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A Model of the Dynamics of the Effect of World Crude Oil Price and World Rice Price on Indonesia's Inflation Rate

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Abstract

This study aims to investigate the dynamics of the effects of world crude oil prices and world rice prices on Indonesia's inflation rate in the period between January 2004 and September 2015. Monthly time series data spanning from January 2004 to September 2015 are analyzed using difference equation model as the econometric tool. Test result shows that there existed a dynamic effect of world oil crude prices and world rice prices on inflation rate in Indonesia. The World crude oil prices positively affected the inflation rate in that each 1% increase (decrease) in the world crude oil prices caused the inflation rate to go up (drop) by 0.33%. The world rice prices also positively affected the inflation rate, where each 1% increase (decrease) in world rice prices was followed by a 0.52% rise (fall) of the inflation rate.

Keywords

Crude oil prices, rice prices, inflation rate, difference equation model.

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Introduction

Crude oil has become an important commodity in the economy, and has become a commodity in world trade. Almost all countries are involved in this trade because oil is vitally needed for production inputs, transportation, and electric energy. Thus, all countries need this commodity. To fulfill their domestic needs for oil, non-oil-producing countries have to import this source of energy from other countries. Similarly, some countries that produce oil but suffer from shortage in oil supply must also import oil to meet domestic needs for this commodity. Agricultural commodities also provide inputs for production in food industries. For example, rice can be manufactured into confectionery, breakfast cereals, wafer, biscuit, and others. Increased demand for oil and agricultural commodities can therefore lead to a rise of the prices of oil and the prices of agricultural commodities.

A rise in the prices of oil and agricultural commodities can increase the prices of industrial goods, and it can even push up inflation. The impact of oil prices and agricultural commodities prices on inflation can occur either directly or indirectly. Higher oil prices have an indirect effect on inflation, while agricultural commodity prices can affect inflation directly since most of agricultural commodities can be directly consumed (Jongwanich and Park, 2011). Because oil is a raw material in industries, an increase in oil price can force companies to rise their production cost, which then cause the companies to increase the prices of their production goods. Therefore, a shock in oil price can trigger inflation, which can then lead to an economic recession (Blanc and Cinn, 2004). Agricultural industries produce food by processing it from agricultural commodities. Food is also part of consumable material group. For these reasons, an increase in the prices of agricultural commodities can increase the prices of food that are produced by industries, and this in turn can affect domestic inflation (Jongwanich and Park, 2011).

There has been a growing interest among researchers in the shock of oil prices, particularly since 1970 (Alom et al., 2013). A number of studies have investigated the effects of oil and food prices on inflation, albeit they only

highlighted the influence of crude oil prices on inflation and other macroeconomic indicators. Among these researchers are Darby (1982), Halmilton (1983), Hunt et al. (2002), Tang and Zhang (2010), Du at al. (2010), Ahmed and Wadud (2011), Ju et al. (2014), Yalsin et al. (2014), and Katircioglu et al. (2015). Furthermore, some studies on the effects of food on inflation have been conducted by, among others, Khan and Ahmed (2014) and Belke and Awad (2015). These studies, however, did not come up with similar conclusions regarding the effect of oil prices on inflation. Ju et al. (2014), for example, reported a positive relationship between oil prices and inflation. Others, such as Ahmed and Wadud (2011), found a negative association. Some, such as Iwayemi and Fowowe (2011) and Roeger (2005), even discovered no association between oil prices and inflation. These varied findings seem to be attributable to differences in the economic conditions of the countries under investigation, in particular with regard to their dependence on oil (Sek et al., 2015). Another possible cause is the different periods which the studies looked into. Studies on the effect of oil prices on inflation were mostly focused on developed countries, for example Blanc and Chinn (2004) in the US, and only very few have been conducted to investigate the issue in developing countries. Additionally, the effects of agricultural commodity prices on inflation are still under-researched. Among few researchers who studied this area is Cheung et al. (2008).

Indonesia is one of developing countries that has oil refinery facilities to produce crude oil. Despite this fact, however, since 2003 Indonesia has become an oil-importing country (net-importer) (Wang et al., 2013). Some countries that have become the main oil suppliers to Indonesia are, among others, Saudi Arabia, Azerbaijan (Europe), Australia, Singapore (Asia), and Nigeria (Africa). Meanwhile, Indonesia is also a rice-producing country. However, the country's rice production cannot yet meet domestic demand for this commodity, and as a result it has to import rice from other countries, such as Thailand, Vietnam, and the USA. It is a fact that imports of world crude oil and world rice commodities can affect the prices of domestic food produced by industries. If this is associated with three indicators of economic trends (i.e. the prices of oil, the price of rice, and inflation), then the prices of oil, the prices of rice, and inflation indicated a similar trend during the 2004-2015 period. Brent crude oil price, for example, increased from $31.28/ barrel in January 2004 to $47.62/barrel in September 2015. World rice price rose from $8.06 per hundredweight in January 2004 to $13.2 per hundredweight in September 2015. Meanwhile, in the same period Indonesia's inflation rate rose from 4.82% in January 2004 to 6.83% in September 2015.

This study aims to examine the dynamics of the effects of world crude oil prices and world rice prices on Indonesia's inflation rate in the period from January 2004 to September 2015. An econometric model used to analyze the effect of crude oil price and the world rice price is the difference equation model proposed by Enders (2015). This model is selected based on an assumption that a certain time lag is required for the prices of world crude oil and world rice to affect inflation. Test results are then expressed in a model of mathematical equation, i.e. the difference equations. Based on this model, a curve diagram called a signal process is created to illustrate the dynamics of the effect of world oil prices and world rice prices on inflation, as has been performed by Cahyono (2014), Adam et al. (2014), and Adam (2014).

Review of literature

In theory, the effects of world crude oil prices and agricultural commodities prices (including rice) on inflation rate can occur through the following channels. Crude oil and agricultural commodities are industrial raw materials. A rise in crude oil prices can increase transportation costs, as well as cost of inputs, such as fertilizer, which in turn can push up the prices of agricultural commodities (Kapusuzoglu and Ulusoy, 2015; Adam, 2015). Furthermore, the prices of crude oil and agricultural commodities can raise production cost of non-food and food industries. An increase in production costs can raise the prices of goods, and at the same time it can reduce company's production, decreasing outputs and in turn leading to inflation (Alom et al., 2013). In terms of trade, increased prices of oil and agricultural commodities can raise the prices of industrial goods in importing countries (Johnwanich and Park, 2009; Misati et al., 2013). Therefore, an increase in the prices of world crude oil and agricultural commodities can cause inflation worldwide (Alom et al., 2013)

Rice is a staple food in some countries, such as Indonesia and Nigeria, and therefore it is consumed more by households in these countries. For this reason, agricultural commodities, especially rice, are imported not only to meet the needs of food

industries, but also to fulfill households' growing demand for the food. Increasing demand for food commodities (including rice) at a rate that is higher than an increasing rate of production can cause the price of this commodity to escalate and can in turn affect inflation (Sasmal, 2015). Apparently, however, an increase in rice price cannot keep people from buying rice to meet their basic need for food. Therefore, if rice prices go up, household consumption is also increased, and this means that, as reported by Oynbo et al. (2013), rice price is positively correlated with household spends for consumption.

Empirically, some studies investigating the effect of oil prices and prices of agricultural commodities and food industry on inflation have been conducted in many countries. Blanc and Chinn (2004) examined the effect of oil prices on inflation in the USA, Japan, and Europe. Their results showed that a 10% increase in oil prices affected inflation by about 0.1 to 0.8%. They also found that the response of inflation toward oil prices was more sensitive in Europe than it was in the US. Alvares et al. (2011) conducted a study in several countries (i.e. Spain, the Euro Area, Germany, France), and found that fluctuation in the price of oil was a cause of inflation, and that the impact of oil prices on inflation in Spain was higher than it was in the Euro Area. Lu et al. (2010) examined the transmission of volatility between oil shocks and inflation in Taiwan in the period from January 1986 to December 2008. They discovered that the price of oil had a nonlinear effect on inflation. Meanwhile, a volatility in oil prices had a very strong influence on inflation. Sek et al. (2015) conducted a study on the effect of oil prices on inflation. They split the study sites into two groups, namely a group of countries with a very high dependence on oil (Singapore, South Korea, Philippines, Greece, Belgium, Italy, Pakistan, India, Portugal, Spain), and a group of countries with low dependence on oil (Norway, Denmark, United Kingdom, Canada, Mexico, Malaysia, Brazil, Venezuela, Ecuador, Bulgaria). Their results showed that oil prices significantly affected domestic inflation. The influence of oil prices in the countries with a high dependence on oil was indirect, meaning that the effect of oil prices occurred through changes in export production costs, whereas a direct effect of oil prices on inflation occurred in the countries with low dependence on oil.

Not only do oil prices affect inflation, but also other macroeconomic indicators. Therefore, a lot of researchers have studied the effect of oil prices on inflation and other macroeconomic variables. Cunado and Gracia (2003), for instance, investigated the relationship between oil prices and two macroeconomic variables, i.e. inflation and output, in some European countries in the period of 1960-1999. Result showed that there was a permanent effect of oil prices on inflation in the short term, and there was the asymmetric effect of oil prices on production index. Cunado and Gracia (2005) did a research in Asian countries (Japan, Malaysia, Thailand, Singapore, South Korea, and the Philippines) within the 1975Q1 -2002Q2 period. In their study, a dummy variable was used to determine the change in the structure of the effect of world oil prices on domestic oil prices, exchange rates, and inflation. Results of analysis indicated that while in the long term oil price affected inflation, the short-term effect of oil prices on inflation was limited. Yalcin et al. (2015) examined the influence of unanticipated oil price changes on three macroeconomic indicators including inflation (CPI), real exchange rate (RER), and GDP, in Turkey. Based on their data analysis, they found that when oil price increases, CPI and RER increases but GDP decreases in the long term.

Cheung et al. (2008) looked into the effects of food commodity prices on inflation in several Asian countries in the 1962-2003 period. Results of analysis using the Philips Curve showed that food prices affected inflation. Ratnasari (2009) investigated factors affecting inflation in Sri Lanka in the period of 1980-2005, and reported that two main factors contributing to inflation were growing supply of money and increased prices of rice. Myint and Bauer (2010) examined markets integration and causal relationship between the prices of local rice and international rice (Thai rice), as well as the effect of the prices on consumer price index in Myanmar from 2001 to 2004. Monthly data were analyzed using the VAR analysis. Test results showed that while market integration was weakened in domestic market, a deficit in the prices of rice affected the consumer price index. Abdoulaye et al. (2015) examined the effect of the prices of cereal commodities (rice, corn, and wheat) on inflation (which was proxied with the consumer price index) in Mali from 1993 to 2015. Results indicated that there was an effect of cereal prices on inflation in Mali in the long term, and there was none in the short term. Belke and Awad (2015) examined the effect of food prices on inflation in MENA, and reported that there were some long-term effects of the prices of food commodity on inflation.

Misati et al (2013) examined the effect of food prices and oil prices on inflation in Kenya. Results of VAR analysis indicated that the prices of oil and food commodity served an important role in measuring inflation. Alom et al. (2013) investigated the effect of oil prices and the prices of agriculture commodities on several macroeconomic indicators (i.e. inflation, lending rate, exchange rate, index of production, and the stock price index) in some Asian-Pacific countries (Korea, Thailand, Singapore, India, Hong Kong, Australia, and New Zealand) in the 1980Q1 -2010Q2 period. Results of analysis using SVAR showed that oil prices affected all macroeconomic variables in all of the countries under investigation, except in Singapore and Hong Kong. The prices of food commodities had a positive effect on inflation, and this occurred only in Korea and Thailand. Khan and Ahmed (2014) studied the effect of oil prices and food commodity prices on Pakistan's economy from January 1990 to July 2011. Results of SVAR analysis showed that while a shock in oil prices negatively affected production index and exchange rate, it had a positive effect on inflation. Further revealed was a fact that the prices of food commodities had a positive effect on inflation.

Material and methods

Data

This study analyzed three types of data, i.e. the prices of world crude oil, the prices of world rice, and Indonesian's inflation rate. The prices of world crude oil are referred to European crude oil price (Brent Spot Price) (USD per barrel), whereas world rice prices are referred to the prices of rough rice (USD per hundredweight). Brent crude oil price is chosen based on a consideration that its prices of crude oil have become one of the references for the prices of crude oil in world crude oil market, while the prices of rough rice has become an imported commodity in Indonesia. Data about the prices of crude oil is taken from the International Energy Administration (www.tonto.eia.gov), while the data about the prices of world rice prices is obtained from the Fusion Media Limited (http://uk.investing.com/commodities). Data about Indonesia's inflation rate (%) is retrieved from Bank of Indonesia (www.bi.go.id). The three types of data are time series monthly data which spanned from January 2004 to September 2015.

The time-series data of world crude oil prices, world rice price, and inflation rate are taken from three websites and are expressed respectively by OIL_t^o, RIC_t^0, and INF_t^0 in which t is time (in month). For the purpose of analysis, the *OIL*, *RIC*, and *INF* variables are used with $OIL = \log(OIL^0)$, $RIC = \log(RIC^0)$, and $INF = \log(INF^0)$.

Method of analysis

The prices of both world crude oil and world rice require a certain time lag to induce any effect on inflation rate. In the meantime, Indonesian government has always made every efforts to control the inflation rate by applying monetary policy, therefore current inflation rate can be associated with inflation rate in the past. Based on this assumption, an econometric model that is used to test the effects of world crude oil prices and world rice prices on inflation rate is the difference equation model proposed by Enders (2015). The model is formulated as follows

$$INF_t = a_0 + \sum_{i=1}^{n} a_i INF_{t-i} + bOIL_{t-p} + cRIC_{t-q} + \epsilon_t \quad (1)$$

in which n is the order of difference equation with $|a_i| < 1, i = 1, 2, 3, \ldots, n$. The term of $bOIL_{t-p} + cRIC_{t-q}$ is called the forcing process, b and c are a short-term multiplier effect. ϵ_t is white noise with $E(\varepsilon_{ti}\epsilon_{tj}) = 0$, $i \neq j$, $E(RIC_i\varepsilon_{t-i}) = 0$, and $E(OIL_i\varepsilon_{t-i}) = 0$, whereas p and q is time lag. The *INF, OIL,* and *RIC* variables are needed to meet a requirement for stationarity.

Model (1) is a special case of the autoregressive distributed lag, namely the ADL model (Enders, 2015) or is a special case of lagged-variable autoregressive model, namely LVAR model (Agung, 2009; Adam, 2014). The following is the ADL model:

$$INF_t = a_0 + \sum_{i=1}^{n} a_i INF_{t-i} + \sum_{j=0}^{p_0} b_j OIL_{t-j} + \sum_{k=0}^{q_0} c_k RIC_{t-k} + \epsilon_t \quad (2)$$

in which n, p_0 and q_0 is time lag. The relationship between p_0 and q_0 and p and q from (1) is $0 \leq p \leq p_0$ and $0 \leq q \leq q_0$. In an equilibrium condition, all variables in equation (2) fulfill $INF_t = INF_{t-1} = INF_{t-2} = \ldots = INF_{t-n}$; $OIL_t = OIL_{t-1} = OIL_{t-2} = \ldots = OIL_{t-p_0}$; and $RIC_t = RIC_{t-1} = RIC_{t-2} = \ldots = RIC_{t-q_0}$, then, equation (2) becomes

$$INF_t = \frac{a_o}{1-\sum_{i=1}^{n} a_i} + \frac{\sum_{j=0}^{p_0} b_j}{1-\sum_{i=1}^{n} a_i} OIL_t + \frac{\sum_{k=0}^{p_0} c_j}{1-\sum_{i=1}^{n} a_i} RIC_t$$

The magnitude of the long-term effect of world crude oil prices (OIL) is

$$\delta_1 = \frac{\sum_{j=0}^{p_0} b_j}{1-\sum_{i=1}^{n} a_i} \quad (3)$$

while the magnitude of the long-term effect of world rice price (*RIC*) is

$$\gamma_1 = \frac{\sum_{k=0}^{p_0} c_j}{1-\sum_{i=1}^{n} a_i} \quad (4)$$

(Heij et al., 2004). Therefore, based on (3) and (4), it can be obtained from (1) that the magnitude of the long-term effect of world crude oil price is $\delta = \frac{b}{1-\sum_{i=1}^{n} a_i}$, whereas the magnitude of the long term effect of world rice price is $\gamma = \frac{c}{1-\sum_{i=1}^{n} a_i}$.

To test the dynamics of effect of world crude oil prices and world rice prices on inflation rate, an analysis is conducted in the following steps. Firstly, the Augmented Dickey Fuller test is performed to determine the stationarity of time series *OIL, RIC*, and *INF*. For example, the stationary time series *OIL* is tested by determining the significance of parameter ρ in the following equation:

$$D(OIL_t) = \alpha + \beta t + \rho OIL_{t-1} + \sum_{i=1}^{n} \theta_i D(OIL_{t-i}) + \varepsilon_t$$

in which $D(OIL_t) = OIL_t - OIL_{t-1}$ is a form of the first difference of the world crude oil variable (*OIL*). Hypothesis H_0: $\rho = 0$ shows that time series *OIL* has a unit root, or in other words, time series *OIL* is not stationary. Hypothesis H_1: $-2 < \rho < 0$ shows that time series *OIL* is stationary (Koop, 2006). According to Widarjono (2009), the time series data of *OIL* is said to be stationary, if the absolute value of ADF statistics is higher than the absolute value of ADF-critics at a level of significance $\propto$(1% or 5%). Secondly, a cointegration test is run when all of the time series data are not stationary at level, but they are stationary on difference (Widarjono, 2009). The Granger Two Step Test is employed to test the cointegration of time series *OIL, RIC*, and *INF*, through two steps. Firstly, the multiple regression equation between *OIL, RIC*, and *INF* is estimated. The residuals of this equation with the *RES* is saved, as follows

$$RES_t = INF_t - \alpha OIL_t - \beta RIC_t \quad (5)$$

where α and β are regression parameters. Next, a test on unit root is conducted. If RES is stationary at level, then the three time series data of *OIL, RIC*, and *INF* are said to be cointegrated. In this case, the regression model is an error correction model (ECM), as follows

$$D(INF_t) = a_0 + \sum_{i=0}^{n} a_i D(INF_{t-i}) + bD(OIL_{t-p}) + cD(RIC_{t-q}) + dRES_{t-1} + \epsilon_t \quad (6)$$

in which RES_t is error correction, and d is parameter (Rosadi, 2012). Finally, a test on the dynamics of the effect is performed by estimating the regression parameters and examining the parameter significance. A statistical test that is used to estimate the parameter regression is the F-statistics test on all parameters, or the t-statistics test on individual parameter by using the level of significance α (1% or 5%). Additionally, P-value criteria is used in testing the significance of the regression parameters.

A good model of regression is one with significant explanatory variables. Good models in (1) and (2) are related to the selection of lag length. There is no general convention about how to select the length of lag. One way to do this is by estimating the regression model (2) in such a way that a_i, b_j, and c_k coefficient are significant at a maximum length of lag (Koop, 2006). Estimating the parameter can be done repeatedly using a backward method, discarding variables with insignificant coefficient (Rosadi, 2012). Other way is by firstly determining the length of lag n in such a way that a_i is significant. Then, p_0 and q_0 are determined in such a way that b_j and c_k are significant, and the value of Akaike Information Criterion (AIC) is minimum (Hill et al., 2011).

