the average age of fixed capital stock, which is estimated on the basis of the ratio of the accumulated bookkeeping depreciation (Barkaszi et al., 2009, European Commision, 2015). Therefore, the FADN takes inflation into account. The FADN revaluation shows an increase of depreciation by approximately one third in comparison with the acquisition costs (European commission, 2016). Nevertheless, the bookkeeping service life is used and neither the time series of investment nor the variability in age structure are reflected.

Due to the missing data on capital stocks in regional (Czech Statistical Office, 2015a) various alternative solutions have occurred. Bielik and Hupková (2011) uses the total assets from survey (book value) as an input for technical efficiency analysis. Špička and Smutka (2014) uses FADN capital indicators for milk farms regional technical efficiency. Latruffe and Piet (2014) use FADN data on capital for farm performance on NUTS3 level of Brittany. Čechura (2010, 2012) use data form CreditInfo Firms Monitor, i.e. the book value of capital. Špička (2014) uses book value of capital from FADN for technical efficiency analysis of mixed farming on the level of EU regions.

The fixed capital or selected characteristics of fixed capital are implicitly part of many other studies focused on modernization or ICT development in the Czech agriculture (Jarolímek et al., 2014; Vaněk et al., 2010). Moreover, the modernization and support of investment into new technologies is also the aim of strategies, plans and programmes (Hlaváček et al., 2012; Ministry of Agriculture of the Czech Republic, 2008). Since the modernization is defined as the strategic goal, it should be connected with the measurable indicator (Doran, 1981; Lawler and Bilson, 2013). Otherwise, managers would not be able to evaluate whether the goal has been reached or not. Moreover, it would be impossible to evaluate the necessity of such goal either.

From that point of view the age of fixed capital represents a possible indicator. Thus, a decrease or at least stability of the average age characterizes the modernization process. However, the age of fixed capital does not represent a common part of official statistics (Harper, 2008). As the national accounts statistics (the Czech Statistical Office, 2015b) publish mainly indicators that express the value of flows and stock, Krejčí et al. (2015) estimate the age of fixed capital in agriculture and compare it with available international data on the age of capital. This research shows that the average age of fixed capital in the Czech Republic reaches a similar level as in the USA and Australia. However, the presented results deal with the age structure for the whole Czech Republic. A significant part of the referred analyses concerns regional data. For a wider applicability of the estimated indicators, improving the relevance and providing the regional detail comprise a necessary step.

The paper aims firstly at estimating and analysing the age of machinery and equipment in Czech agriculture in a regional breakdown. The analysis includes the statement of equilibrium investment and a comparison of a stable and a real age structure for Czech regions (Czech "kraj", NUTS III). Subsequently, due to necessary adjustments of the model, we estimate the value of regional net fixed capital stock in Czech agriculture. In order to do so, we use the adjusted model of PIM and perform multiple computations to obtain the stock and age structure of the machinery and equipment.

Materials and methods

Albala-Bertrand and Feng (2007) suggest the estimation of regional capital stock via the production function and linear programing. However, using production as an input variable for the capital estimation would lead to difficulties in the future application to the productivity and efficiency analysis. Therefore, we apply a similar approach as Derbyshire, Gardiner, and Waights (2013). Nevertheless, those authors used the same service lives and retirement functions for all countries.

The regional stock in our research is computed similarly to national stock via PIM with gross fixed

capital formation as the main model input (OECD, 2009) but divided into regions. For these purposes we apply the Czech official service lives and retirement functions (40 years for non-residential buildings in agriculture, 15.9 years for transport equipment, 14.7 years for other machinery and equipment, etc. see the Czech Statistical Office (2002)).

For the estimation of the regional capital stock in agriculture, we apply the straight-line depreciation, which corresponds with the official approach (the Czech Statistical Office, 2002). The p_k represents the value of the asset in the age equal to k and p_0 is the value of a new asset while m expresses the maximum service life:

$$\frac{p_k}{p_0} = 1 - \frac{k}{m}, \quad k = 0,1,\ldots, m. \tag{1}$$

As the age of fixed capital in this paper is estimated as a modernization indicator, we calculate the age only for machinery and equipment. Considering the most significant types of assets, machinery and equipment, non-residential buildings and cultivated biological resources represented 97.87% of gross fixed capital stock in Czech agriculture in 2013 (the Czech Statistical Office, 2015b). The age of cultivated assets does not directly relate to modernization and aging of buildings does not necessarily represent obsolescence (for the age of the whole fixed capital stock in Czech agriculture see (Krejčí et al., 2015)).

Regional statistics on gross fixed capital formation in the industry and NUTS 3 disaggregation (Czech Statistical Office, 2015a) contain only data from the period between 1995 and 2012. The year 2013 presents only numbers without the industry structure. For the purposes of stock estimation, we also need to divide older data on gross fixed capital formation which represent the input for the PIM. We apply the average ratio of regional gross fixed capital formation. Nevertheless, only 5.43% of the machinery and equipment gross capital stock in 2013 consists of capital from the period before 1995.

The average age of the fixed capital is the weighted average of the age of past investment (gross fixed capital formation), where the weight consists of the current value of the part of past investment (U.S. Bureau of Economic Analysis, 2013). In order to obtain the age structure, we apply the transformation of PIM into the Markov chain (Krejčí and Sixta, 2012; Krejčí, 2010). Since the stages in the aging process (i.e. retirement or age cohort) depend only on the previous state and transition probabilities and the process proves memoryless, the aging process has the Markov property (Tijms, 2003), where n is the stage and X represents the state of the process:

$$P(X_n = i_n | X_0 = i_0, \ldots, X_{n-1} = i_{n-1}) = P(X_n = i_n | X_{n-1} = i_{n-1}). \tag{2}$$

We establish the estimation on the analogy with demography. Therefore, we consider the gross fixed capital stock as the most suitable for age estimation. As the productivity of population does not affect the age of population, we disregard the influence of the wear and tear of the machinery and equipment.

The transition matrix $\boldsymbol{P}$ arises from the official mostly log-normal retirement function (Czech Statistical Office, 2002). The matrix contains m+1 columns and rows, where m has the same meaning as in (1) and $(m+1)^{th}$ represents the absorbing state of retired assets from the examined period. Columns and rows from 1 to m represent age cohorts.

National accounts and thus also the PIM does not express capital stock as a number of various assets but as the value of assets, which provides comparability and homogeneity of asset expression. Therefore, the calculation of the transition matrix elements follows a similar way as the maintenance models (Tijms, 2003; van der Duyn Schouten and Vanneste, 1990). The probability of asset retirement in the ith year of service – a_i – arises from the official retirement function used for national accounts estimations (the Czech Statistical Office, 2015b). The survival probability of the ith year r_i subsequently emerges from (3). Individual elements of $\boldsymbol{P}$ are calculated from the (4) and (5). The conditional probability that the asset will retire in the ith year is $p_{i,m+1}$ and $p_{i,i+1}$ represents the conditional probability of aging from i to i+1.

$$r_{i-1} - r_i = a_i, \; i = 0, \ldots, m, \; r_0 = 1, \tag{3}$$

$$p_{i,m+1} = \frac{a_i}{r_{i-1}}, \; i = 1, \ldots, m, \tag{4}$$

$$p_{i,i+1} = \frac{r_i}{r_{i-1}}, \; i = 1, \ldots, m-1. \tag{5}$$

Table 1 shows the example of the transition matrix $\boldsymbol{P}$ for transport equipment in Czech agriculture. The absorbing state has a value of 1 on the main diagonal (the process cannot leave the absorbing state). In our case the absorbing state corresponds to the "retired" state.

Consequently, the vector of gross capital stock $\boldsymbol{g}_t$ in the year t arises from:

$$\boldsymbol{g}_t^T = \boldsymbol{g}_{t-1}^T \boldsymbol{P}. \tag{6}$$

	1	2	3	4	5	6	…	35	36	37	38	retired
1	0	1.0000	0	0	0	0	0	0	0	0	0	0.0000
2	0	0	1.0000	0	0	0	0	0	0	0	0	0.0000
3	0	0	0	1.0000	0	0	0	0	0	0	0	0.0000
4	0	0	0	0	0.9999	0	0	0	0	0	0	0.0001
5	0	0	0	0	0	0.9989	0	0	0	0	0	0.0011
…	…						...					
35	0	0	0	0	0	0	0	0	0.8091	0	0	0.1909
36	0	0	0	0	0	0	0	0	0	0.8094	0	0.1906
37	0	0	0	0	0	0	0	0	0	0	0.8099	0.1901
38	0	0	0	0	0	0	0	0	0	0	0	1.0000
retired	0	0	0	0	0	0	0	0	0	0	0	1.0000

Source: own processing

Table 1: Example of transition matrix P for transport equipment.

The sum of first m elements of gt equals the total value of gross fixed capital while last $(m+1)^{th}$ element represents the aggregation of retired capital from the examined period. A full description of the implemented software with an alternative Czech PIM calculation appeared in Krejčí and Sixta (2012).

The age structure of fixed capital differs not only by type of capital but also by region. For the description of the structure, many characteristics may be used. Most applicable are the average age of capital, the median of the capital age or any other quantiles (Krejčí et al., 2015). Fluctuation of those characteristics in time depends on a short-term excess or a deficiency of new investment. Such a fluctuation is not desired from the point of view of stability of the structure of capital. Waves caused by a higher or lower intensity of new investment are reflected in the age structure for a long time (up to 40 years when all of the investment are retired). Although an excess wave proves positive at younger ages (a higher share of young capital), in higher ages this wave presents a burden. The value of aged and obsolete capital is going to grow because of such a wave. Moreover, the retired capital grows and demands a new wave of investment for consequent renewal. Therefore, a past short term solution can simply become a current problem.

Similarly to demography, one of the goals should be stable age structure of capital in time. If the amount of new input into the first cohort keeps stable (no matter if the amount remains constant, or constantly increasing or decreasing – the coefficient of annual change stays constant in time) and the principle of exclusion from population stays constant (retirement in the case of capital), then the amount of capital increases constantly (or decreases mirroring the increase or decrease of the input) and the age structure remains stable in time (Lotka, 1939).

A situation where the amount of new investment stays constant in time represents a special case of a stable structure. The process follows the Little's Law (Little, 1961). After a certain period of time, based on the delay between the input and output of population stock, the input becomes equal to output (investment is equal to retired capital in our case). This special case is called the "Stationary" structure (Lotka, 1939).

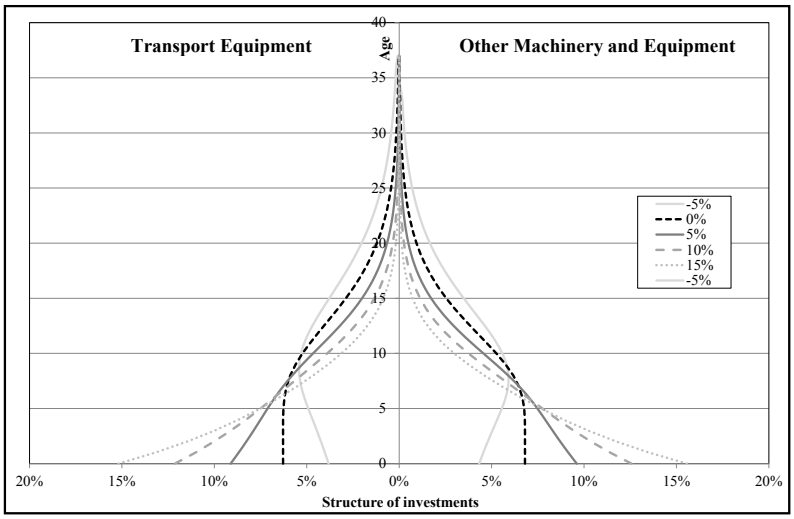
For a basic analysis, we test the relation between the population parameters and the investment behavior impact. Table 2 shows the result of a hypothetical constant annual growth of new investment and the average age of machinery and equipment in Czech agriculture. The stationary structure of Transport equipment has an average age of 9.04 years while Other machinery and equipment 8.35 years. If the aim was to reach a lower average age than for the Stationary structure, it would require an application of an annual growth of the amount of new investment in Table 2.

Figure 1 illustrates the proportions of stable populations with different coefficients of growth of new investment. The stable structure (no matter for which coefficient of investment growth, if bellow or over 1) shows that proportions (as ratio of the whole amount of capital) of age groups remain constant in time. For a situation where the coefficient is below 1, the population has a lower proportion of younger capital and the total amount of capital clearly decreases. Demography denominates such structure as a Regressive

Annual growth of investment	Average age of capital	
	Transport Equipment	Other Machinery and Equipment
-10%	15.0	13.3
-5%	11.5	10.4
-3%	10.4	9.5
-2%	9.9	9.1
-1%	9.5	8.7
0%	9.0	8.4
1%	8.6	8.0
2%	8.3	7.7
3%	7.9	7.4
5%	7.3	6.9
10%	6.0	5.7
15%	5.1	4.9

Source: own processing

Table 2: Annual growth of new investment and correspondent average age of capital for Transport Equipment and Other Machinery and Equipment



Source: own processing

Figure 1: Impact of various levels of annual growth of new investment on age structure of Transport equipment and Other machinery and equipment.

population which is typical for developed countries (Roubíček, 1997). If the coefficient equals 1 (the amount of new investment equals retired capital and the total amount of capital stays constant), the structure is stationary (a curve for 0%). If the coefficient exceeds 1, the structure is progressive and the proportions of younger age groups are larger with the total amount of capital increasing. A progressive population is typical for developing countries with a birth rate higher than mortality rates (Roubíček, 1997).

To evaluate the difference between a real and stable age structure of capital we adopt a simple indicator. This indicator quantifies the difference between the real and both the stable and stationary age structure.

For the quantification of the difference $\boldsymbol{D^s_{u,c}}$ between the real and stationary structure for the region u and the type of capital c, the formula is:

$$\boldsymbol{D^s_{u,c}} = \sum_{i=0}^{m} \left(s^r_{i,u,c} - s^s_{i,c}\right)^2, \qquad (7)$$

where $\boldsymbol{s^r_{i,u,c}}$ represents the real share of capital of the age i on the total value of capital. The type of capital in this case is Transport equipment

or Other machinery and equipment. The variable $s^{s}_{i,c}$ states the same for a stationary population. The u is missing in the subscript because the model parameters (average service life and a retirement function) remain the same for various regions. The quantification of the difference between the real and stable structure b (with a constant coefficient of growth of new investment in time) we use a similar equation:

$$D^{b}_{u,c} = \sum_{i=0}^{m} \left(s^{r}_{i,u,c} - s^{b}_{i,c}\right)^{2}, \quad (8)$$

Results and discussion

Table 3 shows the value of net fixed capital stock in NACE A – Agriculture, Forestry and Fishing (the Czech Statistical Office, 2015c) in individual years for the given period. The sum of value of all regional stocks equals the annual national accounts value (the Czech Statistical Office, 2015b) in constant prices of 2010.

Despite the necessary methodology adjustments, Krejčí et al (2015) compared the average age of capital on international basis. That research compared the age in the Czech Republic with capital age in the USA and Australia for the period 2000-2012. This international comparison showed smaller differences (e.g. net capital stock computed by geometric depreciation profile showed average age in Czech Republic 6.9 and 6.6 in USA) in the comparison with the current research focused on the Czech regions.

Figure 2 shows the development of the average age of machinery in Czech NUTS 3 regions. Similarly to Krejčí et al. (2015) the graph contains a simple extrapolation of age development which keeps the investment at the current level (the average ratio of regional investment for 2013 and 5-year moving average of gross fixed capital formation from the year 2014 to 2020). The average age of machinery in the whole Czech Republic in the period of 2000-2013 was 8.29 years and it decreased by 1.06 years during that period. The average difference between the lowest and highest regional age of machinery and equipment reached 3.27 years. However, in the case of stable investment the difference would decrease to 1.60 years in 2020.

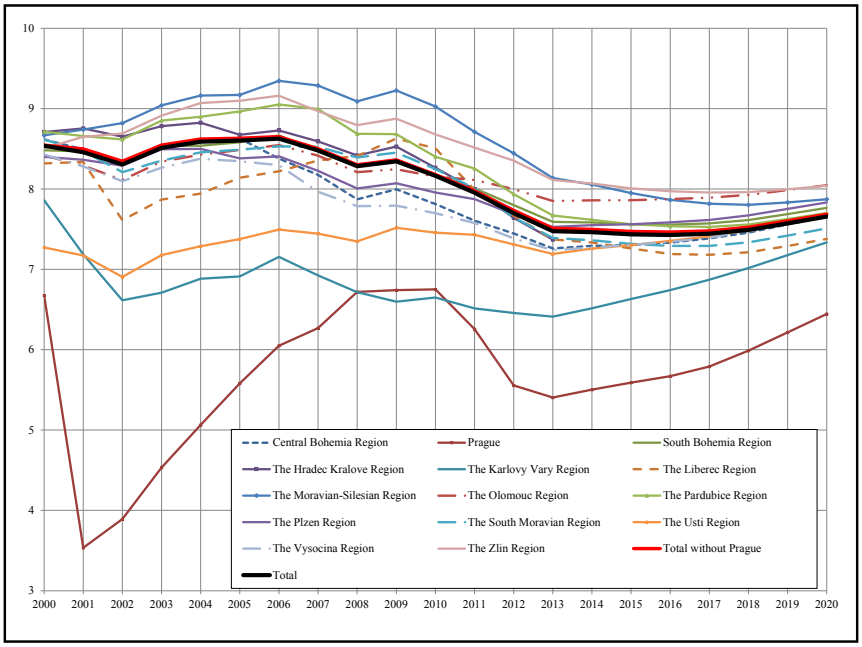
Prague shows the lowest average age, however the impact of the region on the overall average age of machinery stays very little. Despite the share of Prague having increased more than four times since 2000, the share of Prague on total gross capital stock of machinery and equipment in agriculture reached only 1.71% in 2013. Consequently, the average age of machinery with and without Prague exhibit only marginal differences.

Omitting Prague, the lowest average age of machinery and equipment in the period of 2000-2013 occurs in the Karlovy Vary region.

Region	Net fixed capital stock, constant prices prices 2010, mil. CZK					
NACE	2008	2009	2010	2011	2012	2013
The Czech Republic	260 404	257 821	258 780	264 811	280 704	285 464
NUTS 3						
Prague	3 431.31	3 625.72	3 862.73	4 273.64	5 353.17	7 496.98
Central Bohemia Region	34 809.22	34 093.89	34 223.96	35 457.25	37 302.34	35 853.44
South Bohemia Region	29 264.47	29 018.78	28 933.95	29 510.96	30 953.58	30 005.19
The Plzen Region	21 974.59	21 837.48	21 774.01	21 947.11	23 103.28	23 020.30
The Karlovy Vary Region	4 341.42	4 557.69	4 690.88	4 810.01	5 231.64	7 197.71
The Usti Region	11 169.48	10 888.41	11 185.08	11 890.72	12 789.42	14 051.18
The Liberec Region	5 673.12	5 506.05	5 657.03	5 945.62	6 448.10	8 288.99
The Hradec Kralove Region	20 066.07	19 633.43	19 838.38	20 440.19	21 959.11	22 189.16
The Pardubice Region	20 340.10	20 207.39	20 368.80	20 418.75	21 592.56	21 739.44
The Vysocina Region	29 322.75	29 556.64	29 382.51	30 093.57	31 951.93	30 993.66
The South Moravian Region	27 505.51	27 328.47	27 497.00	28 408.36	30 635.12	30 005.95
The Olomouc Region	20 313.38	20 273.54	20 152.22	20 107.39	20 820.25	20 880.97
The Zlin Region	14 426.18	14 088.22	14 077.79	14 067.96	14 471.62	15 253.08
The Moravian-Silesian Region	17 766.39	17 205.28	17 135.65	17 439.47	18 091.87	18 487.95

Source:Data on the Czech Republic are from the Czech Statistical Office (2015b), the regional data are own calculation

Table 3: Regional net capital stock in the Czech Republic, NACE A, constant prices of 2010, millions CZK.



Source: own calculation

Figure 2: Age of machinery and equipment in NACE A in Czech regions (own calculation).

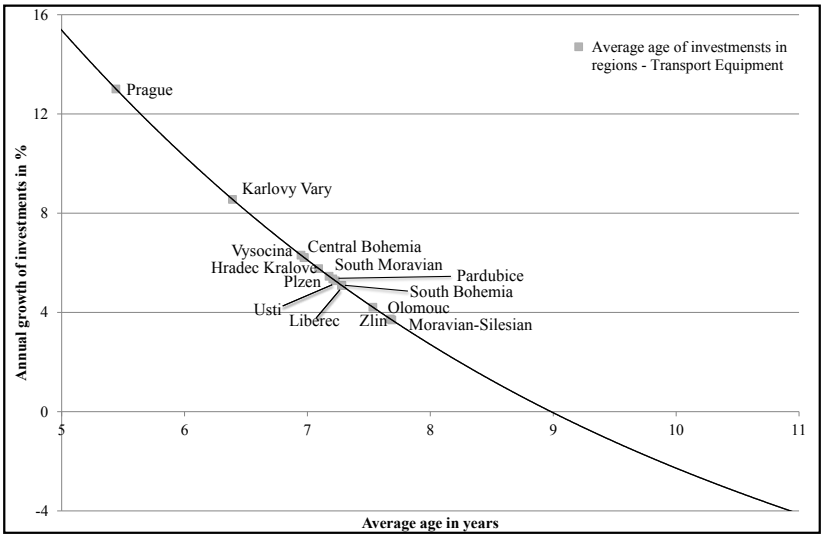
This region recorded a similar share on total gross fixed capital as Prague (1.59% in 2013). The third region with the lowest age of machinery – the Usti region – coincides with the region with the fourth lowest share on total gross fixed capital (4.14% in 2013). On the other hand, the highest age occurs in the Moravian-Silesian Region (8.13 years in 2013), which shows that the relation between the share and age cannot be generalised as the region does not belong among the regions with the highest share of capital stock (5.93% of total machinery and equipment in 2012 represents the sixth lowest value).

The most significant regions with an individual share higher than 10% are the South and Central Bohemia regions, the Vysocina region and the South Moravian region, reaching a total share of 48.75% of gross fixed capital by the end of the examined period. The average age of machinery in the regions reaches 8.22 years, which stays slightly under the average of the whole country. The average max-min difference equals 0.38 years.

The Vysocina and Central Bohemia regions record the highest numbers of cattle and Vysocina has also the highest pig livestock (CZSO, 2015a). These two regions are also the regions with the lowest average age of machinery and equipment if we omit the three above mentioned regions with a small share of capital. On the other hand, the Plzen (a region with the third highest cattle stock) and Pardubice (the third highest pig livestock) regions represent the areas which are above the average age. However, a deeper examination of the link between the type of the predominant production and the age development will be the aim of our future research.

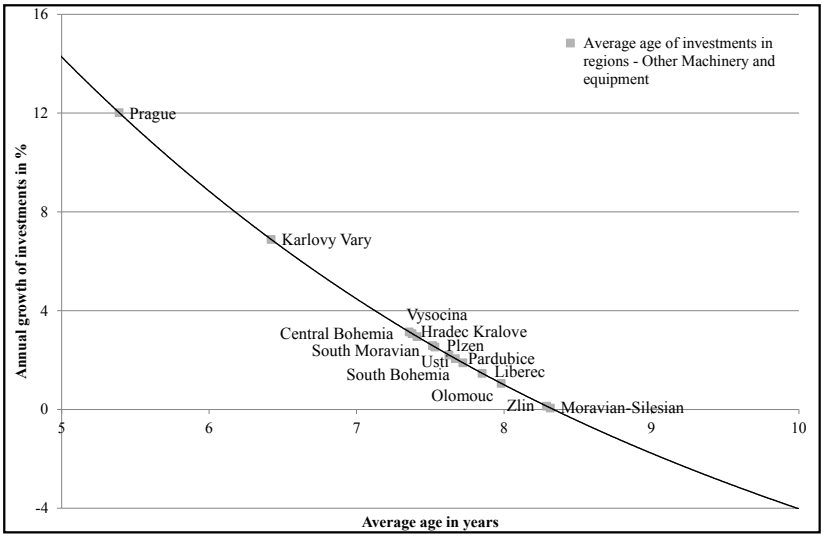
The data show the convergence of the average age of machinery and equipment across the regions. This arises due to a faster increase of investment in the regions with a higher average age in comparison with the regions with a lower age of machinery and equipment.

Figure 3 and 4 show the average age of capital in individual regions. For all regions the average age of Transport equipment remains lower than the average age of the stationary structure so regions must realize an annual growth of investment to keep the average age on the current level. Prague – where the average age is the lowest – should correspondingly record the highest annual growth. To keep the average age at 5.4 years (2013) the annual growth should reach 13%. The second region – Karlovy Vary – should keep a 9% annual growth. The Moravian-Silesian and Zlin regions find themselves in a reversed position, with an almost similar necessary annual growth of approximately 4%. For comparison, in the period of 2005-2013 the average annual growth of gross fixed capital formation in constant prices reached 1.64% for the whole Czech economy, but 8.30% in NACE A (the Czech Statistical Office, 2015b).



Source: own calculation

Figure 3: Average age of Transport equipment in 2013 in NACE A in Czech regions and relationship with necessary annual growth of investment to keep this average age constant (stable structure).



Source: own calculation

Figure 4: Average age of Other machinery and equipment in 2013 in NACE A in Czech regions and relationship with necessary annual growth of investment to keep this average age constant (stable structure).

For Other machinery and equipment, the situation differs slightly. The first two regions remain the same as for Transport equipment – Prague and The Karlovy Vary region. Prague with the average age of capital of 5.4 years should keep an annual growth of new investment at 12%; otherwise the average age is going to increase. The Karlovy Vary region should maintain an annual growth of new investment at 7%. Regions with the highest average age in 2013 – The Moravian-Silesian and Zlin regions – have reached the age level of stationary structure and to preserve their average age of capital the amount of new investment does not need to change. If those regions realised an annual growth of new investment the average age would decrease.

The age of machinery reaches a below the stationary level and was decreasing in the examined period. Such development must be connected with the growth of capital stock. The described behaviour may be observed in a developing industry. However, Czech agriculture is also

characterised by a decrease in labour force (CZSO, 2015a). Therefore, the investment behaviour and the age development also emerges from the factor substitution.

Agriculture relates strongly with land which represents a production factor of a nearly constant (or slightly decreasing) quantity. Thus the reduction of labour force must reach its limits and at the same time the necessity of growing capital stock is likely to diminish. Since even a constant age below the stationary age requires an exponential growth of investment in constant prices, a fully developed industry with growth limits will reach a state fluctuating around the stationary structure and age. In international comparison (Krejčí et al., 2015), the age of fixed capital in United States of America and Commonwealth of Australia show a significantly smoother progression. Such development could be assumed in a developed industry.

Carrying out an age analysis shows that modernisation goals are partly fulfilled - the average age in the examined period is decreasing. Nevertheless, a proper evaluation is impossible as the desired age wasn't specified in the strategy documents. Moreover, the indicator should also work as a justification of the goal. The real necessityof modernisation in the whole industry is justifiable and long term sustainable only in case when the age is above the stationary level. Therefore, as the regional average age is below the stationary level the modernisation goal is currently justifiable only for strictly specified groups or smaller areas at the level of disaggregation that is impossible to cover by data of national accounts statistics.

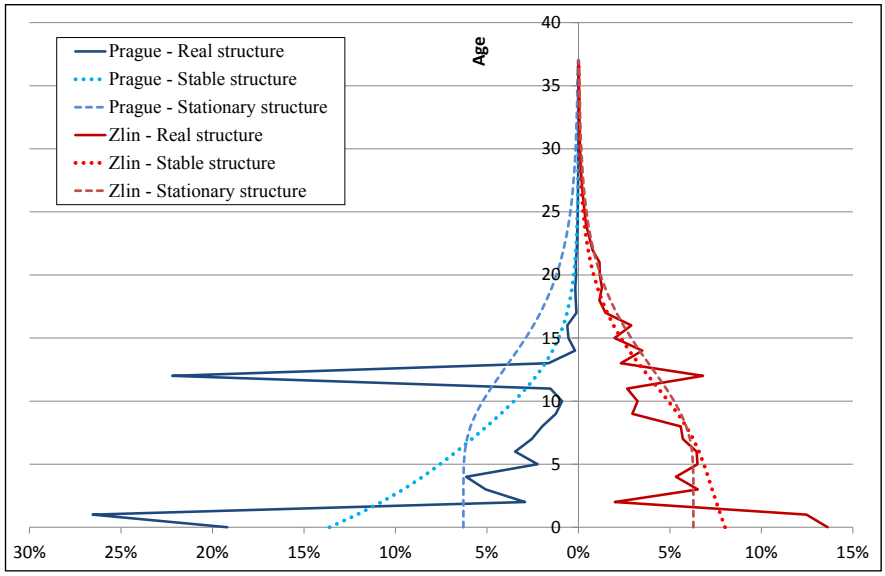
Table 4 shows structure variability according to (7) and (8). The results show that the highest difference between a real structure and a stationary and stable structure for all categories except one is in Prague. Zlin and Olomouc regions recorded their age structures very close to the stationary structure and if we compare the real and stable structure, the Plzen region is closing on it. The heading of the columns of "big" and "small" are connected with another disaggregation. The category "small" represents the institutional sector of Households (legal form of natural person holders). The "big" category contains all other institutional sectors, mainly non-financial institutions (legal forms vary – limited liability companies, joint stock companies and cooperatives). From that point of view, the closest to the stationary or stable structure is the category of Other machinery and equipment in the "big" subcategory.