Given that model (1) is a special of ADL (Enders, 2015), the first thing we do is estimating regression equation (2), followed by selecting explanatory variables with significant coefficient. Next, we re-estimate to obtain model (1). To come up with the best model of estimation, we use AIC as information criteria in setting the time lag *n, p* and *q*. We also compare the statistical value of R-squared (R^2) to the statistical values of Durbin Watson (*DW*) to make sure that the regression model is not spurious. According to Rosadi (2012), a regression model is not a spurious one if the statistical value of *DW* is greater than the statistical value of R^2.

Results and discussion

Unit root test

Results of estimation with regard to the stationary test are summarized in Table 1. As shown in the table, the three time series data of world crude oil prices (*OIL*), world rice prices (*RIC*) and inflation rate (*INF*) are not stationary at the level

Variable	ADF-Statistics	1% Critical Value	5% Critical Value	Prob.*
INF	-2.897638	-3.477835	-2.882279	0.0482
D(INF)	-5.554477	-3.482035	-2.884109	0.0000
OIL	-2.676216	-3.477835	-2.882279	0.0807
D(OIL)	-8.617120	-3.477835	-2.882279	0.0000
RIC	-2.000854	-3.477487	-2.882127	0.2863
D(RIC)	-13.15527	-3.477835	-2.882279	0.0000

* MacKinnon (1996) one-sided p-values
Source: own processing

Table 1: Estimation result of stationary test.

Variable	ADF-Statistics	1% Critical Value	5% Critical Value	Prob.*
RES	-2.801489	-3.482035	-2.884109	0.0609

* MacKinnon (1996) one-sided p-values
Source: own processing

Table 2: Estimation results of cointegration test.

Variables	Coefficient	Std. Error	t-Statistic	Prob.	Other Statistics
D(INFt-1)	0.404107	0.088261	4.578538	0.0000	R^2: 0.252786
D(INFt-2)	-0.217390	0.087817	-2.475500	0.0148	DW: 2.027745
D(OILt-7)	0.266558	0.129669	2.055679	0.0422	AIC: -1.287498
D(RICt-27)	0.427076	0.132586	3.221133	0.0017	

Source: own processing

Table 3: Estimation results of testing the dynamics of the effect.

of significance 1%, since all of the absolute values of ADF-statistics are lower than those of the ADF-critics. The prices of world crude oil, the prices of world rice, and the inflation rate are stationary at the first difference or are integrated order one, *I* (1).

Cointegration test

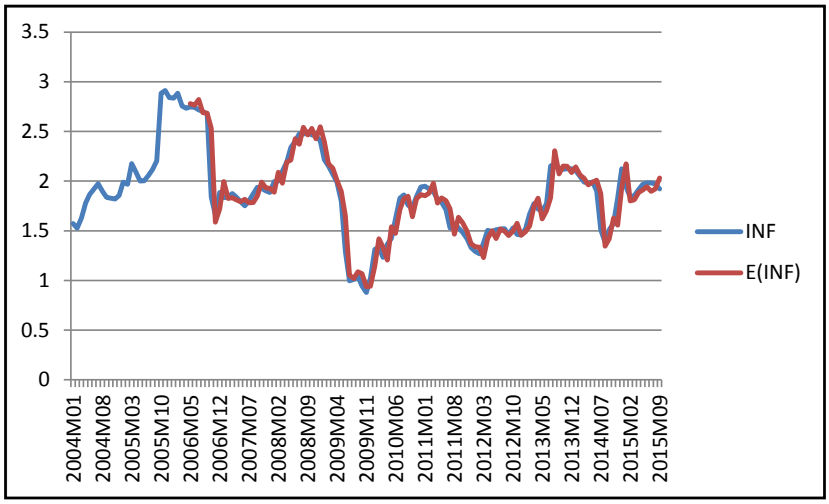
In running the cointegration test, time series data of *RES* is first constructed using (5). Table 2 presents a summary of the estimation results of ADF-statistics and the ADF-critics. By comparing the value of ADF-statistics with the value of ADF-critics, *RES* is not integrated of order zero, I(0). Therefore, the prices of world crude oil, the prices of world rice, and the inflation rate are not cointegrated.

Dynamics of the effect

Since, the prices of world crude oil, the prices of world rice, and the inflation rate are not cointegrated, the regression parameters being estimated are those of model (1). All the statistical values of the estimation results are summarized in Table 3.

As is indicated in Table 3, the coefficient of OIL_{t-7} is significant by 5%, whereas the coefficient of RIC_{t-27} is significant by 1%. This means that simultaneously, there was a dynamic of the effect of world crude oil prices and world rice price on inflation rate. This finding confirms the results reported by Misati et al. (2013), Alom et al. (2013), and Kant and Ahmed (2014), which stated that simultaneously the prices of world crude oil and world rice prices affected the rate of inflation, although these researchers conducted their studies in different settings and periods. Inflation rate is also influecned by past rate of inflation, namely D(INF_{t-1}), and D(INF_{t-2}). The effect exerted by past inflation rate, prices of world crude oil, and world rice prices on current inflation rate D(INF_t) is R^2 x100% = 25.2786%. Thus, other factors contribute the remaining 74.7214% to the current rate of inflation. This needs further research.

Partially, there was an effect of world crude oil prices on inflation rate. The prices of world crude oil required a time lag of seven months to affect the inflation rate. The dynamics of the effect of the world crude oil price on inflation rate is positive with long term multiplier effect $\delta = 0.33$. Given this multiplier effect, every 1% increase



Source: own processing

Figure 1: A signal of the dynamic effects of world crude oil prices and world rice prices on the inflation rate based on the equation (8).

(decrease) in the world crude oil prices rose (fell) inflation rate by 0.33%. Likewise, every 1% decrease (increase) in the world crude oil prices caused the inflation rate to drop (go up) by 0.33%. The results of this analysis is consistent with what was reported by Blanc and Cinn (2004), Alvares et al. (2011), Lu et al. (2013), Sek et al. (2015), Gunado and Gracia (2003), Cunado and Gracia (2005), Ju (2014), and Yalcin et al.(2015). However, except Blanc and Cinn (2004), these researchers did not report the contribution of world crude oil prices on inflation. Furthermore, this particular finding of current research is different from the results of research conducted by Ahmed and Wadud (2011). The difference may be attributed to the economic condition of the countries in the period under investigation (Sek et al., 2015).

The price of world rice also affected the inflation rate positively with long term multiplier effect $\gamma = 0.52$. The prices of world rice required a time lag of twenty-five months to affect the inflation rate. Given the multiplier effect, each 1% increase in the price of world rice caused a 0.52% increase in inflation rate. The finding of this study is similar to the results reported by Cheung et al. (2008), Ratnasari (2009), Myint and Bauer (2010), Abdoulaye et al. (2015), and Belke and Awad (2015), although these researchers did not indicate the extent to which the prices of food commodities affected inflation rate.

Based on the estimation result of the regression parameters, the following model of difference equation is then developed:

$$D(INF_t) = 0.404107D(INF_{t-1}) - 0.21739D(INF_{t-2}) + 0.266558D(OIL_{t-7}) + 0,427076D(RIC_{t-27}) \quad (7)$$

Because $D(INF_t) = INF_t - INF_{t-1}$, then the value of forecasting the inflation rate E(INF) as a result of the effects of world crude oil prices and world rice prices in the period January from 2004 to September 2015 is determined by the following equation

$$E(INF_t) = INF_{t-1} + 0.40407D(INF_{t-1}) - 0.21739D(INF_{t-2}) + 0.266558D(OIL_{t-7})0.427076D(RIC_{t-27}) \quad (8)$$

As noted earlier, the prices of world crude oil and world rice required a certain time lag to influence the inflation rate in period 2004:01-2015:09. In a signal process, the information of the delay is shown in Figure 1. The red curve (curve of E(*INF*)), which almost coincides with the blue curve (curve of *INF*), indicates the dynamics of the effects of world crude oil prices and the world rice prices on the inflation rate.

Conclusion

This study aims to investigate the effects of world crude oil prices and the prices of world rice on Indonesia's inflation rate in the period from 2004:01 to 2015: 09. For this purpose, monthly data are analyzed. An econometric tool used to test this effect is the difference equation model, which is a special form of the Autoregressive Distributed Lag model.

Results of statistical test indicated that the prices of world crude oil, the price of world rices, and the inflation rate are integrated order one, $I(1)$. The three time series data are not cointegrated. Test results indicate that there was a dynamic effect of the world crude oil prices and the world rice prices on inflation rate.The prices of world crude oil positively affected the inflation rate, in which each 1% increase (decrease) in world crude oil prices was followed by 0.33% increase(decrease) in the inflation rate. Similarly, the prices of world rice positively affected the inflation rate, in which each 1% increase(decrease) in world rice prices caused the inflation rate to rise (fall) by 0.52%.

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Information Security Management: ANP Based Approach for Risk Analysis and Decision Making

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Abstract

In information systems security, the objectives of risk analysis process are to help to identify new threats and vulnerabilities, to estimate their business impact and to provide a dynamic set of tools to control the security level of the information system. The identification of risk factors as well as the estimation of their business impact require tools for assessment of risk with multi-value scales according to different stakeholders' point of view. Therefore, the purpose of this paper is to model risk analysis decision making problem using semantic network to develop the decision network and the Analytical Network Process (ANP) that allows solving complex problems taking into consideration quantitative and qualitative data. As a decision support technique ANP also measures the dependency among risk factors related to the elicitation of individual judgement. An empirical study involving the Forestry Company is used to illustrate the relevance of ANP.

Keywords

Information security, Risk factors, Semantic networks, Analytical network process, Multi-criteria decision making, Case Study.

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Introduction

The pervasive uses of and dependencies on information technologies have increased security risks which can induce losses in companies revenue and reputation. Despite the external sources of security attacks, internal abuse and malicious activity may generate an unexpected damage. Companies protect their networks by means of ad hoc security solutions such as access control measures, procedures to prevent and respond to security incidents and risk assessment. The review of the common risk analysis frameworks reveals four mainly steps. They are (a) the classification of information assets according to their sensitivity, (b) the identification of the threats and vulnerabilities, (c) the likelihood occurrences and impact estimation of these threats and (d) the implementation of controls and corrective countermeasures taking into consideration their cost.

In this paper we explore the potential relevance of the Analytical Network Process (ANP) use in information systems security (ISS) context to support the development of individual understanding of security risks leading to richer elaboration of problem spaces. The identification of a number of risk factors requires a classification according to their severity and impact on the information system activity. However, this classification should pay attention to the influence of contextual variables such as the exploration of multiple perspectives of contextual understanding of security risk factors. The involvement of organizational stakeholders to assess security risks with multi-value scales would result in a better understanding of the role

and application of security functions in situated practices and an achievement of contextually relevant risk analysis (Bednar and Katos, 2010, Sadok et al., 2014).

In fact, a number of researchers have identified qualitative and quantitative approaches of IS risk analysis. The reliability of qualitative methods is based on the subjective assessments of experts during the evaluation process (Klimeš and Bartoš, 2015, Bartoš and Walek, 2013, Walek et al., 2013). The quantitative methods are mainly based on mathematical models and can be divided into: i) deterministic methods, ii) probabilistic methods, iii) methods using analogies, and iv) multi-criteria evaluation methods (EIC/ISO). As to the multi-criteria evaluation methods, Delphi method is often used to evaluate risk factors (Briš, 2009, Procházková, 2011b). However and in order to overcome the drawbacks of available risk analysis approaches, Klimeš and Bartoš (2015) suggested fuzzy approach to decision making process based on six sub processes and including several IF-THEN-rule knowledge bases.

Although ANP as a decision support technique has the potential to measure the dependency among security risk factors it is not commonly used in the Czech Republic (Procházková, 2011a). Few studies have been applied ANP to assess the importance of individual elements of the consumer's behaviour of the framing effect (Rydval, 2011, Rydval and Bartoška, 2013, Rydval and Brožová, 2011). As to the Delphi method the ANP uses experts' judgement. It is noticeable that more experts are involved in the evaluation process more relevant the final assessment is.

Consequently, our approach is firstly based on the identification of crucial and significant risk factors leading to the threats and vulnerabilities of information systems. Secondly, the risk factors and relationships between them are described using semantic network in order to develop the decision network. The ANP is then used for the priority evaluation of these factors (Brožová et al., 2015). This leads to a better definition and implementation of effective security countermeasures.

The remainder of this paper is organized as follows. In section 2, a short review of ANP and semantic network concepts found in literature are provided. In section 3 scenarios of security risk factors are described. The section 4 presents the results of an empirical study conducted in the forestry company. Finally, concluding remarks are presented in section 5.

Materials and methods

Semantic network

Semantic network illustrates different points of view as well as the relationships between different relevant elements within a decision context. In effect, semantic networks were originally used to express meanings of various expressions in natural language. According to Sowa (2000) semantic networks are used namely because of their ability to easily provide usable system to represent information and to mainly focus on the organization of a large number of information sources. They also support the description of complex processes and offer a tool to represent the understanding of a problem space.

Semantic (associative) network is defined as a directed graph consisting of nodes and edges (Sowa, 2000). Nodes represent items of described problem and edges connecting these nodes represent relationships between these items. Fundamental types of these relations are as follows:

- IS-AN-INSTANCE-OF (IIO) relationship is used to state that a particular object (instance of a particular class) belongs to the specified class.
- IS-A-KIND-OF (IKO) relationship is used to state that a class is a subclass of another class.
- IS-A-PART-OF (IPO) relationship is used to state that a certain class of objects is composed of some parts.

The semantic network of the decision problem can be used as a starting point for the creation of the ANP decision network. The basic advantage of the semantic network is that it contains information similar to information stored in the human memory, and it is machine-understandable. This means that it can be machine-processed. Therefore, it is possible to analyse facts and information included in the semantic network and to acquire new knowledge about represented facts (Steyvers and Tenenbaum, 2005, Xia and Bu, 2012).

ANP method

The ANP is a multiple criteria decision method based on the network representation of a decision problem which considers the dependence across elements and levels of a decision problem (Saaty, 2001, 2003). The crucial step of the ANP is the pairwise comparison of all pairs of elements related to the same element from higher level

or different cluster from decision network. The steps of the ANP method for this study are as follows:

1. The first step – the semantic network describing the elements of the ISS decision problem and their relationships are constructed.
2. The second step - the network is created based on the semantic network to describe inner dependence within a set (clusters) of decision elements, and outer dependence among different sets (clusters) of the decision elements.
3. The third step - the pairwise comparisons of the elements within and across the clusters are made. The consistency of these comparisons is also checked.
4. The fourth step - if the comparison is not consistent, the decision maker will see how to change and adjust the comparison (Hlavatý, 2014).
5. The fifth step - the normalized supermatrix with the preferences derived from the previous pairwise comparisons is calculated.
6. The sixth step - the limiting supermatrix is computed using program SuperDecision and global preferences of decision elements are obtained (Saaty, 2001).

Evaluation of the pairwise comparisons

The importance of each factor is made using Saaty pairwise comparison of all factors related to the factor or cluster on the higher level (Saaty, 2008). The pairwise comparison is used to estimate the importance of ISS factors in pairs from different points of view. A single number from the fundamental 1–9 scale are standardly used for expert estimation. The Table 1 shows the explanation of each value in this scale in the ISS context comparison of the first and second factor from the pair.

This evaluation could be made for example by a security expert. His judgement has to be consistent, if not we use simple role showing how to improve judgement consistency. The range of feasible values of each preference in Saaty's matrix can be computed from assuming the inconsistency index must not reach over the threshold and ideal values of the selected intensity relatively to the other values on the basis of requirement that the consistency index is equal to 0 (Hlavatý, 2014). If the values in Saaty's matrix are not consistent, ideal values are calculated and the expert got a feedback and an advice on how to adjust the comparison. After this process we obtain the consistent Saaty matrices and the ANP model is calculated by SuperDecision software.

Calculation of the limit matrix

The calculation of the synthetized weights (for example preferences of ISS factors) is then provided using the software SuperDecisions (SuperDecision). The synthetized weights are calculated in the limit matrix. The input to the limit matrix calculation is the normalized supermatrix, which is a matrix of local weights, i.e. preferences derived from the previous pairwise comparisons. The standard steps of the limit matrix calculation are (Saaty, 2001).

1. Raise the matrix to larger powers, and either,
2. The powers will converge to the limit matrix, or
3. The powers will converge to a cycle of matrices and the limit matrix is the average of these.

This algorithm performs remarkably well except in two circumstances (Adams, 2011):

- Hierarchies: In the case of hierarchies the large powers of normalized supermatrix

Intensity of importance	Definition	Explanation
1	Equal Importance	Two factors equally important for ISS
3	Moderate importance	Experience and judgment slightly favour the first ISS factor over the second one
5	Strong importance	Experience and judgment strongly favour the first ISS factor over the second one
7	Very strong or demonstrated importance	The first ISS factor is favoured very strongly over the second one; its importance demonstrated in practice
9	Extreme importance	The highest possible degree of preference of the first ISS factor over the second one

Source: own processing according to Saaty (2008)

Table 1: Fundamental scale of pairwise comparison of ISS factors.

eventually go to zero and then the limit matrix contains all zeros (in other words no nodes get any scores of preferences).

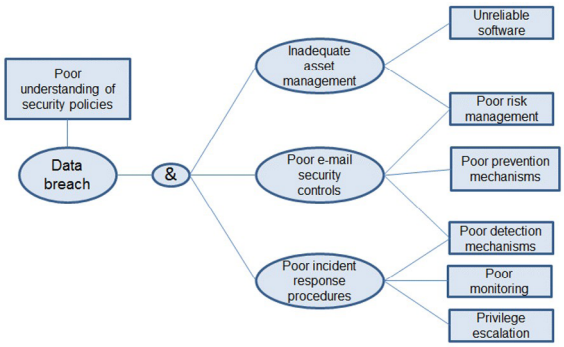
- Sinks in general: Even in networks with feedback, if there are sinks in the network (nodes without connections emanating from them) then the large powers of the normalized supermatrix will still tend toward zero (at least many columns of the limit matrix tend to zero).

Identity at sinks method is the standard approach to avoid this problem with calculation the limit matrix for hierarchies as well as networks with sinks adding self-loop to the sinks (Adams, 2011) and this does give correctly synthesized values for the sinks, but all other nodes get zeros from this calculation. This synthesis is used to determine the weights only of ISS factors which lies in the end nodes of the semantic network. These factors are considered primary in ensuring the ISS. Calculus Type method is another approach (similar philosophy as the differential calculus). This type of calculation again calculates large powers of the supermatrix, but these powers are normalized (Adams, 2011). This normalized supermatrix will not still tend toward zero and returns correctly synthesized values for all nodes in the network. This way we get the weights of all the elements of the semantic network.

Scenarios of security risk factors

In the particular context of ISS it is necessary to construct different scenarios of security risk factors reflecting different points of view. The comparison and integration of security risk factors within a semantic network provide an overview of the relative importance and impact of a particular security risk factor. This leads to identify the most important security risk factors and to assess their impact on the efficiency and effectiveness of an information system. Consequently, appropriate mitigation decisions to cope with and reduce security risks could efficiently be made.