Differences among age structures are graphically expressed in figure 5 and 6. Values for Zlin and Olomouc regions represent age structures with the closest structure to the stable structure and both examples of Prague show a high variability

Region	D^s				D^b			
	Transport Equipment		Other Machinery and Equipment		Transport Equipment		Other Machinery and Equipment	
	small	big	small	big	small	big	small	big
Central Bohemia Region	0.021	0.020	0.014	0.006	0.014	0.016	0.015	0.003
Prague	*0.105*	*0.060*	*0.060*	*0.046*	*0.081*	0.036	*0.038*	*0.026*
South Bohemia Region	0.019	0.019	0.012	0.004	0.014	0.016	0.013	0.002
The Hradec Kralove Region	0.026	0.021	0.015	0.006	0.017	0.016	0.016	0.003
The Karlovy Vary Region	0.029	0.026	0.020	0.009	0.016	0.019	0.014	0.004
The Liberec Region	0.029	0.043	0.026	0.011	0.021	*0.041*	0.026	0.008
The Moravian-Silesian Region	0.018	0.016	0.015	0.005	0.015	0.014	0.017	0.004
The Olomouc Region	0.015	0.019	**0.009**	**0.003**	0.012	0.017	0.010	**0.002**
The Pardubice Region	0.022	0.020	0.011	0.004	0.016	0.016	0.013	0.003
The Plzen Region	0.018	0.016	0.009	0.004	0.013	**0.013**	**0.011**	0.002
The South Moravian Region	0.026	0.024	0.014	0.005	0.019	0.020	0.015	0.003
The Usti Region	0.033	0.036	0.027	0.012	0.024	0.032	0.029	0.009
The Vysocina Region	0.021	0.018	0.012	0.005	0.014	0.014	0.012	0.002
The Zlin Region	**0.014**	**0.015**	0.011	0.003	**0.011**	0.013	0.013	0.002
Total	0.021	0.020	0.013	0.004	0.015	0.016	0.014	0.002

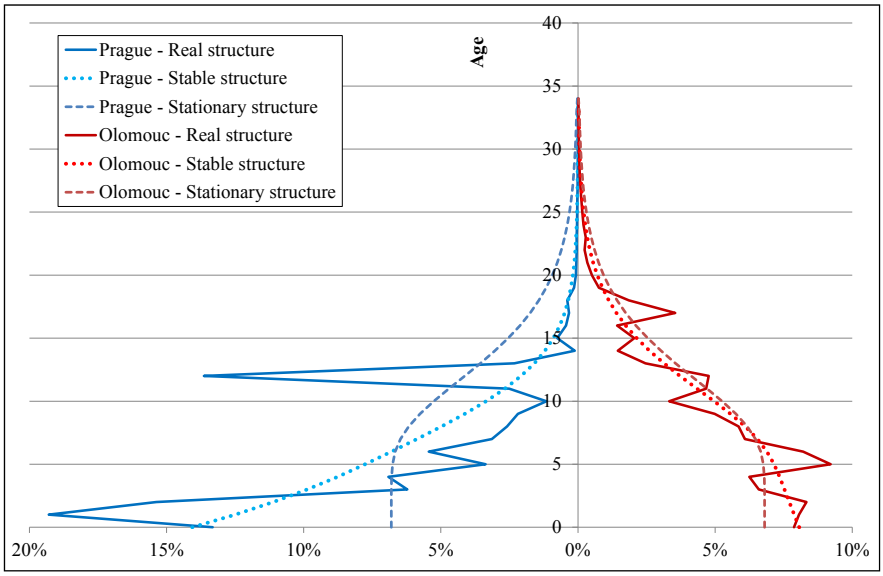
Source:Data on the Czech Republic are from the Czech Statistical Office (2015b), the regional data are own calculation

Table 4: Comparison of real age structure of regions in 2013 with stationary and stable structure.



Source: own calculation

Figure 5: Age structure of Transport Equipment-small in Prague and Zlin region (2013), comparison with stationary and stable structure for both regions.



Source: own calculation

Figure 6: Age structure of Other Machinery and equipment-big in Prague and Olomouc region (2013), comparison with stationary and stable structure for both regions.

in structure and a big difference from the stable structure. This arises from an occasionally high amount of new investment in certain years.

Conclusion

The paper deals with an estimation of the regional age of machinery and equipment in Czech agriculture. To carry this out, we adopt the variant of Perpetual Inventory Method that lead to the age structure. Secondary, we provide regional net fixed capital stock in NACE A for the period of 2008-2013. If a reader is interested in the differentiation of capital stock according to the type of an asset, we can provide such tables on request.

Similarly to demography, an occasional growth of investment represents a burden for the future. A short-run benefit in the form of a big amount of new assets and a drop of the average age is compensated in the long-run when the surviving part of the old investment pulls the average age up.

Keeping the age of machinery below the age of a stationary structure requires a permanent increase of investment. Such process could be expected in developing industries (similarly to demography where the same behaviour is observed in developing countries). The developing does not necessarily mean a completely new kind of production but also the establishment of the common economic activity in new region.

Because the size of agriculture as an industry is strongly interconnected with a relatively stable area of land, a permanent growth of investment in constant prices can hardly be expected. The long-term behaviour of developed regional agriculture should be characterised by mild oscillations in investment. Thus the real age equals to the stationary age or fluctuates around the stationary age. Currently, the most heterogeneous (i.e. bearing the aging burden) age structure of machinery and equipment occurs in Prague and the Karlovy Vary region.

From the perspective of modernisation goals as a common part of strategies and plans. Nevertheless, the decreasing average age does not represent the only possible kind of modernisation. A stable age in a developed industry means using adequate investment to avoid possible future problems. Investment decisions may not be considered as discrete time solutions but as a part of a continuous policy. Every shift of investment must be supported by an indication that it is going to be followed by a need for another renewal of investment in the future.

Our future research will aim on identifying the source of regional differences in the age structure and a connection to development plans and strategies. Moreover, we will focus on the evaluation of the difference between FADN and PIM data on capital stock.

Acknowledgement

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Integrated ICTs for Water Basins Management in Southern Africa: Systematic Review and Meta-analyses for Perceived Relevance Criteria

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Abstract

User-focused design and an implementation of a computer-based Information System (IS) or Information Technology (IT) are considered to play a key role in enhancing adoption, supporting activities and contributing to the sector specific sustainability goals. However, there are general concerns over the practical applications derived from records of failure rates of IS/IT projects in the developing world. This paper aggregates and analyzes stakeholders' perceived usefulness criteria that were documented from water basin focusing on IS and related projects in Southern Africa. Systematic literature reviews and meta-analysis were adopted for data collection and analyses. Literature with academic, practice and hybrid viewpoints was collected from five water basins in Southern Africa. Designed data collection flow chart guided the search for appropriate literature. Analyses of the data were performed by using Statistical Package for Social Sciences (SPSS). Results of the search were classified and presented basing on the domain, yearly waves from 2000 to 2015, trans-basin nature and basin of focus. Literature was distributed across the classes at different magnitudes. The study has found out that relevance criteria as measure of usefulness have been incorporated in designing and implementing the IS/IT projects in the river basins. However, incorporation of relevance criteria was periodically increasing with technological advancement and increasing complexity of managing the water basins. In general, it was responsive to increasing challenges of water resources in the developing countries. This anticipated better results at the levels of output, outcome and impacts of IS/IT projects in the Southern Africa. The study concludes that the current trends of incorporation of the relevance criteria in designing and implementing the IS/IT projects on water resources are potential for impact-based interventions in Southern Africa.

Keywords

Water basins, integrated ICTs, Southern Africa, relevance criteria, meta-analysis.

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Introduction

Relevance judgment, as a formal evaluation, is normally based on criteria. A set of criteria is usually established over time and should be known by the key stakeholders who make use of them. A rigorous measurement of an object's relevance, primarily, depends on validity and reliability. The latter two terms, respectively, describe the accuracy of a measurement as well as its ability to repeatedly produce the same results under similar conditions (Wholey et al, 2010). Rapid deployment of Information and Communication Technologies (ICTs) to support management of water resources in the developing world is among the efforts to address the challenges facing this critical resource for life. However, in Africa and developing countries in general, there are reports showing that ICT for Development projects were not well performing (Heeks, 2003; Dodson et al., 2012). Among the reasons associated with this status were inadequate involvement of stakeholders - hence lack of ownership, inadequate link between a problem and solution that ICT is placed to contribute and generally donor dependency. All of these contribute to lack of sustainability of projects and eventually the way they addressed challenges facing the target sector. Consequently, recurring observations have triggered a question: "How relevant were the ICTs for development

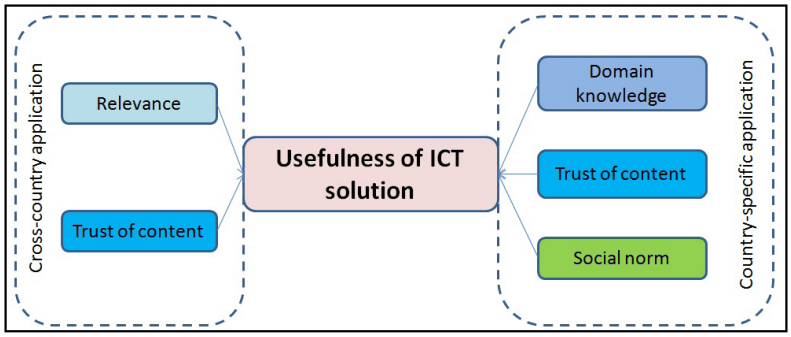
in Africa?" In attempts to answer the question, it is observed that intuitive relevance (or judgment based on common sense) has often become dominant over "inferential relevance", therefore, producing answers with inadequate validity and reliability. Usage of the term "relevance" in intuitive way somehow does not distinguish it from any other English word. Within these circumstances, the "inferential side" of relevance is often ignored. Ambiguity associated with this kind of usage has, eventually, raised the level of concerns over validity and reliability of conclusions made on ICT relevance in Africa.

The role of ICTs for addressing challenges of shrinking water resources is as sound as the importance of water itself. Water resources are used in everyday life for agriculture, household and industry consumption. However, at basin levels, water and agriculture forms a clearer nexus. Water and agriculture are inter-related sectors of a significant importance in developing countries. Agriculture remains to be the engine of economies with water supporting irrigation for agricultural growth and poverty reduction (van Koppen et al., 2005). One of the basic characteristics of water basins in Southern Africa is that availability of suitable irrigable soils along the international rivers is, in general, much greater than the availability of water to support such irrigation (Nakayama, 2003). Inadequate water supply is caused by both traditional and emerging challenges. Traditional challenges have been the population growth and urbanization. While the former drives overutilization beyond threshold to meet the needs of increasing human population, the later is extending fragile resources, increasing pollution from industries and unplanned urban settlements (Kgathi et al., 2006). Amid these challenges, is climate change, which is a factor playing a compounding role making the water basins even more fragile.

More than 90% of water basins in Southern Africa are trans-boundary (Jansky, et al., 2005). The management of vital water resources in these basins is challenged by inadequate: (i) Participation of users; (ii) Coordination of decision-making; and (iii) Control. Technological tools are considered among solutions to address these challenges facing water basins, which are potential areas for agriculture and forestry across the world. Technologies for collecting data and processing them into information, disseminating information and creating as well as transforming knowledge into impactful actions, are being embraced across the scales and dimensions of the ecosystems. Innovative combination of modest and advanced technologies including ICTs is also being tested and or used. Examples are the usage of radio networked with remote sensors; possibility of combining robots with sensors and other software platforms; the Internet web-portals and mobile phones; or the internet web-portals, remote sensors and the higher end mobile phones. User-focused designing and implementing the ICTs is generally considered to play a key role in enhancing adoption, supporting activities as well as contributing approach to meeting the sector specific sustainability goals. However, there are general concerns over the practical applications derived from the records of the failure rates of ICT projects in the developing world. One of the reasons is inadequate involvement of users and thereby not incorporating their needs during the design and implementation phases. Consequently, there is often a missing link between the strategic objectives, processes and the anticipated outcome of such projects.

The Technology Acceptance Model (TAM) which was developed in the late 1980s, has for the last two decades provided a framework for understanding the technology adoption among users. Davis (1989) suggested that, the technology acceptance depends on two main constructs: a perceived usefulness (PU) and a perceived ease of use (PeoU). Although since its formulation, the theory has been revised several times, the two constructs have remained the same. Hundreds of studies on TAM have happened in the developed countries, where the environment for technology acceptance is different from developing countries.

Literature on TAM, that was published recently, indicates slightly different on the importance of the two constructs in both developed and developing world. For example, Miller and Khera (2010) found out that, PU was much stronger predictor of intent to use a technology than PeoU. Furthermore, the study had tested five PU factors which are likely to influence the intent to use a technology: relevance, trust on content, visibility, social norm and knowledge domain. Each of these factors was hypothesized to predict the perceived usefulness across countries. They also found out that, relevance was the strongest factor followed by the trust on the content in influencing the cross-country usefulness of ICT solutions (Figure 1). Social norm and knowledge



Source: Created from Miller and Khera, 2010

Figure 1: Factors influencing usefulness at national and international scales.

domain had a significant relationship at the country level while visibility was insignificant both within as well across countries.

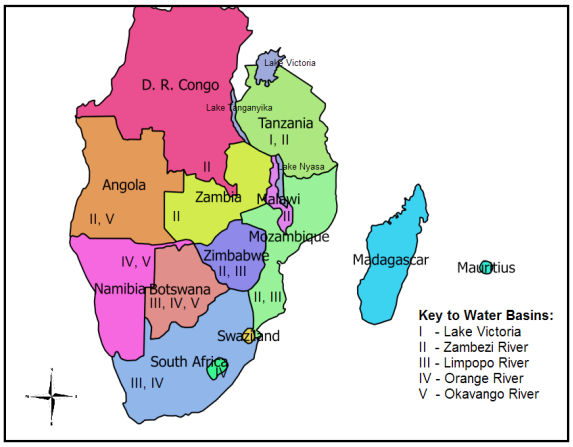
Along this background, we are considering that stakeholders' involvement during designing and developing the technology is the key factor in perceived relevance of ICT for water basins management in the Southern Africa. Relevance is a multi-reference term which was formalized in the end of 1950's within the information science field.