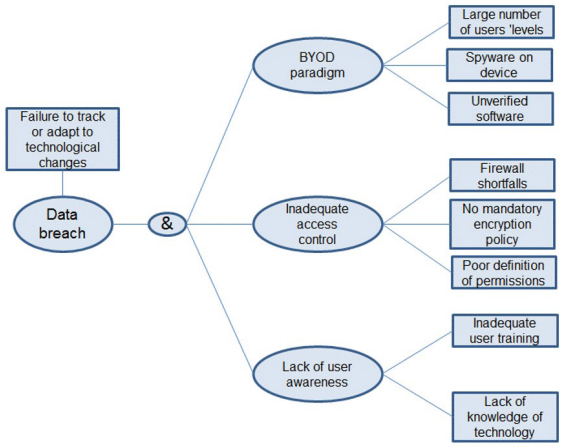
In this section we describe three diagrams as produced by three stakeholders (end user, network administrator, security expert) respectively following a security 'Data breach'. These diagrams contain the most relevant security risk factors and their relations. The view of the security expert related to possible security risk factors explaining the 'Data breach' is captured in Figure 1.



Source: Sadok et al., 2014

Figure 1: Security expert' diagram.

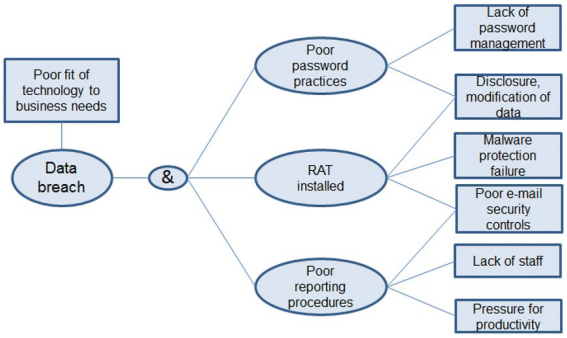
The view of the network administrator about possible security risk factors explaining the 'Data breach' is captured in Figure 2.



Source: Sadok et al., 2014

Figure 2: Network administrator' diagram.

The end user's view about possible security risk factors explaining the 'Data breach' is captured in Figure 3.



Source: Sadok et al., 2014

Figure 3: End user' diagram.

Semantic network as a tool for system analysis of the decision process is used for the description of the IS risk factors and its relations. It shows

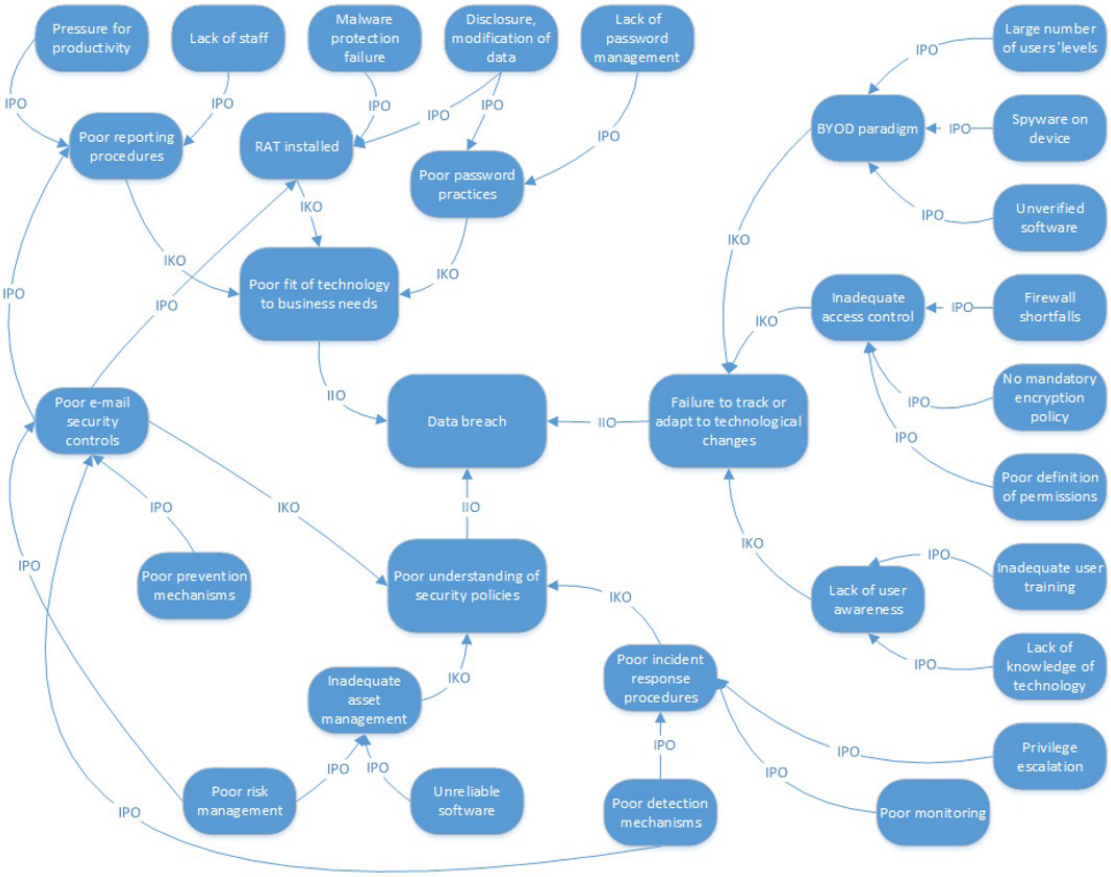
the structure of possible ISS factors, factors hierarchy, relations and factors influenced by different user groups. It can show individual elements influencing issues of 'Data breach'. It provides us with information about relationships in the network between individual factors of the ISS and how they can influence the threatened data. However, it does not give us the quantitative information about the importance of these factors and how much they influence the 'Data breach'. The semantic network is used as a decision network for the ANP method and the SuperDecision program (SuperDecision).

The Figure 4 shows that the issue of 'Data breach' consists of three main instances. They are: 'Poor understanding of security policies', 'Failure to track or adapt to technological changes', and 'Poor fit of technology to business needs'.

Each of these three major instances of the 'Data breach' incorporates various elements expressing different possibilities of the instances development. These elements could be divided into a different number of sub elements describing the component parts of the element responsible for a particular instance of the 'Data breach'.

Some elements, respectively sub-elements can play multiple roles within the semantic network because of the differences between the three points of view. The role of the element and its affiliation to the class of elements or sub-elements is displayed in the Figure 4 using evaluated connection between the elements (IIO, IKO or IPO). For example, the element 'Poor e-mail security controls' plays two kinds of roles. First it is a kind of instance of item 'Poor understanding of security policies' (oriented connection IKO) and second it is a part (sub-element) of the element 'RAT installed' (connection IPO).

The pairwise comparison of items of the created decision network is then made by different groups in the organisation including managers, security experts and end users. This judgement is initially filled in special form in MS Excel (Table 2) which helps users to make consistent decisions during the comparison process.



Source: own processing

Figure 4: Semantic Network of 'Data breach'.

A - most important	Equally									B - most important
A	9	7	5	3	1	3	5	7	9	B
Poor password practices	x									Poor reporting procedures
Poor password practices						x				RAT installed
Poor reporting procedures								x		RAT installed

Source: own processing

Table 2: MS Excel form for pairwise comparisons.

				Weights						
Poor reporting procedures	1.000	9.000	0.333	**0.324**	*-2.206*	*9.000*	*0.333*	*Lambda*	*3.2056*	**Consistency index**
RAT installed	0.111	1.000	0.143	**0.056**	*0.111*	*-2.206*	*0.143*	*Determinant*	*-6E-05*	**0.10**
RAT installed	3.000	7.000	1.000	**0.62**	*3.000*	*7.000*	*-2.206*			
		Ideal values		1						
		1.167	**0.643**							
			0.019							

Source: own processing

Table 3: Ideal values for pairwise comparisons.

After the user files this table the consistency index is computed. If the comparisons are not consistent the automatic calculation shows ideal value of each individual preference relatively to the others two values. These ideal values can support the adjustment of the initial evaluation in case it is not consistent (Table 3).

Results and discussion

The forestry company

Although the dependency of agricultural and forestry companies on IT use is not very high it is not anymore conceivable for these companies to miss the benefits of such use. In fact, the sustainability and competitiveness of their activities are intimately based on the effectiveness and efficiency of their information systems management. However, it is necessary to secure information systems assets to ensure business continuity and economic profits.

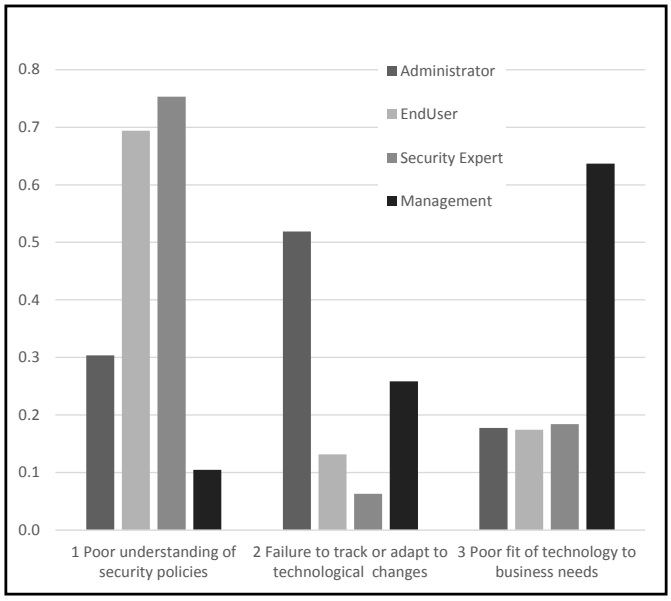
In this section, we describe the application of ANP for risk management in a particular agricultural enterprise. *Vojenské lesy a statky ČR*, a state enterprise, is an organization with a history that goes back to more than eighty years. *Vojenské lesy a statky ČR* manage an area of more than 126,000 hectares of forest land and more than 6,000 hectares of agricultural land and water area. It is one of the largest organizations of its type in the Czech Republic. Its main activities include forest management, trade in timber, hunting, fishing, agricultural activity, nature protection among others. The objective of the enterprise is, in line with the assignment from its founder, the Ministry of Defence of the Czech Republic, to be at the top in the field of forest-based industry and agricultural production. It aims to maintain sustainable forest and agricultural ecosystems using modern technology and knowledge with respect to the environment and maintaining natural landscape features. There is a separate ICT department within *Vojenské lesy a statky* which is in charge of supporting information systems activities and users. In enterprises of such size (more than 2,000 employees), an important number of supporting information systems are used, and the organization information assets are very valuable. As a result, the failure or any actions that compromises the availability, confidentiality or integrity of these assets would cause significant negative impact on the enterprise's operations and performance.

Expert evaluation of the ANP model according to the proposed structure was obtained during discussions with end users, IS network administrators, security experts and also one manager from the same company. Their judgments were checked for their consistency and slightly modified if necessary according to the ideal values guideline. End users evaluated the ISS factors from the group 'Poor fit of technology to business needs', security expert compared factors from the group 'Poor understanding of security policies' and network administrator from the group 'Failure to track or adapt to technological changes'. Manager and all users compared also these three groups. The Table 4 and Figure 5 show weights

Groups of ISS factors	Administrator	End User	Security Expert	Management
1 Poor understanding of security policies	0.303510	0.694061	0.753111	0.104725
2 Failure to track or adapt to technological changes	0.518996	0.131510	0.062917	0.258292
3 Poor fit of technology to business needs	0.177494	0.174429	0.183972	0.636982

Source: own processing

Table 4. Weights of groups of ISS factors.



Source: own processing

Figure 5: Weights of groups of ISS factors.

of three groups of ISS factors. Factors included in 'Poor understanding of security policies' are seen very important for all except for management (all individual weights are greater than 0.3). Generally managers feel 'Poor fit of technology to business needs' as higher important (more than 0.6). Network administrator gives higher importance to ISS factors 'Failure to track or adapt to technological changes' (more than 0.5).

Global importance or synthesized preferences of the partial ISS factors are calculated in the limit matrices. Limit matrix received by Calculus type method (Table 5, Figure 6) shows most important ISS factors from all (preferences higher than 0.07). These factors are mainly from the first ISS factors group ('Poor understanding of security policies') according to the network administrator, end users and security expert. Management also gives the high priority to the factors from the third group of the ISS factors ('Poor fit of technology to business needs').

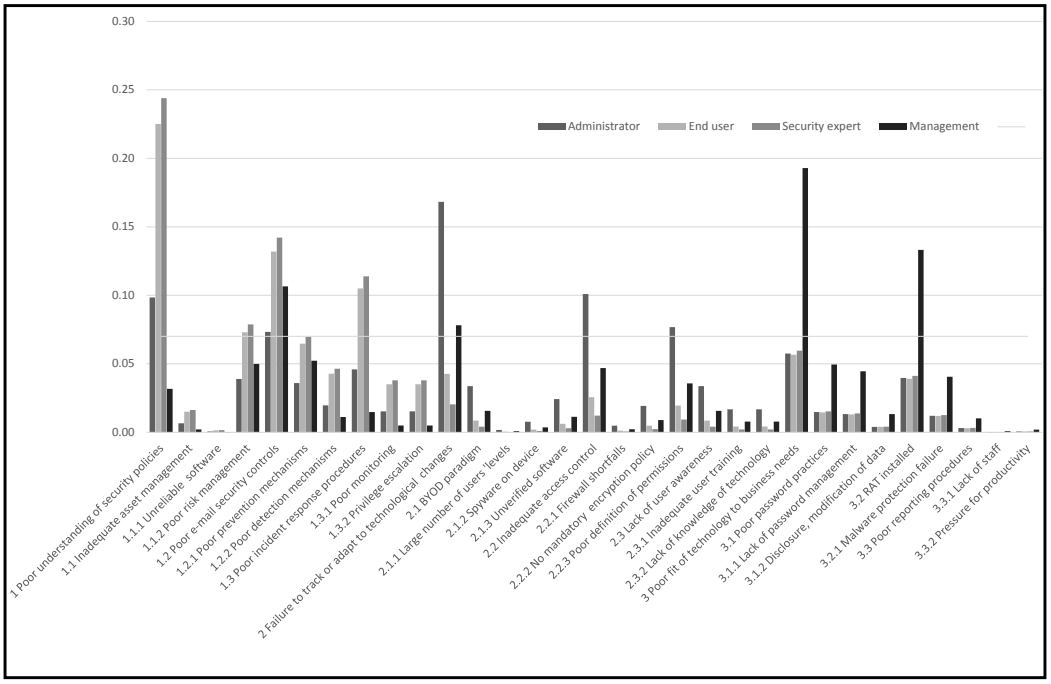
When the Identity of sink method is used, the highest preferences of primary ISS factors are calculated (Table 5, Figure 7). Eight ISS factors can be seen as important ISS factors from different points of view (preferences higher than 0.1). The first six factors 'Poor risk management', 'Poor prevention mechanisms', 'Poor detection mechanisms', 'Poor monitoring', 'Privilege escalation', and 'Poor definition of permissions' are evaluated as very important from practically all stakeholders. The last two factors 'Lack of password management', and 'Malware protection failure' are considered of high importance from the management point of view.

These results are coherent with and support previous works on ISS with a socio-technical perspective. In effect, rather than a dominant emphasis on technologies, for instance, it is essential to fund processes that fully bridge the gap between design and implementation of secure and usable systems through open discussion and dialogue between relevant stakeholders leading to better contextual appreciation of risks. It is also necessary to understand how organizational and environmental factors as well as compliance behavior may affect the efficient use of security controls and policies.

	Administrator		End User		Security Expert		Management	
	Identity sink	Calculus type	Identity sink	Calculus type	Identity sink	Calculus type	Identity sink	Calculus type
1 Poor understanding of security policies		0.0984		0.2251		0.2439		0.0317
1.1 Inadequate asset management		0.0066		0.0150		0.0163		0.0021
1.1.1 Unreliable software	0.0020	0.0007	0.0046	0.0015	0.0050	0.0016	0.0007	0.0002
1.1.2 Poor risk management	0.1201	0.0389	0.2250	0.0730	0.2430	0.0787	0.1582	0.0499
1.2 Poor e-mail security controls		0.0733		0.1320		0.1422		0.1065
1.2.1 Poor prevention mechanisms	0.1108	0.0359	0.1994	0.0647	0.2151	0.0697	0.1652	0.0522
1.2.2 Poor detection mechanisms	0.0606	0.0196	0.1321	0.0428	0.1431	0.0464	0.0362	0.0112
1.3 Poor incident response procedures		0.0459		0.1051		0.1138		0.0148
1.3.1 Poor monitoring	0.0472	0.0153	0.1080	0.0350	0.1172	0.0379	0.0163	0.0049
1.3.2 Privilege escalation	0.0472	0.0153	0.1080	0.0350	0.1172	0.0379	0.0163	0.0049
2 Failure to track or adapt to technological changes		0.1683		0.0427		0.0204		0.0782
2.1 BYOD paradigm		0.0337		0.0085		0.0041		0.0156
2.1.1 Large number of users 'levels	0.0053	0.0017	0.0013	0.0004	0.0006	0.0002	0.0026	0.0008
2.1.2 Spyware on device	0.0236	0.0076	0.0060	0.0019	0.0029	0.0009	0.0117	0.0036
2.1.3 Unverified software	0.0749	0.0243	0.0190	0.0062	0.0091	0.0029	0.0373	0.0113
2.2 Inadequate access control		0.1010		0.0256		0.0122		0.0469
2.2.1 Firewall shortfalls	0.0150	0.0049	0.0038	0.0012	0.0018	0.0006	0.0074	0.0023
2.2.2 No mandatory encryption policy	0.0595	0.0193	0.0151	0.0049	0.0072	0.0023	0.0296	0.0090
2.2.3 Poor definition of permissions	0.2369	0.0768	0.0600	0.0195	0.0287	0.0093	0.1179	0.0357
2.3 Lack of user awareness		0.0337		0.0085		0.0041		0.0156
2.3.1 Inadequate user training	0.0519	0.0168	0.0132	0.0043	0.0063	0.0020	0.0258	0.0078
2.3.2 Lack of knowledge of technology	0.0519	0.0168	0.0132	0.0043	0.0063	0.0020	0.0258	0.0078
3 Poor fit of technology to business needs		0.0575		0.0566		0.0596		0.1929
3.1 Poor password practices		0.0148		0.0145		0.0153		0.0495
3.1.1 Lack of password management	0.0410	0.0133	0.0403	0.0131	0.0425	0.0138	0.1472	0.0446
3.1.2 Disclosure, modification of data	0.0122	0.0040	0.0120	0.0039	0.0127	0.0041	0.0439	0.0133
3.2 RAT installed		0.0397		0.0391		0.0411		0.1331
3.2.1 Malware protection failure	0.0373	0.0121	0.0366	0.0119	0.0386	0.0125	0.1338	0.0405
3.3 Poor reporting procedures		0.0031		0.0030		0.0032		0.0102
3.3.1 Lack of staff	0.0008	0.0002	0.0007	0.0002	0.0008	0.0003	0.0146	0.0008
3.3.2 Pressure for productivity	0.0018	0.0006	0.0017	0.0006	0.0018	0.0006	0.0093	0.0019

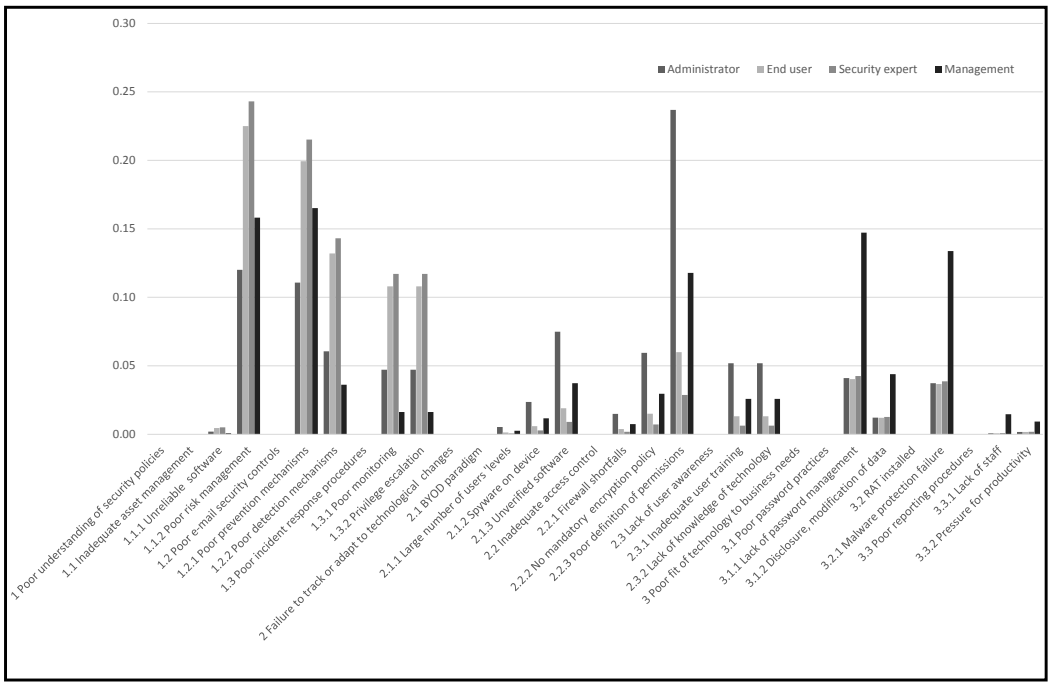
Source: own processing

Table 5: Weights of ISS factors.



Source: own processing

Figure 6: Weights of ISS factors by Calculus type method.



Source: own processing

Figure 7: Weights of ISS factors by Identity at Sinks method.

Conclusion

This paper aimed to shed light on the challenge of introducing security in a sensible and useful manner by addressing the contextual perspectives. The identification of security risk factors as well as the estimation of their business impact require tools for assessment of risk with multi-value scales according to different stakeholders' point of view. We argue in this paper that ANP provides a relevant approach to assess security risk factors taking into consideration quantitative and qualitative data. A case study is discussed to illustrate such relevance. The understanding of the importance

of security risk factors support the definition and implementation of efficient and effective security controls and policies.

Recognizing the complexity nature of security risk management, a number of implications for practitioners and researchers can be identified and should be deeply addressed. For example, to assist and facilitate assessment of risk with multi-value scales according to different stakeholders' point of view, a potential interdisciplinary research area emerges to develop techniques and modelling support for analysis aiming at inquiries into uncertain and complex problems spaces.

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Global Value Chain in Agro-export Production and Its Socio-economic Impact in Michoacán, Mexico

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Abstract

Mexican blackberry production is very geographically concentrated in the Valley Los Reyes, where most of blackberries, which the country exports, are produced. Taking into account that Mexico is the world's largest exporter of this fruit in terms of quantity; we can conclude that a relatively small area produces most of the blackberries that are traded worldwide. The paper aims to analyze the blackberry value chain and its local socio-economic impact. The main conclusion is that the global value chain of blackberries brings benefits for the small farmers and investors too, but it is necessary establish contract terms ensuring that contractors do not abuse their market power. Also it was demonstated the positive local socio-economic impact of the activity.

Keywords

Global value chain, blackberry, socio-economic impact, Michoacán, contract farming.

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Introduction

The actual global economy is formed by global value chains (GVCs) which are embedded within local economic, social and environmental dynamics and the insertion in the GVC depends significantly on these local conditions. Economic conditions include the availability of key inputs: labor costs, available infrastructure and access to finance; social context governs the availability of labor and its skill level, such as female participation in the labor force and access to education (Gereffi and Fernandez-Stark, 2011); and finally environment includes biological, chemical and physical factors, biotic or abiotic (like ambient temperature, sunlight, pH of the water or soil).

The World Hunger Report estimates that the world's poor fall into roughly three categories.

About 60% are small farmers and pastoralists, 20% are landless rural laborers and nonfarm entrepreneurs, and the remaining 20% urban poor. The principal resource of the rural poor is unskilled labour (Haggblade et al., 2012). The concepts of social and economic upgrading are important factors within global value chains because they contribute to more sustainable growth and development: stimulates innovation, promotes employment based on decent work and respect for labour standards (Gereffi and Fernandez-Stark, 2011). Work to promote market linkages in developing countries is often based on the concept of "inclusive value chains", which usually places emphasis on identifying possible ways in which small-scale farmers can be incorporated into existing or new value chains or can extract greater value from the chain, either by increasing efficiency or by also carrying out activities further along the chain (Haggblade et al., 2012). Different public and civil society actors have to work together with the private GVC governance and global lead firms to complement each other and lead to synergistic governance. Policy interventions for sustained poverty reduction require use of GVCs as a policy tool: to generate better employment, enhance skills and knowledge, improve labour conditions and raise incomes.

It is supposed that the foreign investments in developing countries increase private standards in GVCs. Quality standards, such as GLOBALGAP (Good Agricultural Practice), have become critical in GVCs as a number of firms in different countries affect the quality of final products (Lee and Gereffi, 2015). Global lead firms are increasingly facing public pressure to make their supply chains socially and environmentally sustainable (Nadvi, 2014).

Actually the developing country firms tend to be portrayed as 'standard-takers' but it is desirable that they initiate their own effort to improve working conditions, for example collectively within clusters. In agro-food chains, large food manufacturers and supermarkets are increasingly rationalizing their supply chains to work directly with a smaller number of preferred, mostly large, suppliers capable of meeting their stringent requirements, thereby marginalizing smallholders unable to comply the standards (Maertens and Swinnen, 2009).

According to Hecksher – Ohlin theory, trade among regions and countries results from differences in relative endowments of the factors of production (labour, land and capital). This theory explains that each country will export those goods whose production is relatively intensive in the country´s abundant (and therefore cheap) factor (Berry et al., 1997; Knox and Agnew, 2002). Thus, Mexico has large supplies of cheap labor and therefore concentrates on producing and exporting labor-intensive agricultural products like blackberries. Michoacán has natural conditions (favorable climate and soil conditions) for growing fruits which represents a comparative advantage.

In today´s globalized world, demand for exotic seasonal fruit increases and the consumers want products available all year long. The Michoacán production of berry is filling the gap (September to May) of the cycle in the Global North. Blackberries are considered as a luxury product that fills North niche markets to meet the demands of affluent consumers (Chollett, 2010).

The blackberry is an edible fruit of the Rubus genus in the Rosaceae family. The fruit has significant contents of dietary fiber, vitamin C, and vitamin K. Common use is in desserts, jams, seedless jelly, juice and candy. The main attributes of blackberry are health-related, so characteristics of odor, color, taste, maturity and presentation are very important. The product must be free of pathogens or residues of chemicals, main reason why the product should comply with a series of safety requirements and standards. For blackberry fields, only agrochemicals recommended by SAGARPA (Mexican Department of Agriculture, Rural Development, Fishery and Alimentation) and EPA (US Environmental Protection Agency) can be used (Sanchéz, 2008). The majority of the production is exported in fresh form, only the fruit that does not meet standards is processed by agro-industrial factories in Zamora (town situated 1-hour away from Los Reyes).

As with all agricultural growth, two things appear essential for a successful value chain development: creating the right environment for agriculture and investing in rural public goods. There is a positive correlation of agricultural growth with investment in irrigation, transport infrastructure and other technologies (Wiggins, 2013). Governments have a responsibility to provide essential goods and services, infrastructure, such as rural roads, and agricultural research (Pye-Smith, 2013). In the region of blackberry production the government is improving the road infrastructure to transport the berries which are vulnerable to mistreat. The main completed project is the modernization and expansion of the road linking Jacona and Los Reyes. It was initiated in the 2004 with a budget of 200 millions of pesos (Thiébaut, 2009).

The importance of the production of blackberries in the studied region illustrate the production value (in thousands of pesos) of this crop: in Los Reyes, the blackberries production in the last 10 years (2004 – 2014) represented on average 55.19% of the total annual agricultural production value and in Peribán it is 23.90%. The production of blackberries increased in Los Reyes in terms of value more than 8 times in the last 10 years and in Peribán more than 7 times. The planted area and the production in tons increased in the same period 6 times in Los Reyes and 5 times in Peribán. There is no other economic activity with such a high dynamics in the region.

Although the importance of the topic, the number of studies on the blackberries value chain and its socio-economic local impact is small. So the purpose of this paper is to evaluate the global value chain of blackberries and measure the local socio-economic impact of this activity.

The research focused on the evaluation of the global value chain of blackberries, its importance and operating, and the analysis of the possible social and economic impact of the activity.

It aims to answer the following main research questions:

- How is operating the global value chain of blackberries?
- What local impact does the GVC have on income and rural development?

Materials and methods

A combination of research tools was applied to achive the goal. In the first step a literature

review of oficial documents and academic works was conducted. Successively, descriptive stastics, t-test and geografic indicator for the evaluation of the economic concentration were applied to analyze the socio-economic data. The sources of oficial data used for the research were Mexican National Institute of Geography and Statistics, Mexican Agricultural and Fishery Information Service, United Nations Development Programme, United Nations Conference on Trade and Development, International Trade Center, The Organization for Economic Co-operation and Development, World Trade Organization and World Bank Group. Data processing software was used, specifically SPSS (Statistical Package for the Social Sciences).

For the evaluation of the global value chain of blackberries it was used indicators of the involvement of the Mexican economy into the global market: Foreign Value Added, Domestic Value Added and GVC Participation Rate; the importance of the international trade with fresh berries (measured by indicators of Main World Exporters, Importing Markets for Mexican Fresh Berries and Supplying Markets for Fresh Berries Imported by United States of America); the geographic scope indicators (Concentration of Production in Michoacán State and specially in Los Reyes Valley) and government patterns in the chain.

The local economic and social impact can be measured in different ways. One possibility is Human Development Index (HDI) which was created by UNDP (United Nations Development Programme) to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. Its dimensions are: Health (Life Expectancy at Birth Component), Education (Mean of Years of Schooling for Adults Aged 25 Years and Expected Years of Schooling for Children of School Entering Age) and Income (Gross National Income per Capita). All the parameters of HDI for municipalities Los Reyes and Peribán were tested by the one-sample t test to confirm if the population mean (for all 113 municipalities of Michoacán state in years 2000, 2005 and 2010) coincides or no with the values for these municipalities which produce blackberries. It was applied one-sided test at significance level $\alpha = 0.01$.

Another possibility how to measure the economic impact of the activity is the use of the indicator of the Economic Concentration per Capita. This indicator takes into account the value of Total Gross Production of primary, secondary and tertiary sectors and Total Population of the municipality (Palacio-Prieto and Sanchéz-Salazar, 2004). It is presented in thousands of pesos and the data are for 2008 (last published results of statistical census at municipality level for the three sectors). The sample is 113 municipalities of Michoacán state and the year 2008.

$$CCE = \frac{TGPS}{TPM} \text{ (thousands of pesos per capita)} \quad (1)$$

Where: TGPS = Total Gross Production of Agricultural, Livestock and Forestry Production, Fishing and Mining; Manufacturing, Electricity and Water Production, Construction Industry; Transport, Communications, Trade and Services and TPM = Total Population of the Municipality.

The Gross National Income per capita in 2010 is also mentioned for comparison (the sample of 113 municipalities as well).

The quality of life of the population depends on the conditions of housing, therefore has been included in the analysis the indicators of household living standards: Household

Facilities (piped water and drainage) and Household Equipment (washing machine, fridge, earthen floor). All the indicators of 113 municipalities of Michoacán state in years 2000, 2005 and 2010 were tested by the one-sample t test to confirm if the population's mean coincides or no with the values for municipalities Los Reyes and Peribán.

Given the importance of the women participation in the economic activities, it was included in the analysis the Women Employment Rate and the Total Employment Rate (INEGI data, 2010 for 113 municipalities of Michoacán).

Results and discussion

The results are divided in two parts, each focused on response one of the main research questions – characterization of the GVC of blackberries and its economic and social impact.

1. Characteristics of global value chain of blackberries in Mexico

For determining of the GVC and its operation it is necessary to outline the general economic environment where the activity develops, so it is included the chapter of Mexican participation in globalization and the international trade with fresh berries. Then it is targeted the specific

case of the blackberries value chain in Michoacán.

1.1 Mexican Participation in Global Value Chains

The topic of the participation of developing countries in the globalization process and the advantages and disadvantages of engaging in the GVCs is frequently discussed (Gereffi and Fernandez-Stark, 2011; Lee and Gereffi, 2015; Lee et al., 2011; Eaton and Shepherd, 2001; Humphrey and Schmitz, 2000). Inspecting the official data, it is obvious that the share of global value added trade captured by developing economies is increasing rapidly. It grew from around 20% in 1990, to 30% in 2000, to over 40% in 2010 (UNCTAD, 2013). Estimated benefits for Mexico from trade facilitation between 2007 (baseline) and 2014 were 14% for the volume of non-oil and gas exports, 32 % for the volume of non-oil and gas imports, and 7 % for the gross domestic product (Tsigas and Ferrantino, 2014).

The main indicators, which recognize the World Investment Report of Global Value Chains to measure the involvement of the local economy into the global market, are Foreign Value Added, Domestic Value Added and GVC Participation Rate.

Foreign Value added (FVA) indicates what part of a country's gross exports consists of inputs that have been produced in other countries and it is not adding to its GDP. The highest shares of FVA in trade are found in East and South-East Asia and in Central America (including Mexico) where processing industries account for a significant part of exports. Central America share of FVA in exports was of 31% in 2010 (higher than the developing counties average).

Domestic Value added trade share is the trade contribution to the GDP of the country and can be significant relative to the size of local economies. In the case of Mexico, the part of exports created in-country was 68% in 2010. The agricultural exports form part of the Domestic Value Added, so they have a direct impact on GDP. In the year 2014 the agricultural exports amounted 3.96% of total Mexican exports (manufacturing exports being the most important category with 80.5% share). The highest share in agricultural exports in terms of value (millions of USD) has tomatoes (15.64%), followed by other fresh vegetables (13.71%), pepper (12.78%) and avocado (12.56%).

GVC Participation Rate - upstream links (foreign value added in exports) and downstream links (exports that are incorporated in other products and re-exported) - indicates how the country is integrated in international production networks. Depending on the GVC participation of the country we can estimate how much hypothetical damage to GVCs would occur if a country's exports were blocked as well as the vulnerability of the GVC to shocks in an individual economy along the value chain. Mexico has a high participation rate in the upstream component, where it ranks equal with South East Asia. However, it has a lower downstream participation rate, reflecting the fact that it exports relatively more to the United States domestic market rather than for onward exports.

1.2 International trade with fresh berries

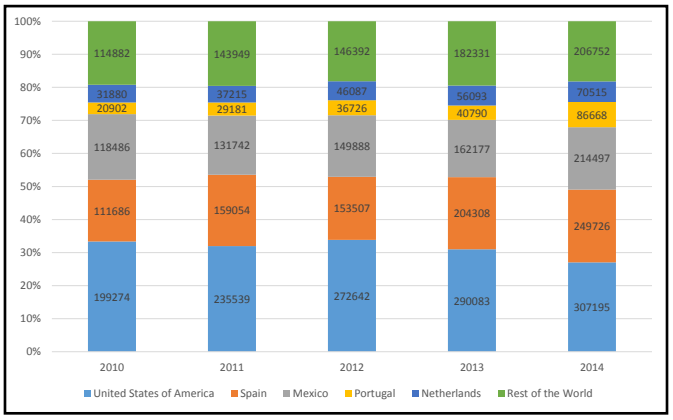
Mexico is the biggest world exporter of fresh Raspberries, blackberries, mulberries and loganberries[1] in the terms of quantity: the exportet quantity (tons) was in 2014 of 63,028 (31.1% of the world exportations) and it is growing up all the years since the 2010. In the 2014 it was 22,404 tons more then 2010 (upsurge of 35.5%). However in the terms of value, Mexico is the third after United States of America and Spain, as displayed in Figure 1.

The exports of Mexican fresh berries keep growing since the 2010, the maximum growth rate was achived between 2013 and 2014 (32%).

The target market of Mexican berries are United States of America, which received 87.9% of total Mexican exports in 2014. In the European market, exports to United Kingdom, Netherlands and Italy have the highest representation. All the exports are growing, except the exports to United Kingdom (reduction of 2% between 2013 and 2014). The largest increase occurred in exports to Italy, where it was 50%. Mexico is the second most important exporter of fresh berries to Netherlands and the third most important exporter to United Kingdom, Italy and Belgium (Figure 2).

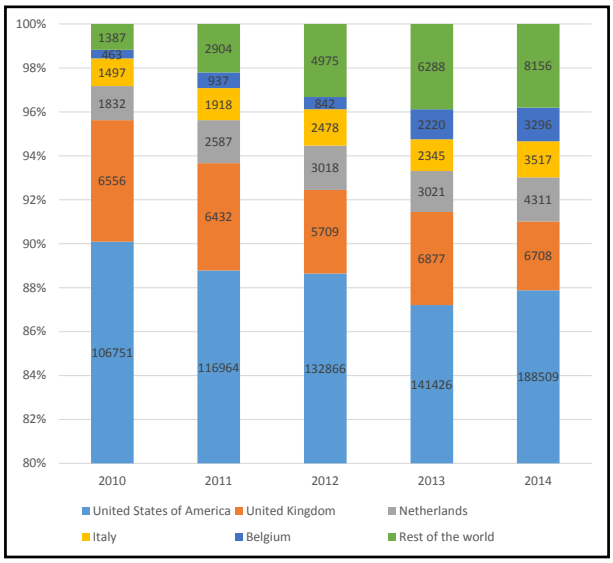
The importance of the Mexican exports to the US market shows the following figure: 97.1% of the imported berries come from Mexico; other suppliers are in substance insignificant. The share of Mexico's exports to USA since 2010 is almost constant; nevertheless the values increased more than twice - from 276,113 thousands of US Dollar (in 2010) to 601,912 thousands of US Dollar (in 2014) (Figure 3).

[1] Product class 081020 of the International Trade Center.



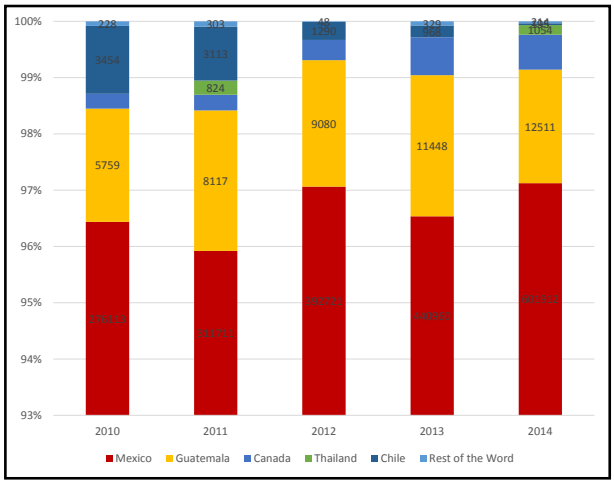
Source: ITC (International Trade Center), 2014

Figure 1: Exporters of fresh raspberries, blackberries, mulberries and loganberries (Thousands of US Dollar).