However, with time, the term has found an application in individual disciplinary, trans-, cross- and multi-disciplinary studies. In the information science, relevance was originally defined by using two viewpoints: system-oriented and user oriented (Vickery, 1958). However, with applications of relevance expanded, alternative ways to relevance definition has been proposed. One of them is a logical way with reference to three parameters: A which stands for "Activity", T for "Thing" and G for "Goal" (Hjørland and Christensen, 2002). The three parameters should align in such a way that a meaningful contribution to the goal could be tracked (ibid). Relevance concept can thus, form a basis for result-based design and evaluation of an information system for water and other sectors. This study uses the TAM to theoretically and systematically understand the aggregate nature and trends of the relevance criteria of ICTs applied for the basin wide management of water resources in the Southern Africa. Specifically, the study sought to answer the following questions:

1. To what extent did the collected and reviewed literature on relevance were distributed in time and space?
2. How aggregate perceived relevance criteria related to ICT for water resources from selected literature were visualized between 2000 and 2015?

Materials and methods

The study focuses on water basins in the Southern Africa region especially on the ICT projects that were implemented in the Lake Victoria Basin, Limpopo River Basin, Zambezi River Basin, Orange River Basin and Okavango River Basin between 2000 and 2015 (Figure 2). This paper adopts a systematic review approach to data collection.



Source: Authors' construct aided by existing base maps

Figure 2: Specific water basins of the Southern Africa of which literature were cited.

Literature with academic view points from published and unpublished research reports were collected on projects conducted in five water basins in Southern Africa listed above. In addition, literature with practitioners view point as well as hybrid views complemented the list of publications. The data collection flow chart with five key steps was adopted as a search strategy designed that focused on: (1) Generic literature related to integration ICTs, water basins, information technologies or information systems; (2) Filtration from step

(1) of literature that were available between the years 2000 and 2015; (3) Filtration from step (2) of literature on issues that were related to the two domains of interest: ICT and water resources management; (4) Filtration from step (2) of literature on projects that were implemented solely on a particular basin or across the study areas; and (5) Filtration from step (2) of literature on relevance. Full texts of literature obtained in step (5) were then read in details to identify surfacing relevance criteria.

Step 1: Generic search for literature generated titles of over 400 documents including journals, books, reports, newsletters and bulletins. Gray literature was validated through tracking and assessing the publishers' websites and the cross-links.

Step 2: Skimmed abstracts revealed that 256 were published between years 2000 and 2015.

Step 3: Among the literature obtained from step (2), 215 informed about ICTs for water resources either at theoretical or practical levels as well as at the regional and/or international scales.

Step 4: Out of literature in step (2), 121 informed about ICT related interventions for one or more of the target sites.

Step 5: At last, 75 out of literature in step (2) informed about the relevance in the contexts of interest, thus, were selected for detailed full-text readings in order to explore more about the perceived relevance criteria. The template composing of attribute of the relevance, explanation and examples was adopted in defining the criteria (Table 1).

Attribute of relevance	Explanation	Examples
Tool	ICT tool developed to support water basin management activities	Web-based, mobile-based tools as well as combination of these tools with community radio
Activity	Water basin management activity supported by the tool	Data collection and processing, data storage, as well as information dissemination
Results	Immediate, intermediate and a long term effects on water basin management.	Enhanced information sharing, reduced conflicts on water allocation, and eco-equity sustainability

Source: Modified from Kontio, et al. (1996)

Table 1: Definition template of relevance criteria.

Summaries of the criteria and associated data were entered in IBM Statistical Package for Social Sciences (SPSS) spreadsheet. Classifications, clustering and trend analyses were performed on the dataset. Analyzed results were further summarized into a visual sketch by using selected waves. A wave was an interval period of 5 years that was used in this study to simplify the trend analysis and visualization of perceived relevance criteria.

Classification of literature reviewed was done in four different classes representing four steps (2-5): First, by domain - technology-based domain (ICT/IS/IT) and a cross-disciplinary domain (Water/Environment/Agriculture). The second was by three waves each with different socio-technical characteristics. Thirdly, by basin, with cross-basin and specific basin based literature. Finally, by sources, focusing on either mainstream IS journals/books or other sources (Donors, host organizations, networks etc).

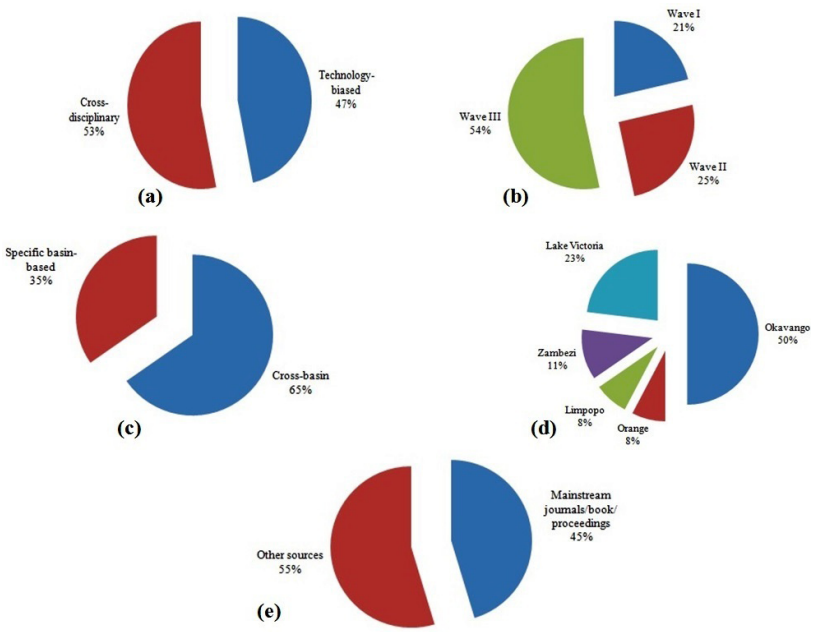
Results and discussions

1. Classifications of literature reviewed

Domains representation is shown by Figure 3a. The majority of publications and other gray literature were cutting across the disciplines (53%) while those from ICT disciplines constituted 47%. This implied that, the socio-technical orientation of ICT solutions for water resources management had been well addressed.

The first wave from 2000/01 to 2004/5 was characterized by establishment or strengthening the formal organizations to address the challenges of a shared water resources in the region. Some of these were Okavango Commission (OKACOM), Orange–Senqu Commission (OSC) and The Limpopo Basin Commission (LBC). Activities such as strategic environmental assessments and strategic action plans were conducted in Okavango, Limpopo and Orange River basins (Nakayama, 2003). ICT solutions were mainly for decision support (Nakayama, 2003; Salewicz, 2003). They were targeting only key stakeholders that participated in decision making. For example, DSS and Trans-boundary Freshwater Dispute Database (TFDD) had the common purpose of preventing conflicts among riparian members. Only 21% of the literature reviewed fall within this wave (Figure 3b).

The second wave from 2004/05 to 2009/10 was characterized by increasing the computational power, booming mobile hardware and networks as well as the emphases towards more participatory ICT tools design and development (Jansky et al.,



Source: own processing

Figure 3: Classifications of literature reviewed.

2005; Andersson et al., 2006; Hughes et al., 2006; Hermans et al., 2006; Macintosh and Whyte, 2008). There was more literature (25%) in this wave compared to previous one. The third wave from 2010/11 to 2014/15 was characterized by even more advanced and accessible computing power, mobile hardware and networks. Socio-technical emphasis was not only on the stakeholders' involvement but also on the public engagements. During this wave, concepts like citizen science, citizen sensors and citizen actuation had emerged (Crowley et al., 2013). Majority of the publications and other gray literature (54%) were found in this period.

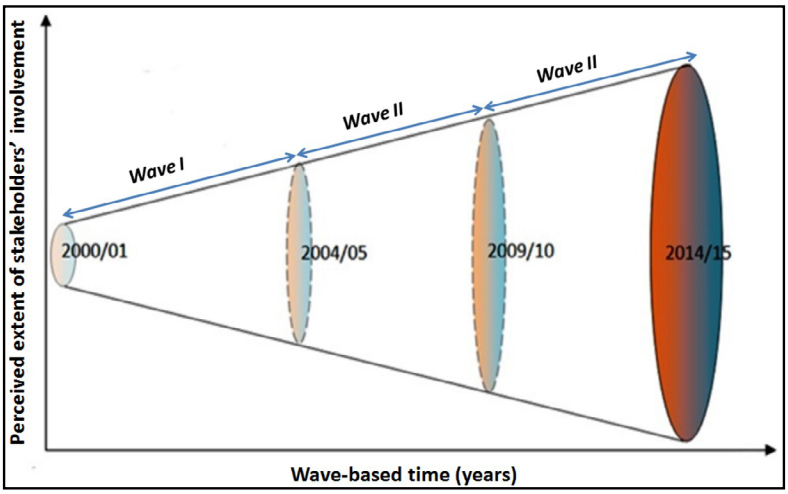
Again the majority of literature reviewed was on cross-basin issues for about 65% while basin-based publications composed only 35% (Figure 3c). In the latter category, Figure 3d shows that Okavango river basin composed the greatest share by 50%, followed by Lake Victoria basin by 23% and then the following river basins: Zambezi by 11%, Orange and Limpopo (Each by 8%). Majority of the literature reviewed were from other sources with 55% while those in the mainstream journals/books/proceedings were 29% (Figure 3e).

2. Trends and aggregation of relevance criteria

The relevance of ICT for water resources management across the waves was determined by both social and technical criteria. Figure 4 shows the three waves, their corresponding yearly intervals and perceived extend of stakeholders' involvement. During wave I, web-based solutions were limited by bandwidth and network coverage; therefore, ICT solutions in the study area were predominantly desktop.

Cost effectiveness was therefore a major criterion. The accessibility to the information during this time was constrained by escalating costs, where access to web-based information, was limited to elites and above the average income earners. Bruch (2003), focused on comparison between cost related to access and usage of ICTs; and contributions in reducing costs related to conflicts in water basins. Apart from the cost effectiveness, other criteria were the quality of information and openness. The quality of information entailed the fitness for the purpose, reliability and legitimacy of information sources (ibid). Majority of ICT solutions for the water resources management during this period, were tools to support decision making (Bruch, 2003; Pereira et al., 2003; Salewicz, 2003). However, hardware constraints such as processing power, portability and storage capacity formed important criteria for consideration in acquisition of ICT solutions.

During wave II, the advancements of ICT in terms of hardware, software and networks changed the emphasis on the relevance criteria towards more participatory ones. Mobile devices including laptops, mobile phones and personal



Source: own processing

Figure 4 :Trends and aggregation of usefulness criteria during different waves.

digital assistants (PDAs) as well as the improved mobile networks created an environment for ICT to support a wide spectrum of stakeholders in the water basin management. Alongside the enhanced portability, there was also an increase in the processing power and storage capacity, which improved the desktop-based solutions. The study by Jansky et al. (2005), revealed that the roles of information systems of informing, automating and transforming were discussed in line with a suggestion for a semi-automated web-based tool to support participatory data collection and management. Data were collected in the field and transferred to the web-servers for management and processing. Although Hughes et al. (2006) focused on Vietnam, the main criteria identified such as flexibility and adaptability apply in other areas including Southern Africa. While flexibility and credibility of tools that support participation or collaboration were emphasized, other criteria such as analytical capability and energy efficiency were suggested.

The most recent wave (wave III) suggested the relevance criteria that were more inclusive in terms of solving societal challenges by using the technology. Computing power continued to increase while portable and fast hardware that support big data storage increasingly became affordable. Software including mobile applications and open source also became accessible and networks coverage and costs became more inclusive. All these were opportunities to advance solutions by communities themselves. Relevance criteria in this phase were those which were related to supporting public engagement; where more actors were included in efforts to solve the water basin problems. Real-time capability of collecting, analyzing and sharing information; web-based solutions to facilitate integration; open standard and flexibility to facilitate access to new and existing databases, were important aspects for basin wide management. Other criteria such as redundancy, interoperability, open standards, quality assurance and multi-language user support had been listed in the literature belonging to wave III. The above criteria were emphasized where integration (combination) of software, hardware and/or procedures were attempted (Zarli et al., 2014; Vitolo et al., 2015; Badjana et al., 2015; Kralisch et al., 2013).

Conclusion

1. Conclusion

This study concludes that despite its huge geographical coverage, issues at the interface of ICTs and water resources in Southern Africa were limited in the literature. Systematic reviews and meta-analysis of the literature contents revealed their distribution across disciplinary domains, yearly wave intervals, the basin location and research outlets. The trends and aggregation nature of perceived relevance criteria of ICTs for water resources management has revealed changes driven by the technological advancement and societal challenges. There was a notable shift from more technological oriented criteria to socio-technical criteria, often with engagement of the public beyond the key stakeholders. The usage of the combination of hardware, software and languages with human-centered approaches were therefore broadly guiding analysis, design

and implementation of ICT solutions for water basins in Southern Africa.

2. Future work

Results and conclusion from this paper may be part of the recipe for further studies intended to assess and evaluate relevance of ICTs applied for the management of water resources in the river and lake basins in Southern Africa as well as in similar environments in developing countries. The identified perceived relevance criteria, though not exhaustive, would help in designing a more robust template or framework to guide the output, outcome and impact evaluation of ICTs and thereby justify for current deployment status in the study area and beyond. Research towards a potential template and possibly framework is being undertaken by Department of Information Systems at The University of Dodoma. This study is expected to partly inform the said research process.

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Mobile Broadband for the Farmers: A Case Study of Technology Adoption by Cocoa Farmers in Southern East Java, Indonesia

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Abstract

The objective of this paper is to examine the factors that affect Indonesia cocoa farmer intention to use mobile phone application. The main factors examined in this study are perceived usefulness (PU), perceived ease of use (PEOU), business factors and individual factors. The study sample consists of 191 respondents in thirteen cocoa farmer centers in southern East Java. Data were analyzed by employing Structural Equation Modeling (SEM). The findings revealed that the user intention on adopting mobile phone application especially by cocoa farmers is significantly impacted by social influence and this is in line with the massive growth the usage of social media application in Indonesia, other factors that determine the adoption are competitiveness pressure and cost perception. This research has a limitation that the generalizability of the findings is limited to the geographical scope of the sample. Based on findings, as the practical implications of this study, to get a higher rate on the adoption of mobile phone application, stakeholders need to ensure the benefit of technology adoption by providing more secure, more comfort, and more sounds like cloud ecosystem to increase the perception on ease of use and perception of usefulness. Novelty of this study is the combination of business factors and individual factors on the existing model of Technology Acceptance Model (TAM).