Source: ITC (International Trade Center), 2014

Figure 2: Importing markets for fresh raspberries, blackberries, mulberries and loganberries exported by Mexico (Thousands of US Dollar).



Source: ITC (International Trade Center), 2014

Figure 3: Supplying markets for fresh raspberries, blackberries, mulberries and loganberries imported by United States of America (Thousands of US Dollar).

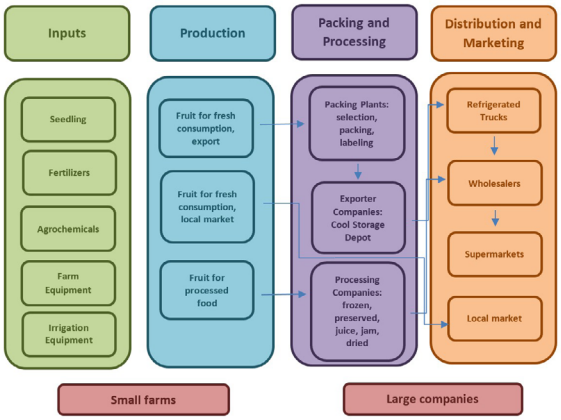
1.3 Geographic Scope of Blackberry Production

Ninety-eight percent of Mexico´s blackberries are grown in the state of Michoacán (production value, 2014), specifically in municipality of Los Reyes (53% of the state´s production value) and Peribán (22% of the state´s production value). The blackberries expanded rapidly in the region: there were approximately 80 hectares in 1995, 500 in 2001 and 5,000 in 2010. Thanks to their high profitability, blackberries soon began to replace the cultivation of sugar cane (former major local crop). The production of blackberries was 65,260 tons (Los Reyes) and 27,191 tons (Peribán) in 2014 and it grew between 2013 and 2014 in both cases. Whereas the harvested area is practically the same, the increase was due to higher efficiency of production.

The majority of fresh blackberry production is exported to United States. After the completion of NAFTA (North American Free Trade Agreement) the export of fresh fruit to the United States is easier because all the tariffs, permits and antidumping regulations were eliminated. Also transportation of commodities with a very short shelf-life is possible due refrigerated storage facilities and trucks.

1.4 Governance patterns of the blackberries value chain

There are different governance patterns of the GVC depending on the degree of power asymmetry and degree of exploit coordination. Berry production forms a vertically integrated chain of production and distribution whose corporate owners rely largely on contract farming[2]. In the case of blackberry agro-export production we can design the GVC like a captive chain. The captive chains (or quasi-hierarchical) is characterized by suppliers with low levels of capabilities, who require high levels of support and are the subject of well-developed supply chain management from lead firms. The suppliers are dependent on one or a few buyers that often wield a great deal of power, control and monitoring. Therefore, the ethical leadership is important to ensure suppliers receive fair treatment and an equitable share of the market price. The lead firms tends to be in areas outside of production and does not encroach on this core competency (through contracting they gain access to the products of the land, since control of land still rests primarily in ejidos[3]) but helps their suppliers upgrade their production capabilities and so benefit itself by increasing the efficiency of its supply chain. It is estimated that 80% of companies engaged in the business of blackberry in the domestic and international market are foreign. The costs and risks of production belong to farmers and the costs and risks of transportations and sale belong to foreign companies, the division of competences shows the following graph. The main blackberries companies represent foreign capital investment: Hortifurt, Sun Belle, Expoberries (Chile), Hurst´s Berry Farm, Sunny Ridge, Driscoll´s (United States), Guimarra/ VBM Berry International LLC (U.S. – Chile joint venture). Mexican companies operating in the sector are Agroindustrial El Molinito, S.A. de C.V., Grupo HerEs and EXIFRUT. All these companies are private, large or medium (Figure 4).



Source: Crespo, based on Fernandez-Stark, 2011

Figure 4: Blackberry Global Value Chain.

The great bulk of agricultural value chains involve sales to companies from independent farmers. Such arrangements frequently involve contract farming in which the farmer undertakes to supply agreed quantities of a product, based on the quality standards and delivery requirements of the purchaser, often at a price that is established in advance. In the 1998 some producers formed an association in response to their vulnerability in relation to foreign companies that determine prices and input requirements. But the foreign exporters did not want to deal with an organized group, and members soon abandoned the association.

[2] Contract farming can be defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices (Eaton and Shepherd, 2001).

[3] Area of communal land used for agriculture based on an understanding of the Aztec calpulli.

2. Economic and Social impact of the blackberry production

Agro-food involves a relatively large proportion of small scale and low-skill labor-intensive production, particularly at the farm level. As the harvest of blackberries is manual, the manpower needs are important. Workers come from the villages of the Valley Los Reyes and the sierra Purépecha (situated on the north of the Valley). Gradually the area of influence was extended and actually incorporates the villages more than 30 kilometers of the Valley as shown in the following map (Figure 5).

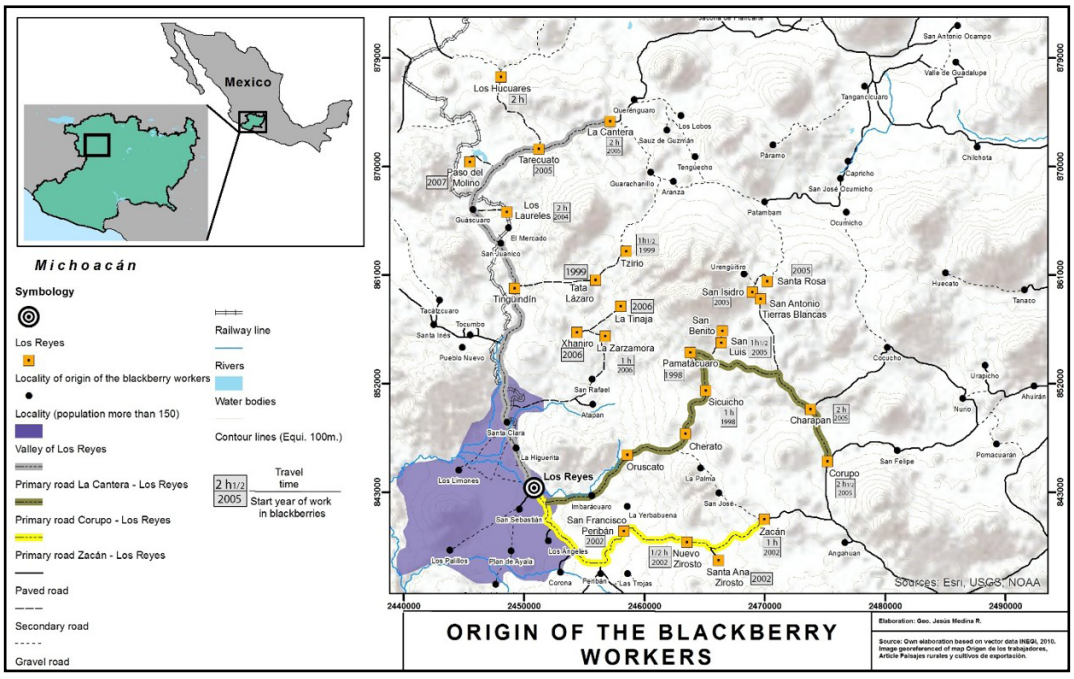
The workers hired for the work on the blackberry fields are often indigenous Purépecha women who are illiterate. Thiébaut (2011) estimate that in the cultivation of blackberry work between 5 and 8 thousands of people and women represent 60 to 70 % of the labor force. Gender implications are important because the work on the blackberry fields represent one of the few opportunities for the women. The companies also prefer to hire women workers; they consider best suited for scrap because it is a delicate work. The profile of a typical worker is a young woman, single and without children. Often teenagers and young adults leave school to earn their own money and gain some independence. These workers are generally mobile and unstable. When the women get married, the majority renounces to work. Other possible profile of worker is older women/widow, often head of households.

Average salaries are 140 pesos per day[4] (6 hours). In rural area this salary is quite high (the daily minimum wage was 66 pesos in 2015). A woman picks 10 boxes (120 containers) per day and each container is sold in the United States for 4 dollars. So we can calculate that the labor cost represents roughly 1.5 % of the price of product.

2.1 Human Development Index

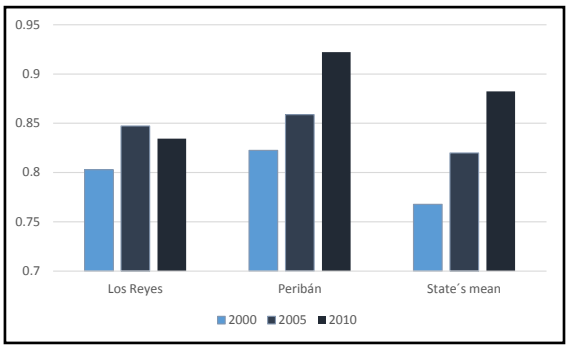
It was expected that the economic and social development of the two municipalities (Los Reyes and Peribán) is higher than the mean of the state. As shows the Figure 9, in the 2010 the HDI of Peribán was significantly higher (0.8310) but it does not apply in the case of Los Reyes (0.8091 when the mean of state was 0.8032). Income index was significantly higher in the two municipalities in the 2010, education and health indexes were significantly higher only in the municipality of Peribán. Income index is very high in the municipality of Los Reyes (0.8148 when the state´s mean was 0.7549), this index is derived from the Gross National Income per Capita, which was 13,184 US dollars in 2010 (state´s mean was 9,501 US dollars). The trends over time show that Los Reyes as well as Peribán recorded economic growth since 2000 as showed

[4] It represents 7.1 US dollars (official exchange rate of Bank of Mexico, 9 September 2015).



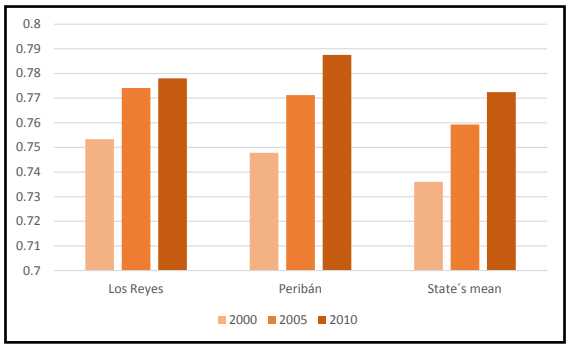
Source: Own elaboration based on vector data INEGI 2010

Figure 5: Origin of the Blackberry Workers.



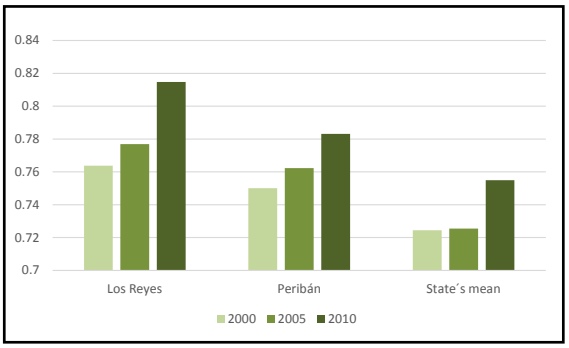
Source: Own elaboration based on UNDP data (HDI 2000, 2005, 2010)

Figure 6: Health Index.



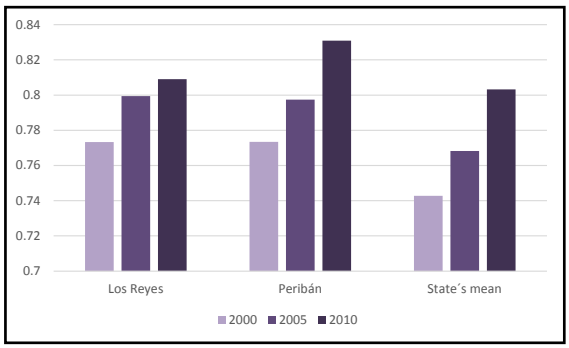
Source: Own elaboration based on UNDP data (HDI 2000, 2005, 2010)

Figure 7: Education Index.



Source: Own elaboration based on UNDP data (HDI 2000, 2005, 2010)

Figure 8: Income Index.



Source: Own elaboration based on UNDP data (HDI 2000, 2005, 2010)

Figure 9: HDI.

in figure 8. The positive social development in the dimensions of education and health was also confirmed (except health index in Los Reyes, which decreased between 2005 and 2010 and was lower than the state´s mean). The figures 6 and 7 show the trends in time.

Indicator	Los Reyes	Peribán	Michoacán State' s Mean
HDI	0.8091	0.8310*	0.8032
Income Index	0.8148*	0.7831	0.7549
Education Index	0.7780	0.7875*	0.7725
Health Index	0.8345	0.9222*	0.8823

Source: Own elaboration based on UNDP data (HDI 2000, 2005, 2010)

Table 1: HDI and its components (2010)

2.2 Economic Concentration per Capita Index

The indicator was significantly higher at the significance level $\alpha = 0.01$ in both municipalities in 2008 (Peribán 92.5, Los Reyes 51.8, state´s mean 26.8 thousands of pesos per capita). The result is very significant at the state´s level: Peribán is the second municipality with the highest economic concentration per capita of Michoacán (after harbor of Lázaro Cárdenas). Los Reyes is the eleventh municipality of the 113 municipalities of ichoacán. Also the Gross National Income per Capita (US dollars) is very high in Los Reyes and both municipalities are higher than Michoacán average.

Indicator	Los Reyes	Peribán	Michoacán State' s Mean
Economic Concentration per Capita (thousands of pesos)	51.8*	92.5*	26.8
Gross National Income per Capita (US dollars) 2010	13,184*	10,909	9,501

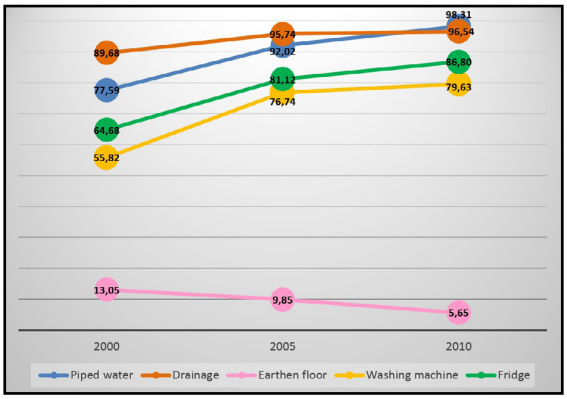
Note: * Statistically significant at the significance level $\alpha = 0.01$
Source: Own elaboration based on INEGI data 2008, 2010

Table 2: Economic Concentration per Capita Index and Gross National Income per Capita.

2.3 Households living standards

The socio-economic development can be measured also by household facilities and equipment. In this sense it was reviewed equipment by piped water and drainage and household facilities like washing machine, fridge and solid floor. The municipality

of Peribán shows in 2010 better conditions than state´s mean in all aspects: piped water have 98.31% of the households (state´s mean 92.06%) and drainage 96.54% (state´s mean 88.64%). 79.63% of households own washing machine (state´s mean 65.28%), 86.80% own fridge (state´s mean 81.88%) and only 5.65% has earthen floor (state´s mean 10.26%). How we can observe in the figure 10, all of this characteristics are improved since 2000. In Los Reyes the development is not so uniform: only one value is higher than state´s mean in 2010 (households that own washing machine) but positive development in time since 2000 was detected in case of piped water, drainage, washing machine and fridge. The share of households that has earthen floor did not reduce.



Source: Own elaboration based on INEGI data 2000, 2005, 2010

Figure 10: Household facilities and equipment, Peribán (% of household which dispose)

Indicator	Los Reyes	Peribán	Michoacán State' s Mean
Household facilities: % of household which dispose of:			
1. piped water	89.45	98.31*	92.06
2.drainage	83.15	96.54*	88.64
Household equipment: % of household which dispose of:			
1. washing machine	68.7	79.63*	65.28
2. fridge	77.06	86.80*	81.88
3. earthen floor	15.1	5.65*	10.26

Note: * Statistically significant at the significance level α = 0.01
Source: Own elaboration based on INEGI data 2010

Table 3: Household living standards

2.4 Women participation

Participation of women in the labour market has a significant positive socio-economic impact. In Los Reyes work more women than state´s mean – 44.0% (compared with 32.5% state´s mean, year 2010), the difference is statistically significant. In Peribán it was not identified this effect. The employment rate for both, men and women, measured by percentage of economically active persons in the total population was in 2010 of 37.69% (Los Reyes) and 37.90% (Peribán), in both cases major than state´s mean (35.27%) and in both cases the difference is statistically significant.

Indicator	Los Reyes	Peribán	Michoacán State' s Mean
Women employment rate	44.0*	31.5	32.5
Total employment rate	37.69*	37.90*	35.27

Source: Own elaboration based on INEGI data 2010

Table 4: Woman participation.

Conclusion

The prospects of the blackberry´s agribusiness are positive, Mexico found its competitive advantage in this sector and it is able to exploit it. The exports of Mexican fresh berries keep growing and in the United States market of fresh berries it achieves almost 98 per cent of the total imports. Of course there is a risk of high specialization in US market. This risk can be reduced by focus to the European market or regionalization of GVCs in response to a variety of factors, including the growing importance of large emerging economies and regional trade agreements (recently signed Strategic Partnership Agreements between China and Mexico or Pacific Alliance).

The contract farming has significant benefits for both the farmers and investors. The main advantages for the small farmers consist in supplies in inputs and production services (about 25 thousands of pesos per hectare), possibility of credit through advances from the investor, introduction of new technology and also learning of new skills, reduction of farmers' price risk (contracts specify prices in advance), access to new markets which would otherwise be unavailable to small farmers. For the investors the main benefits are: working with small farmers overcomes land constraints and security of tenure of the land, less risk by not being responsible for production and more consistent quality of the product. But the farmers have to face production problems (particularly when growing new crops) and investors may be unreliable or exploit a monopoly position.

By the HDI it is possible to compare the development level of localities, states or countries. The economic development was stronger in the case of Los Reyes; however in the social aspects (education and health) it was demonstrated a positive development in Peribán. Also the Economic Concentration per Capita is higher in Peribán.

It is known that the employment of women has a positive impact on the household equipment and facilities. The better living standards exist in Peribán: all the conditions are better than state´s mean. Los Reyes has a positive development since 2000 in majority of aspects, but the difference is not statistically significant, although the women employment rate is much higher in Los Reyes. It shows the ambiguity of the social effects.

The harvest of blackberries offers jobs to the local population, especially to women, who find employment with difficulties. The job in blackberry fields represents an alternative for the young people of the Purépecha ethnicity, who otherwise tend to migrate illegally to United States.

The World Trade Organization (WTO), the OECD and the World Bank highlight that the measurement of value creation and capture is deficient in GVCs. Actually they are developing new ways to measure trade, production and employment. To capture the links between economic and social dimensions of global production and trade it is necessary grasp changing patterns because the employment data by sector are insufficient to measure jobs in diversified value chains and ignore casual jobs. In the near future it is planned to conduct a field research in Los Reyes Valley with the purpose to collect the socio-economic data and explore the phenomenon of migration.

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Temporal Trajectories of HR/VHR Pixels and Detection of Land Take Processes

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Abstract

An increasing share of people and economic activities are attracted by the cities. This fact shows positive aspects and at the same time causes challenges, mainly in reference to the soil whose ecosystem services can be disrupted when the land cover is modified. Therefore, urbanization is a critical issue for the land management.

Contrasting the urban sprawl (i.e. the spontaneous, unplanned process transforming vegetated land covers into artificial ones) is relevant for soil protection in terms of minimizing the land take. Remote sensing technologies have provided support (with an ex-post approach) to understand urban sprawl as a process and to assess its impacts on the sustainability of land management. The current availability of high-resolution/ very-high-resolution (HR/VHR) satellite data suggests to explore a different approach, aiming to deploy timely adequate countermeasures.

The analysis of the urban sprawl processes pinpoints how the induced land cover changes show some specific patterns; moreover, distinctive trajectories in the space of multitemporal / multispectral imagery data can be elicited, relying also upon vegetation indices as the Normalized Difference Vegetation Index (NDVI). Accordingly, suitable precursors of urban sprawl processes can be detected. Such precursors can support a novel ex-ante approach in preventing the consolidation of the outcomes of the urban sprawl processes.

Keywords

Sustainable land management, urbanization, land cover change, remote sensing, satellite imagery, spatio-temporal trajectories, urban sprawl.

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Introduction

Urbanization expands as a response both to the increasing population (requesting new dwellings) and to modifications of the life styles (lowering the quantity of inhabitants per single house and enlarging the built surface available per single inhabitant). It has been estimated that the urbanized population in Europe and in northern America will reach an amount in the range 78% to 85% of the total by 2030 (UNDESA, 2012).

It can be shown that economic development and enlargement of the urban areas are positively correlated. Moreover, compact, densely populated cities can match an increase in economic productivity to a lower consume of resources per person, when a conscious urban governance (specifically, in terms of land planning) is available (EEA, 2015). From this point of view, urbanization is a positive process.

On the other hand, it has to be taken into account that the global footprint of a urban area is usually greater than the area delimited by the city own borders. The above mentioned urbanization trend implies challenging stresses on the interested communities. Accordingly, new problems at unprecedented quantitative and qualitative scales have to be dealt with, in order not to overcome the social and ecological resilience of the interested areas. Among those problems, the soil consumption (i.e. the transformation of the land cover from agriculture and nature to other artificialized classes) appears to be of utter concern; its management requires novel approaches and tools.

Materials and methods

The concepts of land cover, land use and land take are presented, in order to establish a basis for the subsequent analysis. Land take is related to soil sealing and to urban sprawl, both of them disrupting the ecoservices provided by the soil, as a consequence of mostly unplanned changes. An improved land management is necessary in order to control the changes induced by land take. To such purpose, data provided by satellites can be effectively exploited, relying on the increased resolutions of the currently available sensors.

Some definitions

A basic definition of land cover is «the vegetational and artificial constructions covering the land surface» (Anderson et al., 1976). INSPIRE (the EU initiative establishing a spatial data infrastructure in Europe) provides an operational definition of land cover as «physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies.» (INSPIRE, 2007); it also suggests a more generic one in terms of «an abstraction of the physical and biophysical cover on the earth's surface» (INSPIRE LC, 2013).

Land use (even if often intertwined with land cover) is a description of the «territory characterized according to its current and future planned functional dimension or socio-economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational)» (INSPIRE, 2007). An earlier and more compact definition is reported by (Anderson et al., 1976), in terms of «man's activities on land which are directly related to the land».

In Europe, a good level of land cover data harmonization has been provided by the EEA CORINE Land Cover program and the Eurostat LUCAS survey; for both the existing and planned land use, INSPIRE has produced the Hierarchical INSPIRE Land Use Classification System (HILUCS). Strictly speaking, each member State can still use its own classification system; the INSPIRE Directive requires data interoperability, not necessarily data harmonization (at least, as far as suitable transformation tools are made available).

Dealing with the concept of soil consumption (globally referred to as land take), the European Environment Agency (EEA) has analyzed the mutual relations of land take to soil sealing and urban sprawl (Turner, 2002). Soil sealing refers to the generic processes that are responsible of the covering of soil (both urban and agricultural) by impermeable materials (as those used in the building industry or by agricultural practices) in a way that disrupts the ecosystem services expected from the soil as itself. When such disruption of ecosystem services is practically irreversible (as in most cases), land take increases and, at the same time, portions of territory show different land cover.

Such cover changes occur as a consequence of both planned (i.e. duly authorized) and spontaneous (i.e. not legally foreseen) initiatives of development of non-artificialized land. In the latter case, the cover change is usually the result of the urban sprawl, defined as «the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas… [it is] synonymous with unplanned incremental urban development, characterized by a low density mix of land uses on the urban fringe» (EEA, 2006). It is worth noting that the above mentioned definition of the urban sprawl includes a subset only of the more general phenomena of the artificialization of the fringes of the urban areas, phenomena that can have an heavy impact on the environment even if they have duly been authorized.

However, it appears that not everybody dealing with the European environment is acting on the basis of the EEA definition, e.g. the INSPIRE data specifications include the Annex B (even if labeled as "informative", not "normative") where the sprawl is seen as a physiological, not pathological, aspect of the urbanization: «Urban sprawl is an intrinsic dimension of urbanization, which underlies the processes of spatial diffusion occurring in most developed countries. It has been shown that urban sprawl can increase the aggregate urban land use and lower the average land use density while at the same time lowering average commuting travel times and increasing discretionary mobility…Urban sprawl is considered acceptable when the rate of urban sprawling is similar to the population increase» (INSPIRE LU, 2013).

It is interesting to compare and contrast the last sentence of the paragraph above with the fact that the expansion rates of the residential urban areas and of industrial areas have been recorded since 1990 as respectively four times and seven times the rate of increase of population (EEA, 2013). Anyhow, EU policies globally see the need of reducing and mitigating the negative effects of soil sealing (whose expansion the urban sprawl is

a major component), aiming to achieve no net land take by 2050 through the diffusion of applicable best practices and the improvement of relevant governance processes (EC, 2011).

In such context, an improved land management (specifically in terms of halting the urban sprawl) can effectively contribute to minimize the land take and to establish a more sustainable equilibrium among the various land uses. Satellite data can be useful when exploited in the frame of a suitable methodology, supporting their fusion with data from other relevant sources and allowing to detect the urban sprawl since its earliest appearance.

Remote sensing and urban sprawl

Remote sensing (RS) technology has been widely exploited to survey the land (including the urban areas) and to monitor its changes, since the launch of the Landsat-2 satellite in 1975. Urban sprawl effects have became a subject of interest at the beginning of the Eighties, mainly in correlation with the availability of the improved sensors onboard of satellites as Landsat-4 since 1982 and SPOT-1 since 1986. A review of concepts and applications of RS to urban studies is provided by (Bhatta, 2010). A review of the requirements for sustainable land management and of possible uses of RS is provided by (Skidmore et al., 1997).

RS capabilities for land cover assessment have been extensively investigated since the availability of the Multi-Spectral Scanner (MSS) of Landsat-2. The extension of the studies in this domain has been supported by the improved resolutions of the subsequent sensors, starting with the Thematic Mapper (TM) on Landsat since 1982; the Enhanced Thematic Mapper Plus (ETM+) on Landsat since 1999; the High Resolution Visible (HRV) on SPOT since 1986). The initial focus was on defining the actual borders and the past changes of the urban areas.

Currently, future land cover evolutions are mainly estimated as the product of mathematical modeling, possibly supported by aerial and satellite imagery processed by geographical information system (GIS) tools and providing data to simulation models. RS data are mostly used to analyze the actual state of the land cover, in reference to the previous states. i.e. with a ex-post approach: this applies specifically to the description of the urban sprawl phenomena (as in (Ji et al., 2006)).

Earlier sensors (MSS, TM, ETM+ …) from one hand were adequate for such approach. On the other hand, sensors with largely improved resolutions (i.e. up to few meters spatially; return time of few days; more spectral bands) are currently available on recent satellites (e.g. Ikonos-2, QuickBird, RapidEye, Landsat-8, Sentinel-2); the related data suggest to investigate about the feasibility of an ex-ante approach, on the basis of a novel methodology aiming to detect the urban sprawl before its consolidation. Taking into account the actual level of urbanization in Europe, proactive land protection appears to be more effective (even if more demanding) than reactive sanctions of unplanned transformations.

From the very beginning, data interpretation has exploited various algorithms (supervised or unsupervised clustering, linear regression estimators etc.) to categorize groups of spectrally homogeneous pixels, aiming to associate such groups with actual land cover classes. Principal components analysis (PCA) has proved its efficacy in filtering redundant data. Trying to improve the results provided by such “per-pixel” methods, the image interpretation processes have been extended in order to include:

- The time information, by jointly processing images taken in different dates for the same areas;
- The spatial information, carried mainly by image texture and pixel proximity.

The current Object-Based Image Classification (OBIA) methods rely specifically on the latter approach. Such methods, reviewed by [Blaschke, 2010], provide new paradigms for image classification and are specifically suitable for HR/VHR (High Resolution/Very High Resolution) image analysis.

The inclusion of the time information, in particular, has supported the definition of temporal trajectories of the land covers. The spectral properties of the pixels show evolutions that can be revealed by suitable data transformations. For agricultural and natural areas, such evolutions can be foreseen on the basis of information provided by phenological calendars. Being such calendars specific for each vegetal canopy, land cover classes with similar spectral signatures (e.g. wheat and pasture) can be discriminate analyzing the temporal trajectories of their pixels, whose reflectance will reach its annual maximum in different dates and usually along different paths in the spectral space (Schwartz, 2013).

Relying on such improvements, the definition

of a RS-based methodology for the early (i.e. ex-ante) detection of urban sprawl appears to be feasible. To such purpose, it is useful to examine the processes of land cover changes in the periurban areas.

Results and discussion

The urban sprawl mostly modifies the land cover and the land use of areas previously devoted to agricultural practices. Such modification shown specific paths, whose steps can be timely detected by radiometric changes. The vegetation indices and the phenological trajectories of the areas potentially targeted by the urban sprawl support the early detection of modifications in progress, before their consolidation. This appears to be of interest, because halting the land modifications is usually more efficient that restoring the previous states.

Urban sprawl as a process

Urban sprawl is mainly related to land take in agricultural areas where cropping practices are being abandoned (usually with the aim of increasing the financial return of such areas). With reference to the EEA definition (EEA, 2006) as mentioned in the above, the urban sprawl is a consequence of individual decisions (out or against planning policies) of land artificialization, contributing to the larger process of urbanization and of related land take. Such individual decisions have an impact mostly on privately owned parcels previously exploited for the agriculture, while the natural areas are usually of public property and therefore better protected.

The abandonment of the agricultural activities is a process common to all the EU member States, even if at different levels of intensity. There is not a consensus about the long term consequences of such process upon the ecosystem services; in any case, the process is in full development and there is not a sign of its reversal in the next future. Environmental (e.g. soil fertility, terrain morphology, climatology) and socio-economic factors (e.g. market incentives, demographic structure of the workforce, accessibility from/to major towns) are claimed to cause and sustain such process [Pointereau et al., 2008].

The abandonment of cropping practices in the agricultural areas can impact on land cover (as well as on land use) along two quite different paths:

- A process of re-naturization;
- A process of artificialization.

Which one of the above processes actually starts and consolidates is the result of the dynamical properties of the territory (with reference both to the geophysical features and to the socio-economical dimensions).

The two processes differ at least from the following points of view:

- Time scale: re-naturization spans over 10+ years; artificialization quickly develops where an initial seed consolidates;
- Irreversibility: in practical terms, artificialization is irreversible; re-naturization can be halted or steered towards alternative states.

In the following, relevant land cover classes are drawn from the legend proposed by [Aleksandrowicz et al., 2014] that shows eleven classes and is similar to Anderson's level-I legend [Anderson et al., 1976]; the equivalent CORINE land cover classes (EEA, 2007) are also associated.

The process of re-naturization initially moves land cover from class "Agricultural areas" (in terms of CORINE land cover classes: class 2 - Agricultural areas; here the subclasses 2.1.1 – Non-irrigated arable land and 2.4.1 – Annual crops associated with permanent crops are of interest) to "Grassland" and then to "Sparse woody vegetation" (class 3.2 - Shrubs and/or herbaceous vegetation association); after some years, such classes evolve to "Forest / woodland / trees" (class 3.1 - Forest), at least partially.

For sake of completeness, it should be mentioned that class "Bare ground" (class 3.3 – Open spaces with little or no vegetation) can result from re-naturization in some cases. As it will be shown later, such cases are not practically relevant, as far as discrimination of the abandoned land is of interest.

The process of artificialization can be planned or spontaneous. If planned, the class "Agricultural areas" develops directly and rather quickly into class "Urban / artificial" (class 1 - Artificial surfaces, whose subclasses 1.3.3 – Construction sites and 1.1.2 – Discontinuous urban fabric are here of specific interest); such development usually affects areas of medium-to-large size.

If the process is spontaneous, the transformation follows a different trajectory from class

"Agricultural areas" to class "Urban / artificial"; such trajectory comprises class "Grassland" at least as an intermediate step, on a time interval typically of one year or more. Moreover, the transformation of the affected areas from the intermediate class to the final one is not massive; on the contrary, it shows a cascade-like pattern where the modification of a small parcel induces other surrounding parcels to change land cover, with an evident multiplicative and autocorrelated effect. This latter scenario implies the presence of urban sprawl as above defined; the consequences of land taking are obviously not dealt with from a global point of view and the environmental risks are higher than in the scenario of a planned artificialization.

Monitoring the urban sprawl

The aim is to define a monitoring approach, in order not to allow urban sprawl to establish or to consolidate. This requires to address what has to be effectively monitored and how this would be feasible. In the following, such issues will be dealt in detail, in terms of change detection and of RS support to it.

In the above, the possible transformation of the cropland has been related to some environmental and socio-economic factors inducing land cover changes. Such factors can be exploited to make a stratification of the territory, i.e. to outline the areas potentially impacted by the urban sprawl. This stratification takes also into account the planning decisions released by the public authorities. Later, the areas pinpointed by such stratification will be updated on the basis of the possible evolutions of the said factors and planning decisions.

Using the stratified territory as domain of observation, the monitoring approach could rely upon the detection of only the changes from class "Agricultural areas" to class "Urban / articial" on a per-pixel- or, better, on an OBIA- basis.

As a matter of fact, the spectral separation between such two classes is quite wide; moreover, the cascade-like pattern of diffusion could be already evident; therefore the changes are usually easily marked. However, this implies that the urban sprawl process has been already started; the restoration of the previous, non-artificialized cover may prove to be difficult, when the inevitably lengthy administrative and legal procedures have to conflict with the consolidation and expansion of the changes. Therefore, it is of interest to detect an earlier stage, in advance of the actual start of the urban sprawl.

To such purpose, it should be noted that the artificialization of the areas mostly follows the abandonment of the cropping practices and, at least in some cases, also the instauration of the first stages of re- naturization. From this point of view, the change to be detected is from class "Agricultural areas" to class "Grassland", i.e. the one preceding class "Urban / artificial" according to the change trajectory previously suggested. In this case, the spectral distance may prove to be less evident; in the following, some ways to cope with this problem are mentioned.

With this approach, the state of the vegetated land cover and its spatiotemporal trajectories are seen as reliable precursors of land cover changes (and also of related land use changes). This effective information source can be exploited in order to pinpoint the areas potentially prone to land take processes; therefore, sustainable land planning and management can rely on suitable and timely decisions.

The above approach can be seen as a specialization of already adopted change detection methodologies. A review of such methodologies is provided by [Coppin et al., 2004]; object-based change detection techniques are commented in (Hussain et al., 2013). When using HR/VHR images, an operational methodology is suggested in (Aleksandrowicz et al.,, 2014), where the need of algorithms able to automate the change detection is also pinpointed. For detecting urban sprawl precursors, such algorithms have to rely both on production of vegetation indices and on the assessment of the phenological trajectories of the areas of interest.

The vegetated areas show spectral signatures that are very similar; therefore, the different covers cannot generally be discriminated on the basis of spectral data only. However, the maximum level of that similarity is found when the vegetated covers show the same phenological stage. Such stages occur at different dates for different crops during the annual cycle; therefore, multitemporal images can highlight different crops by a proper selection of dates (Gizzi et al., 1980). The relevant dates are provided by phenological surveys (Schwartz, 2013); such surveys often exploit RS data.

The pixels of a multitemporal image referring to the same crop describe a specific family of trajectories in the space of spectral co-ordinates (with the time acting as the positional parameter along the trajectory). This is specifically evident when the spectral co-ordinates are expressed

in terms of brightness, greenness and yellowness, as in the Tasseled Cap transformation suggested by (Kauth and Thomas, 1976), mathematically equivalent to the first three components of a PCA transformation of the image data set.

Such trajectories can vary from a year to another one, according to the variability of the phenological calendar induced by the phytoclimatology. However, the positioning of the trajectories of a given crop relatively to another one is quite constant and allows the crop discrimination inside the same year, what is here of interest. The trajectories are more evident if the original spectral data are replaced by some suitable functions, more correlated to biophysical parameters of the crops. Among such functions, NDVI (Normalized Difference Vegetation Index) is defined as:

$$NDVI = (NIR — VIS)/(NIR + VIS)$$

where VIS and NIR are the radiation measured by the satellite sensor in the band respectively of visible and of near infrared.

NDVI is widely adopted and has been the basis for many other similar indices, a list of whom is provided by [Nouri et al., 2014]. NDVI assumes values in the interval from -1.0 to +1.0: a yearly cropped area in its phenological peak shows NDVI values ranging from 0.6 to 0.9; lower NDVI values (from 0.2 to 0.5) can be found for grassland (as for re-naturized areas). For bare ground, NDVI show extremely low values (less than 0.1), whose annual variability is about nil; accordingly, bare ground is easily discriminated from vegetated covers. On such basis, the appearance of bare ground as possible outcome of the re-naturization process, as previously mentioned, doesn't interfere with the mapping of the abandoned land.

The time trajectory of NDVI is correlated with the values of greenness, as suggested by (Coppin and Bauer, 1994). Therefore, NDVI is here seen as the projection of the n-dimensional trajectory in the spectral space to the 1-dimensional greenness axis in the Tasseled Cap space. The yearly oscillation of the point representing a single pixel on the greenness axis is controlled by the phenological calendar, providing the reference dates for the maximum and the minimum of such oscillation. The yearly trajectory of NDVI for the main crop canopies can effectively be surveyed with a spatial resolution of 30 meters and a return time of 4 days (Pan et al., 2015).

Relying on such experiences, it can be assumed that better results can be expected from HR and VHR satellites and, moreover, when cropped land are being discriminated from abandoned land in a full spectral space, instead of exploiting a 1-dimensional only indices as NDVI and similar ones. However, the process of extracting the principal components (as for the Tasseled Cap transformation) from a large set of high-resolution pixels has to be still completely evaluated (anyway, a useful impact on the noise reduction can be safely expected).

Conclusion

Urban sprawl is a process whose outcome is the destruction of agricultural land and its unplanned transformation into built areas. RS imagery has been exploited to analyze this process and to understand its development in time and space. Methodologies comprising inter alia data transformations, spectral indices, phenological calendars have supported the ex-post inventory and mapping of land cover changes.