Keywords

Technology Acceptance Model (TAM), Five Forces Porter, Cocoa Farmer, Mobile Broadband, Structural Equation Modeling (SEM).

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Introduction

The emerging growth of mobile phone application and its' utilization are enabled by the convergence of rapid growth of broadband infrastructure development and penetration of mobile phone. Some studies highlighted the positive impact of broadband development to the economic development of a country.

Globalization will accelerate the utilization rate of information and communication technology which will contribute to the economy, for every 10% increase in broadband penetration as a main infrastructure of internet will increase GDP of 1%, and double increase in broadband speed will increase GDP up to 0.3%. This positive impact is due to automation and simplification of the process, increase of productivity, and better access on education and health facility (ADL, 2011). Based on the study by Boston Consulting Group (2010) about economy value of internet in G-20 countries stated that internet penetration in Indonesia contribute 1.3% of total GDP in 2010 and projected to reach 1.5% of GDP in 2016. This number is relatively lower compared to other G-20 countries which is 5.3% of total GDP, and potentially reach a higher rate if we compare to other G-20 countries achievement of average 5.3%.

Indonesia is an agricultural country given the role and contribution of the sector to the economy. Daryanto (2009), as cited in Nabhani et al. (2015A), the agricultural sector has always been a mainstay in the development of the national economy despite facing greater challenges as the influence of globalization which requires the necessity of building a strong competitiveness and a specific requirement in building the competence in agro-technopreneurship is concern and awareness

of the e-commerce, information technology and application of the latest technology (Gumbira-Said, 2010) as cited in Nabhani et al. (2015A).

One of the seed Indonesia agriculture commodities is cocoa which put Indonesia as a top three global producer country (ICCO, 2012) and in Indonesia, this commodity plantation is dominated by farmers rather than estates or corporations (Panlibuton, 2004).

USAID (2013), in their study reported that information and communication technology help farmer in expanding their market by finding new buyers, getting the highest price and trading management, compliance, and better production management. Other benefit is access to technology and information which will expand their basic income as part of their sustainability strategy (UNDP, 2012), and according to FAO (2013), the role of information and communication technology in agriculture are better production system management, access to the market and financial institution; and cellular phone is the most favorite device use by the farmers in their social networking with other farmers or agriculture expert. It is also found that the utilization of m-commerce remain as the epicenter of ongoing digitalization of peoples‘ life (Pousttchi et al., 2015).

Nabhani (2015B) states that there is a possibility to explore the massive development of broadband infrastructure to give the benefit to Indonesia cocoa farmers by giving them access to a wider market and latest technology, it might increase the degree of complexity of production process but on the other hand will give them access to niche markets that appreciate a more sophisticated type of product.

Davis (1989) introduced Technology Acceptance Model (TAM) with a background of recent development on computer technology and its adoption by organization and any conducted research could not explain the resistance or acceptance on a new system. He proposed that user motivation could be explained by the following factors: perceive ease of user, perceived usefulness and attitude toward using with a hypothesis that the intention behavior is a main factor that will affect the actual system use. Somehow, this intention is influenced by two main perceptions which are perceive usefulness and perceive ease of use. These two factors were affected by the characteristic of system design represented by external variables. This study analyses the cocoa farmer’s acceptance on massive mobile phone application penetration in Indonesia using the expansion of basic theory of Technology Acceptance Model developed by Nabhani (2015A).

Materials and methods

This study analyzes the farmer’s acceptance on mobile phone application technology using the modified Technology Acceptance Model developed by Nabhani (2015A), a model that combined the business factors and individual factors as the latent variables that impacting user’s intention on adopting new technology through Perceived Usefulness (PeU) and Perceived Ease of Use (PEOU) on introduced technology.

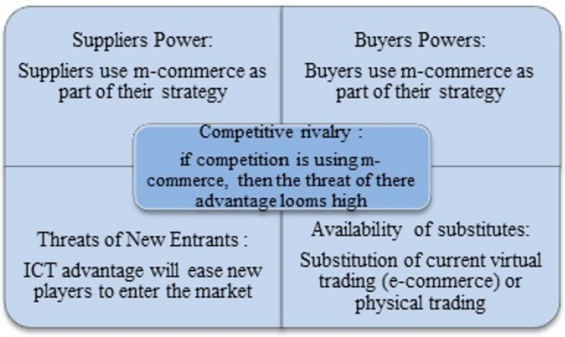
Based on the problem statement mentioned above, the research objective of this paper is to identify and determine the impact of business factors and individual factors that influences the adoption of mobile phone application by cocoa farmers.

Literature review

Nabhani (2015A) developed a modification of Technology Acceptance Model that initially a theory and model introduced by Davis (1989) by adding business factors and individual factors as the determinant factor of Perceived Usefulness (PeU) and Perceived Ease of Use (PEOU) that finally will impact to user’s intention on adopting introduced technology.

Business factors

To define the business factors that will influence an individual/organization in technology adoption decision, this paper uses Five Forces Porter as the key variables. In order to secure their advantage in the market place, five competitive forces were those that organizations needed to heed Porter’s (1979). This will include the threat of new entrants, bargaining power of customers, bargaining power of suppliers, threat of substitute products or services and jockeying among current customers. A firm need to put a plan of action in a strategy against these forces, positioning the firm with their capabilities to provide the best strategy over the competitive forces, influence the balance through strategic moves in order to improve the company’s position, and anticipate shifts in the factors underlying the forces and responding to them (Porter, 1979) (see Figure 1).



Source: Swilley, 2007

Figure 1: Mobile commerce adoption using Five Forces.

Swilley (2007) included the five forces Porter as part of business environment that were taken into account during the adoption of m-commerce with the following considerations:

- Threats of New Entrants - mobile commerce service will ease new players enter into the market.
- Power of Suppliers – if it is already adopted by the suppliers, it will become a competitive advantage to use the same communication technology.
- Power of Buyers – as adopted by the buyers, a firm need to consider to user the same technology
- Competitive rivalry - if competition is using m-commerce, then the threat of the advantage looms high
- Availability of substitutes - is a substitute of current virtual trading (e-commerce) or physical trading

Individual factors

This paper addresses some findings from previous researches as follow:

1. Perceived cost

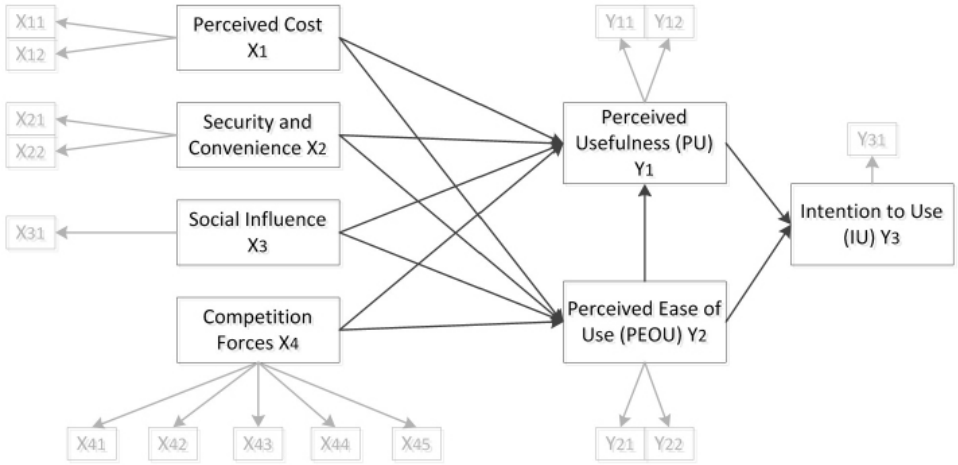
Wymer and Regan (2005) in their research concludes that from all the factors affecting the m-commerce adoption that consistently exist across all groups was cost perception as the barrier. Khalifa and Shen (2008), combine the variables of Theory of Planned Behavior (TPB) which are subjective norm and self-efficacy into Technology Acceptance Model (TAM). Five external variables identified on the research were perceived cost, privacy, security, efficiency, and convenience. A cross-sectional survey study to B2C respondents in Hong Kong was performed to test the research model. Islam (2011) in his research on m-commerce adoption in Bangladesh by mobile users used the variable of perceived cost, comprehensive and updated information, security and convenience as key factors on m-commerce adoption.

2. Social influence

The social influence is determined by how any human society use any new system and how it is perceived by an individual for making improvements in their living condition and status (Sadia, 2011) and most people uses any system or services because of the opinion of others or by observing different people in different situations (Davis et al., 1989)

3. Security and convenience

These variables were raised by Khalifa and Shen (2008), Islam (2011), Yu (2013) and Al



Source: own processing

Figure 2: Conceptual framework.

Khasawneh (2015) on their research in examining the m-commerce adoption. Security refers to the safety of exchanged information (Khalifa and Shen, 2008) especially on sensitive personal info (Yu, 2013) such as credit card number, address, and phone number, while convenience refers to the extent to which m-commerce makes easier for customers to conduct transactions compare to traditional way (Khalifa & Shen, 2008) (see Figure 2).

Research method

This study employed descriptive quantitative data analysis. Hypotheses were developed from theoretical reviews and empirical studies. Subsequently it followed a confirmatory strategy of research in which a process of confirming or disconfirming hypotheses is employed to answer previously identified research questions.

1. Sampling procedure

In this study, a non-probability sampling was employed, and the sampling method used was convenience sampling. The sampling frame consisted of farmers in thirteen cocoa centers in southern East Java (Bakung, Gandusari, Kademangan, Kediri, Kesamben, Malang, Ngantang, Selopuro, Selorejo, Srengat, Trenggalek, Tulungagung, and Wonotirto). The survey method used a standardized questionnaire to collect desired information from respondents. In anticipation of a low response rate, the personal survey interviews were conducted between Octobers to December 2015. Prior to conducting a full scale survey, a pilot-test to 10 respondents was executed to solicit feedback in terms of understanding of the survey wording and evaluate the measurement reliability and validity.

2. Operational variable and definition

All data was generated from questioners and was designed, based and modified on previous studies.

- **Intention to use**. It is users' feeling on their encouragement to utilize the mobile commerce services, users' impression, prefer to interaction through m-commerce, and expect their stakeholders to use it. Adopted from Davis (1989) using Likert scale (1-5)
- **Perceived usefulness**. It is the level of confidence of users that the service will provide benefits to the business, work faster, more efficient, easier, more effective, and give the overall benefit. Adopted from Davis (1989) using Likert scale (1-5)
- **Perceived ease of use.** The level of confidence of users that the service is easy to use consist of easy to learn, easy to administer, easy to interact with, easy to become proficient, and easy to understand in overall. Adopted from Davis (1989) using Likert scale (1-5).
- **Business pressure**. Business pressures to adopt m-commerce services, it means new players in the market, supplier power, buyer power, competitors with m-commerce, substitution to e-commerce service that already exists. Adopted from Swilley (2007) using Likert scale (1-5)
- **Perceived cost.** Perceptions about the cost of technology adoption such as the price of smart phones and internet connection tariff. Adopted from Islam (2011), Khalifa and Shen (2008), and Li et al. (2007) using Likert scale (1-5)
- **Security and convenience**. Level of security and convenience in doing transaction via mobile device. Adopted from Chen et al. (2013), Sadia (2011), Wei (2009), and Bigne et al. (2007) using Likert scale (1-5)
- **Social influence**. User adoption impacted by their community adoption on m-commerce. Adopted from Sharma and Gupta (2003), Sadia (2011) and Yu (2013) using Likert scale (1-5).

3. Hypotheses

This research examines the following hypothesis:

H_1: Cost perception has positive impact to perceive usefulness (PU)

H2: Safety and security have positive impact to perceive usefulness (PU)

H_3: Social influence has positive impact to perceive usefulness (PU)

H_4: Cost perception has positive impact to perceive usefulness (PU)

H_5: Cost perception has positive impact to perceive ease of use (PEOU)

H_6: Safety and security have positive impact to perceive ease of use (PEOU)

H_7: Social influence has positive impact to perceive ease of use (PEOU)

H_8: Competitiveness pressure has positive impact to perceive ease of use (PEOU)

H_9: Perceive ease of use (PEOU) has positive

impact to perceive usefulness (PU)

H_{10}: Perceive ease of use (PEOU) has positive impact to intention to use (IU)

H_{11}: Perceive usefulness (PU) has positive impact to intention to use (IU)

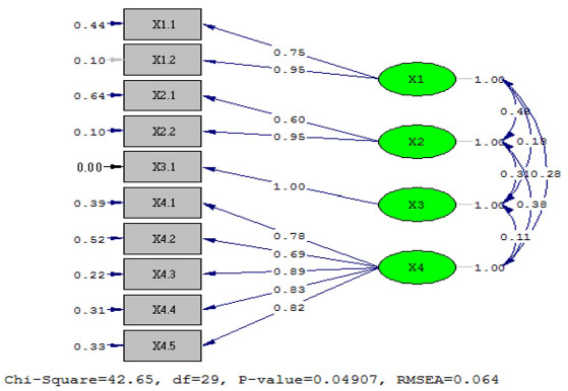
Results and discussion

Results

Based on descriptive analysis on the sample's profile, this paper reveals some high level findings. Firstly, 48% of the age of cocoa farmers is above 55 years old, meaning that Indonesia cocoa is facing problem on farmer regeneration (Nabhani et al., 2015B). Secondly, in term of education level, 60% of sample are below senior highs school, Zhang (2009) concluded that the lower educational level the lower their technology adoption capability. Thirdly, based on in-depth interview with cocoa farmers association, the feasibility level of cocoa plantation will meet the scale if the plantation area is above 0.5ha and it is represented by 24% of sample size. Out of total 193 respondents, mobile phone penetration is 60% and smart phone penetration is 24%. To gain a better insight of respondent and firm profiles, distribution frequency was used and the results are shown in table 1.

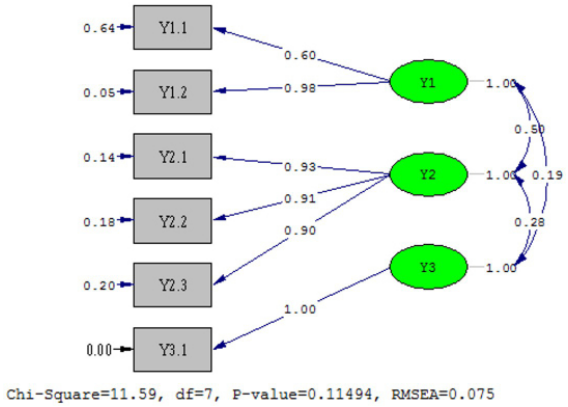
Validity and Reliability Test

The statistic procedures in LISREL were utilized on conducting the validity and reliability test. Based on the result as shown in the table 2 and table 3, it is concluded that all the indicators of both exogenous and endogenous variables in the model are valid (SLF ≥ 0.50dan |tcalc|>1.96) and reliable (CR ≥ 0.70 and VE ≥ 0.50).



Source: calculation result

Figure 3: SLF of exogenous variable in farmer's adoption model.



Source: calculation result

Figure 4: CFA of endogenous variable in farmer's adoption model.

Individual profile				Business profile			
		Count	% age			Count	% age
Age	<25	16	8%	Year of business	<1	5	3%
	25-55	84	44%		5.I	69	36%
	>55	91	48%		>5	117	61%
Gender	Male	51	27%	Plantation area	<500m2	88	52%
	Female	140	73%		500m - 0.5ha	41	24%
Education	< High School	115	60%		0.5 -1 ha	10	6%
	High School	69	36%		>1ha	30	18%
	Diploma	2	1%	Communication device	Feature Phone	70	37%
	Bachelor/Master	5	3%		Smartphone	46	24%
	Doctoral Degree	0	0%		No Phone	75	39%

Source: calculation result

Table 1: Respondent profile.

Variable	Indicator	Loading factor	ei	Tcalc	CR	VE
Cost perception	X1.1	0.75	0.44	9.17	0.843	0.731
	X1.2	0.95	0.1	13.69		
Security and safety	X2.1	0.6	0.64	5.9	0.765	0.63
	X2.2	0.95	0.1	8.35		
Social influence	X3.1	1	0	15.17	1.000	1.000
Competitiveness	X4.1	0.78	0.39	9.17	0.901	0.647
	X4.2	0.69	0.52	8.2		
	X4.3	0.89	0.22	11.79		
	X4.4	0.83	0.31	11.07		
	X4.5	0.82	0.33	10.44		

Source: calculation result

Table 2: Validity and reliability of exogenous variable.

Variable	Indicator	Loading factor	ei	Tcalc	CR	VE
Perceive ease of use (PEOU)	Y1.1	0.60	0.64	5.58	0.783	0.725
	Y1.2	0.98	0.05	7.60		
Perceive usefulness (PU)	Y2.1	0.93	0.14	12.93	0.896	0.812
	Y2.2	0.91	0.18	12.41		
	Y2.3	0.90	0.20	12.20		
Intention to use (IU)	Y3.1	1.00	0.00	15.17	1.000	1.000

Source: calculation result

Table 3: Validity and reliability of endogenous variable.

Path Coefficient and T-test

The conceptual structural equation model was tested using LISREL 8.80, as shown in above table, the chi-square (χ^2) is equal to 101.48 with the degree of freedom (df) is equal to 70, so that the χ^2/df (chi-square to freedom ratio) is 1.45 which is less than the cutoff good fit < 3.0, this indicates a good fit between the model and the collected data (Kline, 2004). As shown in table 4, seven out of eleven hypotheses received significant supports (H_1, H_2, H_3, H_6, H_7, H_9, and H_{11}), while four hypotheses where rejected (H_4, H_5, H_8 and H_{10}).

Path		Path coefficient	T calculation	Remark
X1 → Y1	γ_{11}	0.38	5	Signficant
X2 →Y1	γ_{12}	0.15	1.83	Signficant
X3 →Y1	γ_{13}	-0.16	-2.43	Signficant
X4 →Y1	γ_{14}	0.09	1.17	Not Significant
Y2 →Y1	β_{12}	0.16	1.37	Not Significant
X1 → Y2	γ_{21}	0.3	4.52	Signficant
X2 → Y2	γ_{22}	0.27	4.33	Signficant
X3 → Y2	γ_{23}	-0.09	-1.39	Not Significant
X4 → Y2	γ_{24}	0.29	5.9	Signficant
Y1 → Y3	β_{31}	0.14	0.65	Not Significant
Y2 → Y3	β_{32}	0.31	2.36	Signficant

Note: if $|t_{calc}| > 1.96$ → significant
Source: calculation result

Table 4: Evaluation on path coefficient and tcalc.

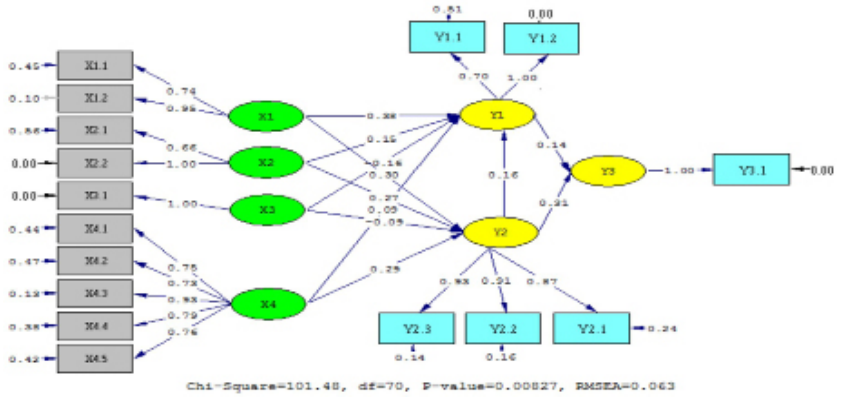
Goodness of Fit (GOF)

Based on the GOF table calculation result as presented in table 5, all indicators indicates that the model is good and fit. The questionnaire result is able to confirm the developed theory. The model shows a good fit between the conceptual model and the data with RMR = 0.044, RMSEA = 0.063, GFI = 0.99, AGFI = 0.98, CFI = 1.00, NFI = 0.98 (Designed cutoffs: RMR ≤ 0.05 or ≤ 0.1, RMSE RMSEA ≤ 0.08, GFI ≥ 0.90, AGFI ≥ 0.90, CFI ≥ 0.90, and NFI ≥ 0.95, Hair et al. (2010)).

Discussion

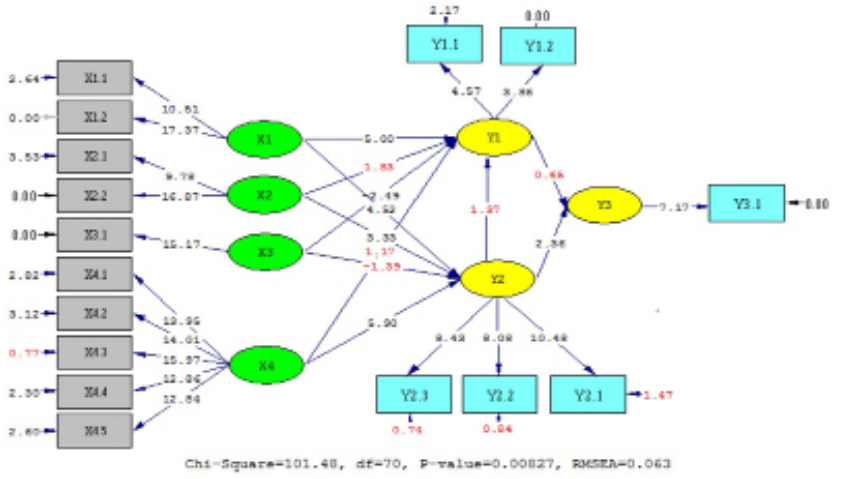
This study is performed to examine the factors (both business environment and individual) influence the acceptance criteria of the mobile phone application and in line with some recommendation from previous studies that an empirical study shall be conducted to some specific products/services in specific industries (i.e. fashion or gadget) (Yu, 2013) with more heterogeneous respondents (Zhang, 2009) with visibility to business performance post adoption (Khalifa & Shen, 2008) (Swilley, 2007) to reveal the characteristics of specific communities in adopting new technology.

Perceive ease of use (PEOU) is positively influenced by cost perception, security & safety, and social influence, where social influence was found to score the highest mean among other factors.



Source: calculation result

Figure 5: Standardized Loading Factor (SLF) of the model.



Source: calculation result

Figure 6: Tcalc of farmer's adoption model.

Goodness-of-Fit	Cut-off Value	Result	Remark
RMR(Root Mean Square Residual)	≤ 0,05 or ≤ 0,1	0.044	Good Fit
RMSEA(Root Mean square Error of Approximation)	≤ 0,08	0.063	Good Fit
GFI(Goodness of Fit)	≥ 0,90	0.99	Good Fit
AGFI(Adjusted Goodness of Fit Index)	≥ 0,90	0.98	Good Fit
CFI (Comparative Fit Index)	≥ 0,90	1	Good Fit
Normed Fit Index (NFI)	≥ 0,90	0.98	Good Fit
Non-Normed Fit Index (NNFI)	≥ 0,90	1	Good Fit
Incremental Fit Index (IFI)	≥ 0,90	1	Good Fit
Relative Fit Index (RFI)	≥ 0,90	0.97	Good Fit

Source: calculation result

Table 5: Fittest criteria on the SEM model.

These findings confirmed prior empirical studies conducted by several researchers (Khalifa and Shen (2008), Islam (2013), and Sadia (2011). In contrary, social influence is insignificant as a determinant of Perceive Usefulness (PU), while other factors (cost perception, security and safety, and competitiveness pressure) are significant to Perceived Usefulness (PU).

Perceived Usefulness (PU) significantly influences

Intention to Use (IU), while Perceive Ease of Use (PEOU) is insignificant. Interesting fact that most of respondents perceive that ease of use on mobile phone application is not determined by the competition, but they perceive that this technology is useful if their competition environment us it as part of the business which drives them to have the intention to use mobile phone application. Based on the finding in the field, most of respondents that intent to or already use mobile phone application prefers to get benefit on access to information such as update commodity price and technology as other players in the industry may do it.

In term of theoretical implications, it can be considered that the major novelty in this research is the intention to explore the adoption of mobile phone application comprehensively. This study extends the current literature in two areas. Firstly, this research used a basic version of the TAM with the combination of business environment factors and individual factors (Nabhani et al., 2015B). Secondly, this paper also examine the impact of adoption to their business performance, existing smartphone users agree that the extend utilization of mobile internet in their business improve their overall business performance.

Managerial implications on this study, based on the result of this research and past studies literature review about the different factors effecting the m-commerce adoption, this paper suggest that the supporting industry along the value chain (infrastructure provider, device manufacturer and retailer, and application developer) should try to make their services better by creating an ecosystem of mobile phone application in general (Zhang et al., 2002). The three main pillars in internet ecosystem are telecommunication network infrastructure, device penetration, and supported by application. By bringing those together, it will make the mobile phone transaction become easier and useful. This will increase the awareness about those services and will push their customer loyal to their services in accepting and adopting this technology for a long term period. These stakeholders also need to campaign the benefit of technology adoption to increase the customer awareness. Community based approach is another primary consideration in deploying this application. Individual or organization which has intention to adopt this technology should assess the projected benefit and ease of use of m-commerce in their business. Government intervention absolutely is a necessary to push optimum utilization of broadband for the benefit of farmer in Indonesia (Stoica et al., 2005).

Conclusion

This study employs a non-probability sample of cocoa farmers in southern East Java. The decision to use convenience sampling was chosen due to the respondent's availability during the survey. This method may limit the generalizability of the results of this study. Since this study only examines the mobile phone application usage at farmer level, future research that includes more sample size on trader (local trader, district trader, and exporter) will enhance our understanding in this specific industry. Secondly, the fact from culture perspective that people in East Java is tend to be more communal, it will be better to put a cultural perspective as part of variable on the determinant of technology adoption (Frolick and Chen, 2004). Finally, future research in different sub-sectors of agriculture will broaden our perspectives on the importance of broadband/internet adoption, thus could give us better insight of how broadband/internet adoption could have different or the same impacts across different industries with the inclusion of other factors such as environmental and technological evolution (Alfahl et al., 2012).

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Do Digital Public Services Matter? A Comparative Study of the Czech Republic and the Republic of Kazakhstan

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Abstract

Provision of quality public services has been in great concern of many governments for longer period of time. An interesting fact could be observed that, as to the demand and supply of digital public services, some developed European countries could lag behind some upper-middle-income countries. The paper explores differences in digital public services provision (supply side) and use (demand side) between the Czech Republic and Kazakhstan. A document analysis was done and a comparative study based on secondary data was elaborated. We can confirm that even a country from outside of the EU (Kazakhstan) can provide a better organized supply of digital services than an EU member state (Czech Republic) at least on the national level. According to the Digital Economy and Society Index (DESI) benchmarking, there are also significant discrepancies among national, regional and local services in the EU. The same phenomenon is also reported from transitional countries like Kazakhstan.

Keywords

Digital public services, electronic public services, rural development, e-government, European Union, DESI, EGDI, Czech Republic, Kazakhstan.

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Introduction

Provision of digital services from government to citizens and businesses has evolved during past 25 years. From setting up a website and publishing basic contact information online in early 1990s, through electronic forms to download, to sophisticated web and mobile applications that enable us to fill in a tax return and pay at the same browser window.

Digital public services or e-government services refer to electronic services provided by a municipality or by central government. Example of a local (municipality) service could be ordering and renewing waste collection, while a central government service could be e.g. applying for new ID card. Some services are used on regular basis (e.g. change of the employer at the social insurance administration), while some other services are used sporadically (e.g. paying parking fine).

According to (Lindgren and Jansson, 2013), a public electronic service is in part a process creating value for someone else (e.g. citizen, business, etc.) and an IT artifact that mediates the public service. Regarding the fact that electronic public services have direct impact on citizens, businesses and even government, EU has laid out twelve principles for implementation of these services (EC, 2010). On the other hand, it is up to the Member States which principles will be deployed and preferred (Limba and Gulevičiūtė, 2013). Even if academics and practitioners urge to prescribe design specifications for the development of user-centric and quality-driven e-government websites, the consensus is missing (Tan, Benbasat, and Cenfetelli, 2013). However, public service provision today should not be only about a series

of transactional services but more about an integrated set of services organized around the life event of the user (EC, 2014).

Citizens and businesses expect quality public services, including electronic public services. Higher satisfaction of online service users can be achieved by development of strategies for services improvement, analysis of quality and definition of accountability (Sá, Rocha and Pérez Cota, 2015). A survey in China showed that perceived quality of offline and online services has a high impact on overall public satisfaction with electronic government services (Fan and Yang, 2015). Ease of use, trust and public value belong among factors affecting citizens' attitudes toward electronic public services (Al-Hujran, Migdadi, Al-Debei and Chatfield, 2015).