The availability of HR and VHR data allow a novel ex-ante approach to the sustainable land management, based on the early detection of suitable precursors of urban sprawl. Such precursors are the (mainly reversible) land cover changes preceding the actual onset of the (practically irreversible) urban sprawl. Instead of mapping the irreversible outcome of the urban sprawl, the already proved methodologies are used in order to:

- Locate the areas whose the risk of urban sprawl is higher;
- Focus the monitoring efforts upon such areas, in order to globally detect the precursors;
- Act locally, before appearance/consolidation of urban sprawl.

The huge amount of HR and VHR data to be routinely processed for monitoring the areas of interest requires the availability of reliable tools for the automation of the workflow. Relevant algorithms should to be based on OBIA techniques, preferably to per-pixel approaches, in order not to leave out non-spectral information carried by satellite imagery.

When using HR and VHR data, a point surely requiring some more consideration is the building of the legend describing the land cover classes. Applying OBIA in a strongly automated workflow, a greater integration of the semantic definition and of the image separability of the land cover classes appears to be necessary. The hierarchical legends should include on their nodes classes differentiated by both meaning and appearance, at least

in a balanced way. Anyway, this would entail revising some administrative rules, not only some technical ones. Should this improvements be feasible, change trajectories could be expressed as a more precise succession of classes; therefore, more powerful precursors will be available.

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African Countries' Agricultural Trade Value Chain Assessment Case study: Tanzania (Cashew nut exports)

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Abstract

Sub-Saharan Africa lost its status as a net exporter of agricultural products in the early 1980s when prices for raw commodities fell and local production stagnated. Since then, agricultural imports have grown faster than agricultural exports. In order to get to the bottom of this critical issue, UNIDO in partnership with the AU, IFAD, AfDB, FAO, and UNECA, developed the African Agribusiness and Agro-Industries Development Initiative (3ADI). The major objective of the 3ADI is to increase private sector investment flows going into the agriculture sector in Africa by mobilizing resources for agribusiness and agro-industrial development from the domestic, regional or international financial systems. This formed the basis of research with the objective of assessing the value addition chain for some vital agricultural commodities in the 3ADI focus countries. UNIDO is developing several action plans in a few African countries – one of them is Tanzania. In the case of Tanzania, the findings show the potential in cashew nuts. The paper's main goal is to propose a plan or set of steps leading to the improvement of added value generation in the area of agricultural trade in Tanzania. The paper is focused on one commodity Cashew-nuts. Tanzania boosts high volumes of local supply of this commodity, which is the key prerequisite for the value addition chain through local processing. The results from the analysis prove significant economic losses related to the current structure of Tanzanian trade in cashew nuts. The main problem of the current cashew nut trade activities is the very low added value of exported cashew nuts. The paper analyses the structure of value added activities related to the cashew nut trade and proposes a plan for increasing the share of processed cashew nuts at a much higher unit price in comparison to raw cashew nuts. The simulated development in the cashew sector in Tanzania to the year 2030 is based on two expectations a 5% increase of evaluation of particular steps and a 5% growth of processed cashew nuts export volume resulting in significant growth of export incomes and provides an important material stimulating discussion related to the importance of the transformation of the export structure from unprocessed raw products to processed – finalized products.

Keywords

Agribusiness, agricultural commodities, Africa, Tanzania, UNIDO 3ADI, local processing, value addition chain, cashew nuts, export, structure.

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Introduction

The Agricultural sector, respectively rural areas, plays a crucial role in the African region (Nyantakyi-Frimpong, 2014; Ambaye et al, 2014). In rural areas we can find over 675 mil. people (almost 60% of the total population). In the agricultural sector almost 237 mil. economically active people are employed (almost 52% of the total economically active population). The specific case represents, in this case, the Sub-Saharan region where almost 57% of economically active persons work in the agricultural sector (217 mil. out of 382 mil. people). Despite the fact that for many people the agricultural sector represents the only possibility to satisfy their basic needs, the agricultural sector represents only an appendix of the total African economy GDP formation (only about 10% respectively about 326 bn. USD). If we focus our attention especially on the Sub-Saharan region, we can see that the agricultural GDP value

is equal to about 261 bn. USD. But it is necessary to emphasize that agriculture plays a different role in individual African countries, while there is a set of countries where the share of agriculture in the total GDP formation is lower than 5% (e.g. South African rep.), there are also many countries where agriculture contributes over 50% of the national GDP value (e.g. Sierra Leone) (Clarke, 2006). African countries were supposed to be strong agricultural exporters in the past. But this situation changed at the beginning of eighties. Since then African countries agrarian trade has been in constant deficit. Since 1980 until nowadays (2013), the value of agrarian trade negative balance has increased from cc 1 bn. USD to almost 40 bn. USD. The majority of the trade deficit is represented by the trade deficit of Northern African countries (over 30 bn. USD). The trade deficit of Sub-Saharan countries is much lower, but still significant at between 7 and 10 bn. USD. Despite the fact that African countries agrarian production potential is significant, the enormous population growth (Jenicek, 2010) (while in 1950 African population was about 220 mil. people, nowadays there are more than 1.138 bn. people) together with the political and economy instability of the region (Reid, 2014) are the main reasons of the constantly growing food deficit in the region (Jenicek, 2011). The specific problem related to African agricultural trade is the existing disproportion in area of agrarian trade commodity structure (Jordaan, 2014). While more than half of agricultural exports are represented by raw production or semi-finalized production, about 70-80% of the total agrarian import value is represented by finalized food production. The African region is the source of basic raw agricultural materials for processing industry in other regions. Its food processing capacities are very limited (Schoenfeldt, Hall, Nicolette, 2013; Maitah et al., 2013;). The result of that development is the fact that African countries are exporting a huge quantity of agricultural products with limited or almost no added value, while a significant portion of imported products is represented by highly processed production with much higher unit/kilogram prices. The problem of Africa is its inability to improve and increase its home processing capacities and another problem of African food sector is the low level of agricultural production efficiency (Mugera, Ojede, 2014). Despite 24% of the world's agricultural land and 16% of arable land being in Africa gross production amounts to only 8% of world agricultural production (326 bn. USD from of 3817 bn. USD. African countries have specialized moreon the export of cash-crops (Anderman et al., 2014) (However this kind of specialization is accompanied by two effects. The first can be supposed as positive, while the second as negative. The positive effect is that it is very easy to sell those products whilst on the other hand the generated added value is limited or even zero.). The majority of exports is represented by raw-unprocessed commodities. One of the reason for such an approach to agricultural trade is the existence of tariff escalation in developed countries (Narayanan, Khorana, 2014) and the low level of development of the internal African market (While for example in the Europe more than 70% of all exports is between European countries, in Africa the share of intra-regional trade in individual countries' foreign trade is about 20%.).

Production and Commodities	In 1000 USD	Share of total
Agricultural Products, (Total)	45 204 232	
Commodities	**Export value**	
Cocoa, beans	6 764 173	14.96%
Coffee, green	2 051 060	4.54%
Cotton lint	2 042 791	4.52%
Rubber natural dry	1 960 725	4.34%
Crude materials	1 899 731	4.20%
Tobacco, unmanufactured	1 792 503	3.97%
Oranges	1 281 808	2.84%
Tea	1 192 657	2.64%
Sugar refined	1 185 562	2.62%
Maize	1 158 388	2.56%
Cashew nuts, with shell	1 047 146	2.32%
Sugar Raw Centrifugal	877 314	1.94%
Sesame seed	870 365	1.93%
Wine	780 887	1.73%
Oil, palm	723 715	1.60%
Grapes	696 517	1.54%
Food Prep Nes	687 101	1.52%
Cocoa, paste	584 756	1.29%
Cocoa, butter	487 685	1.08%
Tangerines, mandarins	467 069	1.03%
Top 20	28 551 953	63.16%

Source: FAOSTAT, 2014

Table 1: African countries agricultural export performance and structure 2011/2012 (in 1000 USD)

When talking about agricultural trade, it is necessary to highlight the fact that African trade is going to be negative in the future. The expected population growth (in 2100 the population is expected to reach more than 2.3 billion people), will have a negative effect on the ability of the region to generate enough food to cover domestic demand at the same time as generating an overproduction for export purposes

(Khan et al., 2014). For the future Africa will be definitely dependent on importing a significant quantity of agricultural and foodstuff products and its export ambition will be limited only to a specific segment of commodities. The main task of African agrarian trade policy will be to keep the negative trade balance to a sustainable level.

As has already been mentioned above, Africa lost its net export status in the early 1980s when prices for raw commodities fell and local production stagnated (Green, 2013). Since then, agricultural imports have grown faster (8.2% a year) than agricultural exports (cc 5% a year in 1961 – 2012) and by 2011/2012 reached a record high over 80 bn. USD yielding a deficit of over 35 bn. USD. Its agricultural export performance on the other hand measured only about 45 bn. USD. The value o f agricultural exports from France, the Netherlands or Germany is currently greater than for the whole African continent.

The low performance of agricultural exports in relation to imports is a result of the limited added value of African exports and constantly increasing domestic demand for agricultural products. The inability of Africa to improve infrastructure, efficiency of the production of farms and the capacities of local processing companies is the main barrier for the future positive development of the agrarian trade of African countries.

On the base of the above mentioned facts, it has become evident that there is need to develop a value chain assessment methodology upon which the development strategies can be founded. UNIDO developed The African Agribusiness and Agro-Industries Development Initiative (3ADI) in partnership with the AU (African Union), IFAD (International Fund for Agricultural Development), AfDB (African Development Bank), FAO, and UNECA (United Nations Economic Commission for Africa), has as the major objective to increase private sector investment flows going into the African agriculture sector. This will be done by mobilizing resources in the domestic, regional and international financial systems for agribusiness and agro-industrial development. The focus areas include transfer/development of skills and technologies for the post-production segments of agri-value chains; innovative institutions and services; financing and risk mitigation mechanisms and enabling policy promotion for the development of agribusiness.

If we are analyzing the potential of individual African regions for the future improvement of agricultural and foodstuff sector performance, it is necessary to focus our attention especially on countries located in Sub-Saharan Africa. These countries have some agricultural potential as their climate and environment condition provide at least some chances to improve the position of this region compared to the rest of the world. Of course it is not possible to develop one universal strategy for all Sub-Saharan countries. Every country is different. Therefore it is necessary to develop individual strategies focused exactly on individual countries' needs, ambitions and possibilities.

This paper is focused on Tanzania. Tanzania is one of the countries that were studied under the 3ADI project. It is a country situated in east Africa. Tanzania is an agricultural based country. The agricultural sector contributes approximately 25% to the GDP added value and it employs cc 76% of the economically active population. Its agricultural exports are valued at about 1 bn. USD a year and the share of agrarian export in total exports is about 20%. The commodity structure of Tanzania agrarian exports are as follows:

Trade and Commodities	In 1000 USD	Share of agricultural trade
Total Merchandise Trade	4 734 960	
Agricultural Products, Total	982 513	
Commodities	**Export Value**	
Coffee, green	140 043	14.25%
Tobacco, unmanufactured	106 585	10.85%
Cashew nuts, with shell	105 699	10.76%
Sesame seed	73 077	7.44%
Crude materials	58 961	6.00%
Cotton lint	53 596	5.45%
Tea	46 938	4.78%
Flour, wheat	40 071	4.08%
Peas, dry	34 338	3.49%
Cloves	31 416	3.20%
Top 10		70.30%

Source: FAOSTAT, 2014

Table 2: Tanzanian agricultural export performance and structure 2011/2012 (in 1000 USD).

It is possible to see the majority of export value is represented by unprocessed products with very limited added value. On the other hand all the above mentioned commodities are used in the markets of developed countries as components in high priced finished foodstuff products. To improve the situation of Tanzania and other African countries, it is necessary to change the structure of exports. It is necessary to reduce the share of raw products and to increase

the share of semi-finished or even finished products. In this case a very good opportunity for Tanzania could be the trade in Cashew nuts. Tanzania is one of the leading producers (8th), and exporters (5th) of Cashew nuts (cc 10% of world exports). The majority of its Cashew nuts production is exported in the raw unshelled form (cc 150 000 tonnes). Only about 15 - 20 000 tonnes a year is exported shelled (after processing this is about 4 000 tonnes). The difference between the slightly different forms of export is apparent. While the export of Cashew nuts with shell/raw cashew nuts is valued at cc 165 mil. USD, the export of the commodity with a bit of processing (Cashew nuts shelled) is value at only cc 23 mil. USD (There is a significant difference in the final unit price – while 1 kg of raw nuts is exported for 1 USD, one kg of processed nuts is exported for more than 6 USD). As in other branches, the lack of capital for crop utilization is evident here, so the major part of the harvest is exported in the raw form.

This paper's main goal is to suggest a set of steps leading to the improvement of added value generation in the area of agricultural trade in Tanzania. The paper is focused on one commodity Cashew-nuts.

Materials and methods

Agricultural commodities are subjected to various processes of value addition. Originally Michael Porter's concept of the value chain recognized that apart from the manufacturer, the value of a product is created by a multitude of other players: component vendors, distributors, retailers, and end users all contribute value. An example of the agricultural value chain would be: the farmer receives seeds, fertilizer, pesticides, water, etc. from other entities; the product of the farm is further increased in value by many other entities, such as supermarkets and restaurants. Without a robust chain of participating entities, not as much value can be delivered to the end user (Inclusive Technologies, 2012). The value chain is a mechanism that allows producers, processors, and traders - separated by time and space – to gradually add value to products and services as they pass from one link in the chain to the next until reaching the final consumer (domestic or global). The Main actors in a value chain are firms from the private sector (UNIDO, 2011a).

The nature of this research problem requires countries where the appropriate data is available in databases (e.g. FAOSTAT) to be studied. This is the reason why we chose Tanzania for our research. Another reason why Tanzania is the target country of our research activities is UNIDO research conducted just a few years ago. One of the co-authors of this paper is an active member of the UNIDO team and this paper represents a revision of previous research.

To be able to understand the current Cashew nut foreign trade activities in Tanzania, the paper provides an overview of trade and production activities for the period 2005 – 2013. The paper analyses the volume of Cashew nut production and trade in raw cashew nuts (with shells) and processed cashew nuts (shelled and roasted). The paper analyses the impact of processing activities on final Tanzania cashew nut export performance.

The base databases used for the construction of this paper are: FAOSTAT (United Nations), UN Comtrade database, WDI database (World Bank) and CBT database (Cashew nut Board of Tanzania).

Technically the analytical part of the paper is divided into two main parts. The first analyses the current Cashew market development. This part of the paper also includes a simulation related to the possible income if 100% of cashew nut production were traded not as unprocessed raw cashew nuts, but as processed cashew nuts.

The second part of the paper analyses the value chain related to the cashew nuts processing procedure. The paper analyses the structure of the individual steps related to increasing added value of the finished product. Finally a plan for increasing export values from trade in cashew nuts is proposed.

Results and discussion

Global annual consumption of cashew nuts/kernels is approx. 550,000 tonnes. The value of the cashew nut business is about 5 billion USD each year. Consumption is growing by 6 - 8% per year. Supply/demand is developing into acute shortage. 90% of African Cashew nuts are exported for processing in Asia each year - processing at origin would have inherent cost and environmental savings. Cashews are grown by smallholders and require minimal inputs (ANSAF, 2014a).

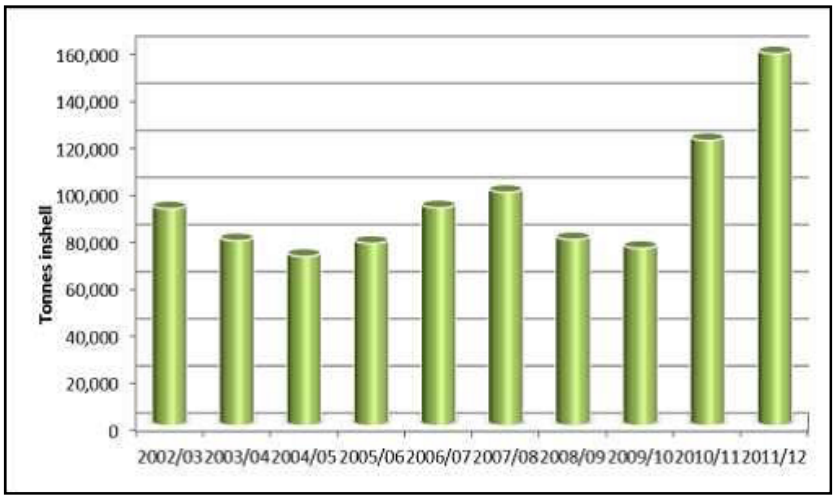
One of the main world and especially African cashew nut producers is Tanzania. Its production is about 10% of the total world production and is continuously rising. Related to quality indicators - Tanzanian cashews are supposed to be one

of the best in Africa. The significant advantage of Tanzania is the harvest season. The main portion of the harvest takes place in the part of the year when global harvesting is at its lowest and demand at its peak (ANSAF, 2014a).

Despite its status as Africa's third – and the world's eighth – largest cashew nut producer, Tanzania has missed out on adding value to its agricultural output. Only 10-15% of domestic output is currently processed and the remainder is exported as raw nuts. Studies have shown that the sector has the potential to provide 45,000 jobs, including for women and young people, if a larger proportion of the cashew nuts produced were processed locally Some 700,000 rural households - and an even larger but an undefined number of farm workers - generate income by producing raw cashew nuts while only some 5,000 to 8,000 are employed in the processing of nuts (UNIDO, 2013).

The production of cashew nuts in Tanzania recorded a significant growth during the last decade. While in 2002/2003 the volume of production was less than 100 thousand tonnes, in 2011/2012 the volume of production almost reached 160 thousand tonnes (see Figure 1).

A Tanzanian export of cashew nuts represents over ninety percent of total local production. However the majority of export activities are represented by the export of unprocessed production. The current raw cashew nuts export volume was 150 882 283 kg. On the other hand the export of processed cashew nuts was only 3 821 482 kg (cc 15 000 000 – 20 000 000 kg raw equivalent). The value of exports of raw cashew nuts is equal to 165 mil. USD whilst that of processed nuts is 23 mil. USD. There is also a significant difference between the unit price of raw cashew (cc 1.1 USD/kg) and processed cashew nuts (6.1 USD/kg). But it is necessary to emphasize that from one tonne of raw nuts we can get between 200 - 350 kg of processed nuts. The cashew market is very unstable and it is possible to see the cashew price oscillating and also the volume traded is very volatile (the reason for this volatility is the political instability existing within the region and also weather and harvesting problems). On the other hand cashew nut unit prices are growing. In the analyzed time period the raw nuts' unit price recorded an inter-annual growth of 4.4% a year and the unit export price of processed nuts recorded a growth of about 6.2% a year. The final value of exported raw nuts recorded growth of 19% a year and the final value of exported processed nuts had growth of 17% a year (during the period 2005 – 2013). The reason why the value of exported raw nuts is higher in comparison to that of processed nuts' is the continuous volume growth of raw nut exports and the inability of Tanzania to increase the export volume of processed cashew nuts. It is the inability of Tanzania to change the structure of its cashew trade which is one of the main barriers to the cashew industry development. Although Tanzania is one of the main producers its role in the retail market area is marginal. Tanzania is losing a significant portion of income coming from world market, because of its inability to improve the value added chain. The following Table 4 provides a simple simulation related to the lost opportunities in the cashew market. On the base of results shown in Table 4 we can see that Tanzania exported in period 2005 – 2013 cc 747 mil. kg of raw cashew nuts, which is equivalent to cc 200 mil. kg



Source: ANSAF, 2014b

Figure 1: The development of Tanzanian cashew nut production.

of processed cashew nuts. If we take in consideration that in the monitored time period the average unit price of raw nuts was much lower in comparison to that of processed nuts (for details see Table 3). We can see that for its raw nuts exports Tanzania got cc 702 mil. USD for the whole analyzed time period. On the other hand if 100% of the raw nut trade were converted into processed nuts trade the export value would have reached 992 mil. USD in total. In this case it is also necessary to take into account the impact of the side effects of the processing activities. These side effects are because the processing process is accompanied by the production of by-products such as Cashew nutshell liquid (CNSL) and cashew shells. Both these by-products can also be traded internationally. The expected volume of by-products is calculated in Table 5. Therefore if we take into consideration not only trade in processed nuts, but also the trade in CNSL (estimated export value cc 84 mil. USD) and cashew shell (estimated export value cc 23 mil. USD), the final positive impact on Tanzanian export is not only equal to the difference between raw and processed nuts export value (cc 290 mil. USD), but the final positive impact is 397 mil. USD for the whole analyzed time period. It is the inability of Tanzania to increase its processing capacities which has resulted in huge economic loses.