In general, electronic government services are much likely used by enterprises than by citizens from the long-term perspective. In 2013 in the EU, there were 88 % of enterprises that used the Internet to interact with public administration while only 46 % of the EU-28 citizens used e-government services in 2015. The interactions include: obtaining information or forms from websites, returning filled in forms, following administrative procedures completely electronically or offering products in public authorities' electronic procurement systems (eTendering) (Eurostat, 2014). Though, there is limited empirical research of e-government for businesses (Reddick and Roy, 2013; Skersys et al., 2011). For example, in Netherlands, companies reported at least a partial reduction of administrative burden in less than half of observations, which opposes usual claims about contributions of e-government for companies (Arendsen, Peters, ter Hedde, and van Dijk, 2014). Reporting and other information requirements of administration, taxes, social insurance, various requests for permission, subsidies and grant funding belong to most frequent duties toward government. Evaluation of e-government effects on companies has not brought sufficient evidence (Arendsen et al., 2014; Jones, Irani and Sharif, 2007; Kunstelj and Vintar, 2004), or includes a limited rehearsal and quantification of factors influencing satisfaction of enterprises with electronic public services (Reddick and Roy, 2013).

ICT and rural development

Information and communication technologies greatly impact inhabitants and their quality of life in rural areas. Effective use of ICT can remove geographical boundaries and bring rural communities closer to global economic systems (Nayak, 2010). Geographically, rural areas are more difficult to service with roll-out of fibre optic cable (Townsend, 2013) and sometimes even with wireless broadband Internet. Moreover, people in rural and urban areas have different attitudes toward technologies (Gilbert et al, 2010).

In Europe, connectivity and use of Internet are monitored within Digital Agenda for Europe 2020 policy. As of 2015, 97 % of European households had access to fixed line broadband connection (at least 30 Mbps) and 79 % to mobile 4G LTE Internet. However, rural coverage remains significantly lower (EC, 2015).

Much more remarkable differences could be observed especially in geographically large countries such as China where the gap between rural and urban areas is astoundingly huge (Lijuan et al, 2014). An institutionalized program called "Village Informatization Program" (VIP) was introduced in China to provide a single platform for inhabitants in rural areas for access to communication infrastructure and applications of "comprehensive information services". The VIP program is an unique approach to e-government (Xia, 2010).

Further, in Iran where some rural areas are affected with high poverty, people are excluded from new technologies such as ICT. Therefore, the implementation of tangible outcomes of development policies such as ICT centers may help to adopt new technology despite economic background of people (Khalil Moghaddam and Khatoon-Abadi, 2013).

Australia's rural areas where lives about 30 % of population continue to be at a digital disadvantage. For example, Australian farming community needs government extension services targeted for farmers, extension professionals (consultants) and managers (Miah, 2012).

Global benchmarks to measure e-government and information society

Interaction of businesses and citizens with the public sector has become a priority for many national governments and also at international level such as in the European Union. The Digital Economy and Society Index (DESI) has become a high-level tool to measure and track progress of EU countries towards a digital economy and society (EC, 2016a; Sorrentino, De Marco and Depaoli, 2015).

DESI is a composite index that summarizes some 30 relevant indicators on Europe's digital performance and tracks the evolution of EU Member States, across five main dimensions: Connectivity, Human Capital, Use of Internet, Integration of Digital Technology, Digital Public Services. Each dimension is divided in a set of sub-dimensions, which are in turn composed by individual indicators (as depicted on Figure 1). Each dimension has its weight in overall score. The weights reflect the EU's digital policy priorities (EC, 2016a).

Dimension	Weight
1 Connectivity	25%
2 Human Capital	25%
3 Use of Internet	15%
4 Integration of Digital Technology	20%
5 Digital Public Services	15%

Source: (EC, 2016a)

Table 1: DESI weights of dimension.

United Nation's Department of Economic and Social Affairs (UNDESA) has been monitoring e-government globally on biannual basis since 2003. UN uses E-government Development Index (EGDI) that comprises three normalized scores: Online Service Index, Telecommunication Infrastructure Index and Human Capital Index, where all of them have a fair weight (one third). Online Service Index (OSI) is described as follows: "OSI is calculated from data provided by each country's national website assessment, including the national portal, e-services portal and e-participation portal, as well as the websites of the related ministries of education, labour, social services, health, finance and environment as applicable. The e-participation index (EPI) is derived as a supplementary index to the UN's E-government Survey. It extends the dimension of the survey by focusing on the use of online services to facilitate provision of information by governments to citizens ("e-information sharing"), interaction with stakeholders ("e-consultation") and engagement in decision-making processes ("e-decision making")" (UN, 2014).

The level of government's performance in delivering online services to the citizens is categorized into four stages of service delivery: Emerging, Enhanced, Transactional, and Connected. Online services are assigned to each stage according to their degree of sophistication, from the more basic to the more sophisticated. In each country, the performance of the government in each of the four stages is measured as the number of services provided as a percentage of the maximum services in the corresponding stage. Examples of services include online presence, deployment of multimedia content, governments' solicitation of citizen input, widespread data sharing, and use of social networking (UN, 2014).

However, some countries argue that the UN survey either does not capture their latest innovations or does not provide enough guidance to be useful in practice. The survey seeks to capture the amount of services offered, but for example in Denmark there are currently fewer services offered than before. Denmark has automated its tax filing process, which means there is no longer a need to file taxes, online or offline. Another difficulty is assessing qualitative differences between similar services. For instance, UK spent billions on failed e-health records, whereas Estonia has a very successful system in place, yet the UK ranks well ahead of Estonia in the UN survey (EIU, 2013).

As the UN specialized agency for ICTs, International Telecommunication Union (ITU) is the official source for global ICT statistics. ITU uses the ICT Development Index (IDI) that combines 11 indicators to monitor and compare developments in ICT between countries and over time since 2009. IDI focuses also on the digital divide and the development potential of ICTs. The IDI is divided into the following three sub-indices: Access sub-index (40 %), Use sub-index (40 %) and Skills sub-index (20 %) (ITU, 2015).

EGDI is based on a survey questionnaire to tick off whether particular features are present or not. This approach removes any qualitative judgments about each feature, but it also limits the survey to a set of binary questions. EGDI does not provide the information to what extent digital services are easy to use or how they differ in terms of quality (EIU, 2013). EGDI is also used by OECD as a basis for calculation of E-government Readiness Index that measures government's capacity to use ICT-enabled public administrations and to develop and implement e-government services, scale from 0 (low) to 1 (high) (OECD, 2014). Unlike DESI, EGDI and EPI do not consider particular interactions regarding life events of citizens and businesses.

World Economic Forum (WEF) has been providing the Global Information Technology Report since 2002. In the report, the Network Readiness Index

(NRI) is used to measure the "degree to which a community is prepared to participate in the Networked World" and to estimate a community's potential to participate in the Networked World in the future (Kirkman, Cornelius, Sachs, Schwab and World Economic, 2002). The report presents assessment of countries' capacity to exploit ICT. The Network Readiness Index (NRI) comprises 53 individual indicators distributed across four pillars such as Environment, Readiness, Usage and Impact subindexes. There is Government usage under Usage pillar that also regards availability and quality of government online services. Actually, WEF's benchmark draws on UN's Government Online Service Index data (WEF, 2015).

	DESI	EGDI	NRI
Started since	2012	2001	2002
No. of sub-indexes / dimensions	5	4	4
No. of indicators / components	30	18	53
Digital public services	yes	yes	yes

Source: compiled from (EC, 2016; UN, 2014; WEF, 2015)

Table 2: Comparison of DESI, EGDI and NRI.

Ardielli and Halásková (2015) argue that e-government data of international organizations are not consistent with each other due to different time periods, methodologies of data collecting and processing and various focus of e-government services. For comparative purposes, synthetic approaches such as methods of multi-criteria evaluation of alternatives (Ardielli and Halásková, 2015) or multiple criteria decision making methods (Máchová, 2015) should be used. Moreover, current benchmarking and ranking tools do not differentiate between static websites and highly integrated and interactive portals (Rorissa, Demissie and Pardo, 2011).

The attempt to make an international comparison of digital society indicators between the EU and 15 other developed countries was introduced in the International DESI (I-DESI)(Mateus, 2016). I-DESI shows that the top EU countries such as Denmark, Sweden and Finland are also top worldwide performers in digital. There are some differences in data collection and definition since scores and rankings of EU countries in DESI are not the same in I-DESI. However, the European countries need to significantly improve in order to catch up with its best performers as well as with the most digitized countries in the world (Japan, South Korea and the USA) that have all scores above the EU average (Burden, 2016; Mateus, 2016).

After reviewing main global benchmarking tools above, an interesting fact could be observed that, as to the demand and supply of digital public services, some developed European countries such as Czech Republic could lag behind some upper-middle-income countries such as Kazakhstan. The main aim of the paper is to explore differences in digital public services provision (supply side) and use (demand side) between two countries – the Czech Republic and Kazakhstan.

Materials and methods

In this study, a document analysis was conducted to understand current state of digital public services in the Czech Republic and the Republic of Kazakhstan. Research includes a thorough review of texts and documents such as: government publications, international reports, official statistical resources and scientific papers.

The comparative study was made between the Czech Republic and the Republic of Kazakhstan on the basis of the UN's E-government Survey 2014, WEF's The Global Information Technology Report 2015, OECD's Science, Technology and Industry Outlook 2014 and ITU's Measuring the Information Society Report 2015.

In the study, following research questions were addressed.

Research Question 1: What are differences in digital public services supply and demand among an EU and non-EU country?

Research Question 2: Are there available comparable data about the use and quality of digital public services at national and local level among an EU and a non-EU country?

Results and discussion

For the sake of comparison, some background data about both countries should be considered. In the Table 3, basic economy characteristics and number of Internet users are presented.

In DESI 2016, the Czech Republic has an overall score of 0.5 and ranks 17th out of the 28 EU Member States. A brief assessment of the Czech digital landscape shows that there is a good take-up of fast broadband and mobile broadband, which goes hand in hand with a decent level

	Population (in millions)	**Size** (in sq km)	**GDP** (in bln. USD, 2015)	**GDP per capita** (in USD, 2015)	**Income** (World Bank, 2016a)	*Internet users* (% of population, ITU, 2014)
Czech Republic	10.6	78,867	$331.4	$31,480	High-income	79.7 %*
Kazakhstan	18.1	2,724,900	$430.5	$24,345	Upper-middle-income	54.9 %

Note: * population of age 16-74

Source: compiled from (World Bank, 2016a; CIA, 2016; IMF, 2015; ITU, 2015)

Table 3: Czech Republic and Kazakhstan - basic characteristics.

of digital skills and engagement of Czech citizens in a variety of online activities. Czech internet users excel in online banking and in online shopping. In Czech private sector, digital technologies are used both to improve efficiency and productivity of companies as well as to access wider markets and help to lead the ranks in turnover from online sales. Moreover, the Czech Republic is below average in the provision of digital public services, which is its main challenge to progress further in the digital economy. The country falls into the cluster of falling behind countries (such as Bulgaria, Greece, France, Hungary, Poland and Slovakia) whose score is below the EU average and which grew slower than the rest of the EU since 2015 (EC, 2016a).

Kazakhstan e-government evaluation is not included in DESI, nor in International DESI, which compares EU member states with several world leading digital countries outside of the EU. According to the UN, Kazakhstan has kept its leading position in e-government in Central Asia region and is the only country in Central Asia to show improvements between 2012 and 2014, jumping from a global ranking of 38th in 2012, to 28th in 2014. The decline in global ranking has been a trend in the region with the exception of Kazakhstan since 2008. UN argues that it could be attributed to insufficient development of telecommunication infrastructure and online presence. Kazakhstan is also between 50 top performers in e-participation. (UN, 2014).

A direct comparison of government online services is available only in the UN survey where the Government Online Service Index ranked the Czech Republic on 84th position and Kazakhstan on 23rd position.

A summarized view on the e-government in both countries according to the global surveys referenced above is presented in further text.

Czech Republic e-government ranking

According to the executives' opinion survey conducted by the WEF in 2013 and 2014, the Czech Republic ranked 116th in importance of ICTs to government vision of the future which denotes to what extent does the government have a clear implementation plan for utilizing ICTs to improve the country's overall competitiveness, 84th in Government Online Service Index, 56th in impact of ICTs on access to basic services which means to what extent do ICTs enable access for all citizens to basic services (e.g., health, education, financial services, etc.), and 116th in government success in ICT promotion which measures how successful is the government in promoting the use of information and communication technologies (ICTs) (WEF, 2015).

Among selected economies of Eastern Europe, Hungary, Russian Federation, Czech Republic and Poland are far in advance of provision of online services to disadvantaged and vulnerable groups as compared to Belarus and Ukraine (UN, 2014).

Digital public services in the Czech Republic

To obtain a richer picture of provided digital public services in the Czech Republic, we can use recent Digital Economy and Society Index (DESI) benchmark. The benchmark was firstly conducted in 2012 for three various life events and their related services. In 2013, other four life events were examined and assessed in the EU member states. Among the life events assessed in 2013 belong:

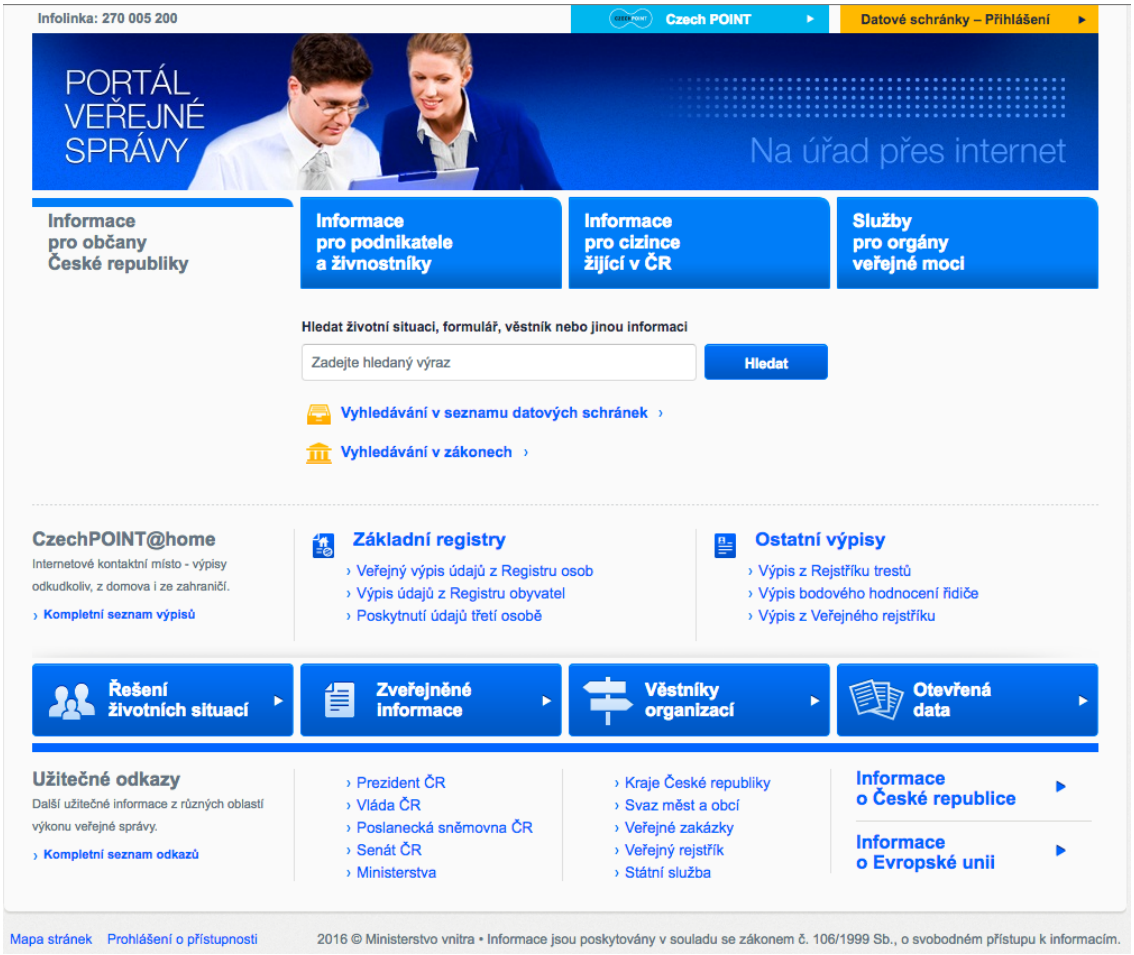
- Regular business operations;
- Moving (general administration);
- Owning and driving a car;
- Starting a small claims procedure.

In the Table 5 below, a list of related online services is presented. Every life event was assessed by two

Life event	Service labels	Location
Regular business operation	Obtain information on employee contractual agreements / regulation Requesting a refund of VAT Possibilities for objection and appeal against a claiming refund of VAT decision	National
Starting a small claims procedure	Obtain information on related legislation and rights Start a small claim procedure (issue the money claim at court) Share evidence/supporting documents by citizen Obtain information on case handling Retrieve judgement Appeal against court decision Obtain information on how to start a civil/small claim procedure	Regional/National
Moving (general administration)	Obtain information on local facilities (e.g. schools, sports, health facilities) Obtain permits for moving Obtain information on rights and obligations when moving abroad Issue a registration certificate	Local
Owning and driving a car	Dealing with driving fines	National

Source: compiled from eGovernment raw data (EC, 2014)

Table 5: Czech Republic - assessment of four life events and background digital services.



Source: http://portal.gov.cz

Figure 1: Portal of public administration in the Czech Republic.

mystery shoppers who followed given scenario with tasks. Since the evaluators were not coming from the country, they had to work with information provided in English, which was often lacking or insufficient. The benchmark is quite robust because the assessed services were examined on all levels – national, regional and local.

Czech citizens have greatly adopted e-services such as e-banking and Internet. The Czech Republic is also on the top position in the number of e-shops per capita in the Europe. However, the overall supply of e-government and online public services have not been viewed positively (EC, 2016b).

Governments are aware of making their online services user-friendly. But, their focus is still mostly on making services available, they are lagging behind in improvement of services speed, ease of use, and transparency (EC, 2016a), which is also the case of the Czech Republic (EC, 2014).

A notable fact is that as of 2016 in the Czech Republic there is no national government portal that would provide all digital public services on one place. Instead, all national services are scattered on websites of various ministries or central government authorities such as the Czech Social Security Administration and other. The portal of public administration **www.portal.gov.cz** serves as a mere directory with prevailing text information about life events and links to respective authorities or forms. The portal operates only in Czech language and provides a simple hotline support (see Figure 1).

Digital public services in rural areas in the Czech Republic

The Czech Republic has a decentralised administration with 13 regions and 6,249 municipalities including the capital Prague (Czech Statistical Office, 2013). More than 73 % of population lives in urban areas. There is a legal requirement that each municipality has to publish basic information online such as the representatives' names, working hours, contact details, minutes from representative meetings and municipality budget. However, further electronic services are optional and depend on decisions of the municipality management. A detailed evaluation of Czech municipality websites was conducted in June 2015 with the use of Citizen Web Empowerment Index (CWEI) introduced by UN (Ntaliani et al., 2015; UN, 2014). The issues of digital divide and deficiency of fast Internet access are still echoing in the Czech Republic namely in rural areas as was pointed out in (Vanek, Cervenkova, Jarolimek and Simek, 2010).

The main point of contact with government services is through the network of assisted places called Czech POINT that was started in 2007. The network currently operates at more than 7170 places all over the Czech Republic. More than 79 % of branches are placed at municipality offices and 14 % at Czech Post offices. Among the most used documents that could be obtained from Czech POINT belong verified copies from the Cadastre of Real Estate, the Companies Register, the Trade Licensing Register and the Criminal Record Register (MOIA, 2016).

Kazakhstan e-government ranking

In the WEF survey, Kazakhstan ranked 43rd in importance of ICTs to government vision of the future, 23rd in Government Online Service Index, 62nd in impact of ICTs on access to basic services and 24th in government success in ICT promotion (WEF, 2015).

Kazakhstan is 2nd among middle income countries in online service delivery and 23rd globally. The country belongs to 11 upper-middle income countries and 36 high income countries providing online services for older persons. Kazakhstan has also ranked among countries with score higher than 66.6 % in whole government and in data publishing (UN, 2014).

Both the Czech Republic and Kazakhstan are one of those putting out information and services for the immigrants. Kazakhstan also provides online services for women (UN, 2014).

Digital public services in Kazakhstan

Kazakhstan is a very large country with size equal to the Western Europe. Kazakhstan is facing much more diverse socio-economic and technological conditions than many successful e-government countries with relatively small territorial entities such as Baltic states or the Czech Republic. There are also significant variations in Internet availability, usage, affordability and reliability between large cities and rural areas (Janenova, 2010).

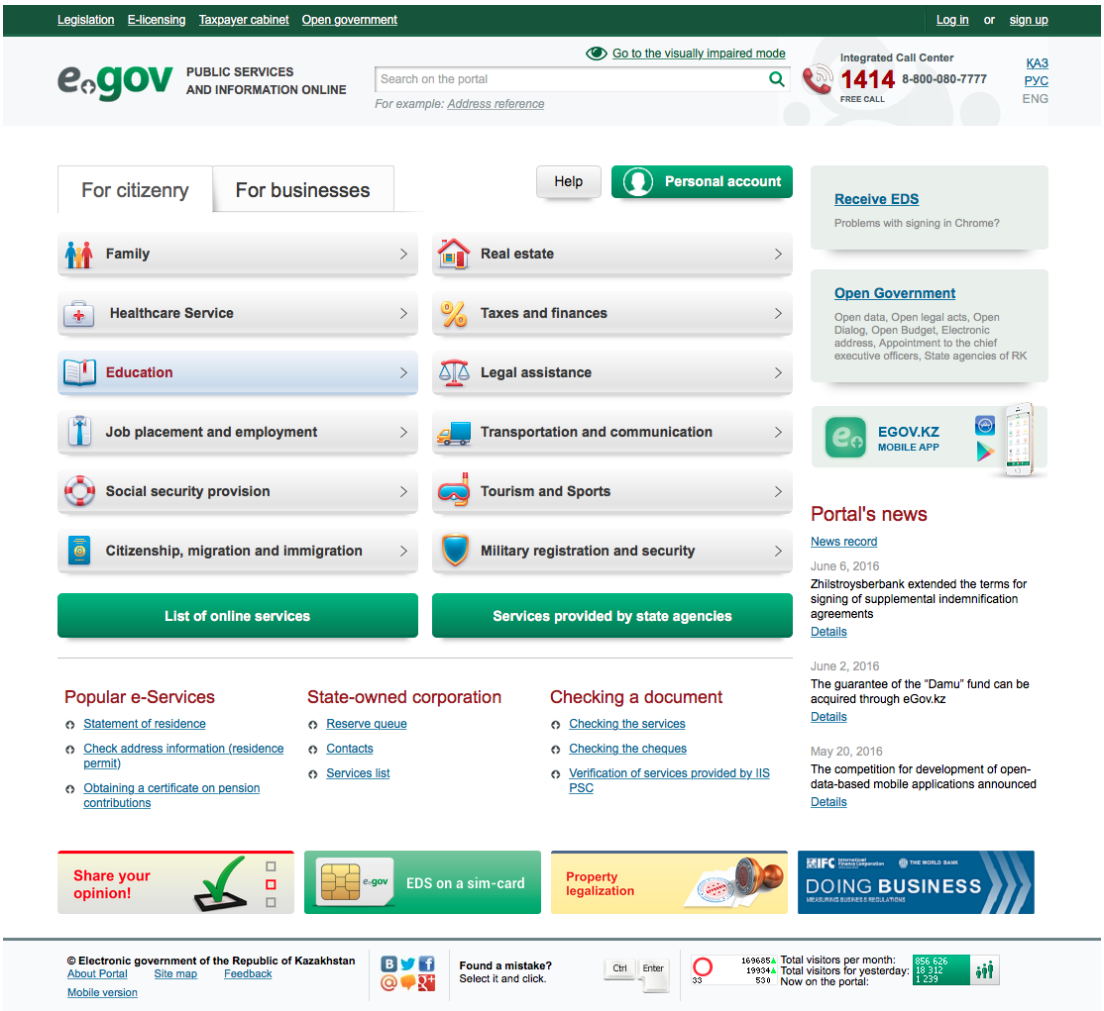
All central digital public services are provided at the national portal egov.kz (see Figure 2). Currently, there are more than 100 services at different stages of delivery supporting various life events of citizensand businesses. As of 2016, there were 17 digital services available

through mobile application and 2 services via SMS service. The portal operates in three languages – Kazakh, Russian and English. Most of information, news, guidelines and even education videos on the portal operate in all three languages, which is very remarkable. Portal users can also interact with provider via free hotline support, feedback form, and polls. There are also large frequently asked questions and knowledge base sections.

Digital services that enable electronic submission require to have a valid electronic digital signature (EDS) which can be obtained on chip ID card or as a file on PC. Currently, more than 3.5 million users at the national portal E-gov.kz has received EDS (Interfax, 2015). Certificates for EDS are issued for free.

Kazakhstan is also ranked well in conditions for starting and operating business. According to the latest Doing Business 2016 report from the World Bank, Kazakhstan ranked 41st globally (World Bank, 2016b). Kazakhstani government attributes electronic services the ability to establish good environment for business. For example, registering a new private limited liability company requires only 2 days in Kazakhstan including all administrative steps such as issuance of the electronic certificate and the certificate of state registration of a company. The registration of small or middle-sized company is free of charge as of 1st January 2015 (World Bank, 2016b).

It also has to be noted that the above presented digital services are available in Kazakhstan on the national level. More detailed data about evaluation of digital services at regional or local



Source: http://egov.kz

Figure 2: Electronic government of the Republic of Kazakhstan.

level is lacking and requires further research.

However, Kazakhstan still struggles with corruption in public administration that hinders efficiency and quality of public services. Politicians and administrative government executives didn't want to participate and help with the integration of online systems (Bhuiyan, 2010; Janenova, 2010). They knew that such systems will decrease their importance, they will lose their power, status and all the illegal payments that they receive due to the corrupted governmental system. For instance, it took 8 years to persuade the Traffic Police to create e-services for issuance of driving licenses – which, in traditional offline form, was considered to be a highly corrupted service.

Kazakhstan was ranked 123rd globally in Corruption Perception Index in 2015 (Transparency International, 2015). According to the latest survey, e-government activities in Kazakhstan are assessed positively by citizens for its impact on the reduction of administrative barriers and corruption (Sheryazdanova et al., 2016)

Thus, scholars believe that e-government in Kazakhstan can helps to reduce corruption and brings more accountability in public service (Sheryazdanova et al., 2016). However, implementation of services such as Citizen Service Centers cannot automatically fix deficiencies in the work of public sector. The policies and approaches that work in developed countries should be critically analyzed and considered before they are implemented in transitional countries such as Kazakhstan (Janenova and Kim, 2016).

Digital public services in rural areas in Kazakhstan

In Kazakhstan, there are 14 provinces and 3 cities and more than 52 % of population lived in urban areas (CIA, 2016). Kazakhstani government has introduced a way of combined public service delivery via Integrated System for Citizen Service Centers that was established in 2007. The centers are operated by the state company "Government for Citizens" that was established in 2016. The system provides a nation-wide network of one stop shops around Kazakhstan and serves as an offline "alternative delivery" of services for citizens (Janenova, 2010; Janenova and Kim, 2016). Currently the centers are present in 16 cities around Kazakhstan. To serve people in remote settlements, there also mobile Citizen Service Centers operating around the country. In total the branches operate at 270 places in Kazakhstan. At the Center, citizens can ask for assistance in 8 life events such as licensing and permits, migration and archives, real estate, registration and business development, family and education, social security and employment, transport and communications and tourism and sports (Government for Citizens, 2016).

Source: http://kzregdev.kz/content/representatives-european-union-oss

Figure 3: Citizen Service Center in Kyzylorda, Kazakhstan.

Conclusion

The paper presented multiple points of view on digital public services provided by governments in the Czech Republic and Kazakhstan addressing the question whether or not digital public services matter. Our answer to the question is: 'Yes, digital public services matter'. However, the implementation, provision and local conditions may lead to very different results, as we reflected in the comparative study.

The aim of the paper was to compare e-government between two countries from and outside the EU. Regarding the first research question, we can confirm that a country from outside the EU (Kazakhstan) can provide better organized supply of digital services than an EU member state (Czech Republic) at least on the national level. Even if the provision is good on the supply side, the other side of the coin – satisfaction of the real users has to be examined as well. In this respect, the most advanced measurement of digital public services from the user's perspective has been provided by DESI so far. We propose that similar benchmarking of digital public services should be conducted in several countries outside of the EU to provide comparable data.

To address the second research question, we conducted thorough literature review of global e-government surveys, which provided interesting facts about remarkable performance of digital public services in a transitional country such as Kazakhstan that was higher than services in a developed economy such as the Czech Republic. On the other hand, mere comparison of e-government indicators provided by respective surveys does not show a rich picture and the whole context in which e-government and digital public services are operated. The issues such as digital literacy, access to the Internet, multilingualism and corruption significantly influence any digital service provision.

European DESI data has also revealed significant discrepancies among national, regional and local services in the Czech Republic. In Kazakhstan, a survey on quality of local e-services is lacking. For rural development, the survey should consider differences in rural areas and their communities.

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