	Raw Cashew nuts export value in USD	Processed Cashew nuts export value in USD	Raw Cashew nuts export quantity in kg	Raw cashew Unit value USD/kg	Processed Cashew nuts export quantity in kg	Processed Cashew Unit value USD/kg	Inter annual growth rate of raw cashew nuts unit value in USD/kg	Inter annual growth rate of processed cashew nuts unit value in USD/kg
2005	39 230 276	6 548 534	50 565 466	0.776	1 739 636	3.764		
2006	35 023 672	14 876 949	55 064 832	0.636	3 821 512	3.893	0.820	1.034
2007	5 189 570	22 241 148	8 860 620	0.586	5 980 826	3.719	0.921	0.955
2008	42 871 000	26 503 195	52 742 661	0.813	7 724 955	3.431	1.388	0.923
2009	68 379 973	21 845 070	95 576 751	0.715	4 874 088	4.482	0.880	1.306
2010	98 603 277	26 541 421	102 706 979	0.960	6 675 534	3.976	1.342	0.887
2011	105 699 286	17 459 241	99 425 279	1.063	3 791 847	4.604	1.107	1.158
2012	142 293 971	19 041 867	130 882 422	1.087	3 355 052	5.676	1.023	1.233
2013	164 904 531	23 269 272	150 882 283	1.093	3 821 482	6.089	1.005	1.073
Average value	78 021 728	19 814 077	82 967 477	0.859	4 642 770	4.404	1.044	1.062
GEOMEN - inter annual growth rate	1.1966	1.1717	Min	0.586	Min	3.431	GEOMEAN	
			Max	1.093	Max	6.089		
			Standard dev.	0.198	Standard dev.	0.920		

Source: UNIDO 2013; UN Comtrade, 2014; FAOSTAT 2014; own calculations 2014

Table 3: Selected characteristics of Tanzanian cashew nuts export activities.

	Raw nuts - export quantity in kg	Alternative Processed Cashew nuts production (all exported raw production is converted into processed one) in kg	Alternative exported value in USD	Real value coming from actual raw cashew export in USD	Difference between actual raw nut export value and hypothetic export value of processed nuts in USD	Additional income coming from CNLS export in USD	Additional income from cashew shell trade in USD	Final added value positive effect in USD
2005	50 565 466	14 039 869	52 850 458	39 230 276	13 620 182	5 676 275	1 538 901	20 835 359
2006	55 064 832	15 289 151	59 519 875	35 023 672	24 496 203	6 181 356	1 675 834	32 353 393
2007	8 860 620	2 460 216	9 148 906	5 189 570	3 959 336	994 657	269 663	5 223 657
2008	52 742 661	14 644 383	50 242 745	42 871 000	7 371 745	5 920 678	1 605 162	14 897 585
2009	95 576 751	26 537 579	118 938 206	68 379 973	50 558 233	10 729 060	2 908 767	64 196 061
2010	102 706 979	28 517 339	113 382 788	98 603 277	14 779 511	11 529 471	3 125 768	29 434 750
2011	99 425 279	27 606 151	127 110 195	105 699 286	21 410 909	11 161 081	3 025 893	35 597 883
2012	130 882 422	36 340 456	206 253 173	142 293 971	63 959 202	14 692 333	3 983 255	82 634 790
2013	150 882 283	41 893 562	255 092 840	164 904 531	90 188 309	16 937 436	4 591 927	111 717 673
Total	746 707 293	207 328 706	992 539 186	702 195 556	290 343 630	83 822 348	22 725 170	396 891 148

Source: UNIDO 2013; UN Comtrade, 2014; FAOSTAT 2014; own calculations 2014

Table 4: Simulation - raw cashew trade vs. processed cashew trade: 100% of raw cashew nuts is processed and then exported.

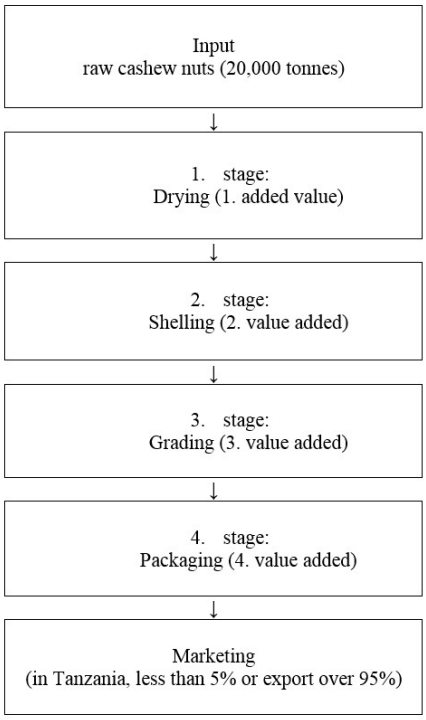
	CNLS production in kg	Shell production for feed stuff in kg
2005	12 613 945	25 227 890
2006	13 736 346	27 472 693
2007	2 210 350	4 420 700
2008	13 157 063	26 314 126
2009	23 842 357	47 684 713
2010	25 621 047	51 242 094
2011	24 802 401	49 604 803
2012	32 649 628	65 299 256
2013	37 638 747	75 277 495
Total	186 271 884	372 543 769

Source: UNIDO 2013; UN Comtrade, 2014; FAOSTAT 2014; own calculations 2014

Table 5: The volume of by-product production related to cashew nuts processing.

Plan for future cashew trade added value development/improvement

On the basis of the research activities undertaken and field survey individual steps related to cashew nuts processing activities/ added value growth were identified. The value chain for cashew nuts in Tanzania contains several operations as shown in Figure 2. Nowadays the processing capacity in Tanzania is about 20 000 tonnes of raw nuts. However that volume is equal to only 15% of the available production volume and on average is used for less than 70%. The processing capacity related to export activities is very important for Tanzania. Over 95% of the available production is exported and less than 5% of available domestic cashew production is sold on the Tanzanian domestic market. Tanzania sends the majority of its cashew exports to countries in Southeast Asia – especially India. Those countries afterwards receive the majority of the income from cashew processing business. Although Tanzania is a key producer its share of the final retail price is marginal. To improve the current situation UNIDO together with other foreign experts have proposed a plan for improving the Tanzanian cashew nut business. The plan is based on the identification of individual added value operations and their impact on the final price. The next step is a transformation plan focused on encouraging the growth of the volume of processed exports.



Source: UNIDO, 2013

Figure 2: Value chain operations.

On the base of field research conducted by UNIDO, the value added at the individual steps was identified (see Table 6). The results are as follows: 1 tonne of raw cashew nuts from the producer to manufacturer amounts to 1000 USD. This is the value of cultivation and harvesting. The cost estimate for growing cashew nuts is put at 500 USD and harvesting at 500. Farmers harvest the crop often on their own, as they are often too poor to hire outside labour. The own processing process represents about 369 USD (including fixed cost, variable costs and profit margin) per one tonne of raw cashew nuts. The result of that added value process is the fact that while one kg of raw nuts is exported for cc 1 USD, one kg of processed nuts can be exported for more than 6 USD (from one tonne of raw nuts it is possible to get between 220 - 350 kg of processed nuts). If we analyse the value added of individual steps – the most valuable are shelling and peeling. It is possible to see that although the individual steps are not cost intensive their impact on final prices is significant. The major advantage of Tanzania is the very cheap labour force available. It is cheap labour which provides Tanzania with the significant competitive advantage over other producers (Nuran, Zabibu, 2014).

Steps of value addition (1 tonne of raw cashew nuts)		TSh	1USD ± 1700 TSh
Growing (incl. use of pesticides etc.)		850 000	500
Harvesting		850 000	500
Grading of raw nuts	12 workers x 900 TSh	12 580	7.4
Boling and cooling	3 workers x 2 800 TSh	9 860	5.8
Shelling of raw nuts		257 210	151.3
Drying	2 days x 3 workers x 5 700 TSh per day	39 440	23.2
Peeling		131 240	77.2
Grading of kernels	2 days x 3 workers x 2 800 TSh per day	19 720	11.6
Roasting	2 days x 3 workers x 2 800 TSh per day	19 720	11.6
Packaging		98 430	57.9
Marketing costs		39 440	23.2
TOTAL		**2 327 640**	**1 369.0**

Note: TSh – Tanzanian Shilling
Source data: UNIDO (2011b) and own calculations, 2014

Table 6: Source data for value chain of the commodity cashew nuts in Tanzania.

Tanzania cashew nuts export - transformation plan

A simulation of the development of the cashew sector in Tanzania to the year 2030 was carried out. This consisted of a 5% increase (this increase is fully in compliance with Tanzanian agricultural sector development and abilities) of processed tonnes of cashew nuts in Tanzania per year (lowering the export of raw cashews) and 5% increase per year in the evaluation of particular steps in the value chain (the real growth of the value of processed cashew unit price is about 6%). Table 8 provides an overview of the development of added value related to the processing of one tonne of raw cashew nuts. Table 9 provides an overview related to the expected development of the added value in future years. It is possible to see the impact of the structural transformation of exports (the growth of the export of processed nuts) on cashew exports would be significant. While the current added value coming from trade in cashew nuts is about 7 mil. USD and the share of processed nuts (the volume of nuts used for processing) is less than 15% of total production, in 2030 it is expected that the volume of processed nuts in total nut production will have risen to be about 30% and the realized added value coming from trade in processed nuts will reach almost 39 mil. USD. Those 39 mil. USD represents additional income coming to the Tanzanian economy. The proposed plan represents additional export incomes for Tanzania in value of 344 985 842 USD (for the whole analysed time period). In fact the value of export incomes will be even higher because it is also possible to expect the growth of production and especially export of the side-products related to cashew nuts processing activity (CNSL and cashew shells for feeding). The proposed plan does not only have an impact on the value of exports, but it is also possible to expect a significant impact on the number of people working in the agricultural and the food processing sectors. The transformation plan, if it is undertaken has the potential to generate several thousand new jobs as well as having the potential to increase the income of Tanzanian farmers.

Year	Processed tonnes of cashew	Year	Processed tonnes of cashew
2013	20 000	**2022**	31 026.6
2014	21 000	**2023**	32 577.9
2015	22 050	**2024**	34 206.8
2016	23 152,5	**2025**	35 917.1
2017	24 310.1	**2026**	37 713
2018	25 525.6	**2027**	39 598.6
2019	26 801.9	**2028**	41 578.6
2020	28 142	**2029**	43 657.5
2021	29 549.1	**2030**	45 8404

Source: own calculations based on UNIDO estimations, 2014

Table 7: The simulated development in the cashew sector in Tanzania up to the year 2030.

Value added in the step (USD)	Grading of raw nuts	Boiling and cooling	Shelling of raw nuts	Drying	Peeling	Grading of kernels	Roasting	Packaging	Marketing costs	TOTAL
2013	7.4	5.8	151.3	23.2	77.2	11.6	11.6	57.9	23.2	369.0
2014	7.8	6.1	158.8	24.3	81.0	12.2	12.2	60.8	24.3	387.4
2015	8.2	6.4	166.8	25.5	85.1	12.8	12.8	63.8	25.5	406.8
2016	8.6	6.7	175.1	26.8	89.3	13.4	13.4	67.0	26.8	427.1
2017	9.0	7.0	183.9	28.1	93.8	14.1	14.1	70.4	28.1	448.5
2018	9.5	7.4	193.1	29.5	98.5	14.8	14.8	73.9	29.5	470.9
2019	9.9	7.8	202.7	31.0	103.4	15.5	15.5	77.6	31.0	494.5
2020	10.4	8.1	212.8	32.6	108.6	16.3	16.3	81.4	32.6	519.2
2021	10.9	8.6	223.5	34.2	114.0	17.1	17.1	85.5	34.2	545.1
2022	11.5	9.0	234.7	35.9	119.7	18.0	18.0	89.8	35.9	572.4
2023	12.1	9.4	246.4	37.7	125.7	18.9	18.9	94.3	37.7	601.0
2024	12.7	9.9	258.7	39.6	132.0	19.8	19.8	99.0	39.6	631.1
2025	13.3	10.4	271.6	41.6	138.6	20.8	20.8	103.9	41.6	662.6
2026	14.0	10.9	285.2	43.7	145.5	21.8	21.8	109.1	43.7	695.8
2027	14.7	11.5	299.5	45.8	152.8	22.9	22.9	114.6	45.8	730.5
2028	15.4	12.0	314.5	48.1	160.4	24.1	24.1	120.3	48.1	767.1
2029	16.2	12.6	330.2	50.5	168.5	25.3	25.3	126.3	50.5	805.4
2030	17.0	13.3	346.7	53.1	176.9	26.5	26.5	132.7	53.1	845.7

Source: own calculations based on UNIDO estimations, 2014

Table 8: The expected added value development related to one tonne of processed cashew nuts.

Years	Predicted Added value in USD
2013	7 380 000
2014	8 135 400
2015	8 969 940
2016	9 888 433
2017	10 903 091
2018	12 020 020
2019	13 253 546
2020	14 611 331
2021	16 107 219
2022	17 759 605
2023	19 579 313
2024	21 587 903
2025	23 798 688
2026	26 240 693
2027	28 926 801
2028	31 894 916
2029	35 161 744
2030	38 767 198

Source: own calculations based on UNIDO estimations, 2014

Table 9: Prediction of Value added from all the tonnes of processed cashew nuts in Tanzania in USD.

Conclusion

Further to the philosophy of 3ADI, the cashew nut case study in Tanzania particularly shows how important an indicator the value added chain is. The dominant factor in the value added chain is the inclusion of new technology selected in the manner that one is able to increase the value of a particular commodity and in particular cases for several commodities. As we can see from the cashew nut results, particularly in the field of the harvest and postharvest processes, the application of new technology and processes plays an irreplaceable role in the value added chain. Along with the inclusion of the proper technological upgrade, an upgrade and development in crop logistics is crucial. The value addition for Cashew nuts can take two main directions. The inclusion of new technology should be focused either on the improvement of yields from existing resources (a decrease of production and processing losses), or an increase of production. Considering the Tanzanian production scheme, in both cases the maximum potential is still not reached so yield improvement should be considered as the best approach.

The largest gaps in the value chain are closely linked to the general economic situation as well as the geographic location of farmers - the possibilities to improve the current situation exist especially in the following areas: production technology optimization, product handling and logistics including accessibility of inputs for producers. The value addition improvement in both cases is closely linked to the stability and predictability of the economic and political

environment, encouraging upgraded investment and the development of processing facilities. This development of processing facilities therefore allows various contract farming schemes, improving the resourcefulness of the prime producers.

On the basis of the results of the conducted analyses – the transformation of the structure of Tanzanian cashew exports is needed. Exports based on raw production represent a significant barrier for the transformation of the Tanzanian economy. Although Tanzania is a significant raw cashew nuts exporter, its share of the processed cashew nuts market is marginal. The full potential of Tanzania is not being realized. Every year Tanzania is losing 30 – 40 mil. USD as a result of its inability to export processed cashew nuts and by-products. The transformation process of the Tanzanian export structure together with added value growth are necessary for the future stability of Tanzania and for the fixing or even improving its export position and revealed competitive advantage in relation to main competitors. It is also necessary for Tanzania to improve its political and economy environment, to make them more stable. The transformation of the Tanzanian economy, including the agricultural sector's production and trade, is not possible without the significant participation of foreign direct investment and also government support activities. The 3ADI programme in this case represents a valuable activity, providing support to the Tanzanian government in the area of decision making related to its national economic transformation.

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Income Impacts of Credit on Accessed Households in Rural Vietnam: Do Various Credit Sources Perform Differently?

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Abstract

This study uses the Propensity Score Matching to examine the income impact of different credit sources on accessed households in the Northern Mountains of Vietnam. Results show that overall rural credit serves an important role in improving household income with respect to total income, per capita income and non-farm income. However, different credit affects recipients heterogeneously. Whereas a significant increase in household income can be achieved through accessing commercial and informal loans, there is no significant increase of all income components associated recipients of preferential credit. These results imply that a successful credit scheme needs to consider variations in transaction costs, disbursement scheme, loan characteristics and typical socio-economic conditions of credit recipients.

Keywords

Impact, household income, rural credit, Vietnam.

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Introduction

The development of rural credit sector in developing countries is calling for greater evidence which implies the importance of reviewing the evidence of the credit impacts on rural households. Present literatures have showed that credit might have significant impact, no impact and mixed impacts depending on certain conditions.

A great deal of previous research has considered the provision of credit to be an effective tool for poverty reduction. For example, Guirkinger (2008) estimated the effects of formal credit and found that credit constraints lowered the total agricultural output in Peru by 26%. In other words, credit improves crop productivity through the elimination of access constraints. In a similar way, Dong et al. (2012) concluded that income of farmers in the Heilongjiang province of Northeast China could be improved by 31.6% with the removal of credit constraints. One study by Mahjabeen (2008) examined the welfare impact of microcredit in Bangladesh. The author concluded that the average income and consumption of all rural households were found to increase by 73% and 50% respectively. A recent study by Milan (2012), who employed a fixed effect model with panel data to examine the social performance of microfinance institutions in Cambodia. Findings showed that that there is a remarkable increase in the mean clothing and footwear expenditures of credit recipients when compared to non-recipients.

A number of other studies reached different conclusions, finding no positive increase in household welfare. The effects of credit were first demonstrated experimentally by Banerjee et al. (2009). In their study, 104 slums in Hyderabad of India were randomly selected to open a microcredit branch while the remaining slums were not. After 18 months of providing loans to treated areas, there was no effect of small loans on average monthly per capita expenditure, heath, education and women's decision making. The way in which credit influences productivity and efficiency of maize and tobacco in Malawi was studied extensively by Diagne and Zeller (2001). It was shown that credit has little or no impact on the technical efficiency and productivity of tobacco and maize production in Malawi. This

finding is supported by the fact that complementary inputs such as fertilizer, land, seed, etc. are not available to farmers in the region. In an analysis of Brümmer and Loy (2000), results showed that the European Farm Credit Program from 1987 to 1994 is far more cost effective to increase competitiveness of farms over time. The finding could be interpreted as dairy farms being highly dependent on the herd scale rather than credit only. Several authors deal with the question of loan disbursement schedules. For instance, Hazarika and Alwang (2003) reported that access to credit had no significant impact on cost inefficiency among smallholder tobacco cultivators in Malawi. The credit disbursement by formal sources was faulty. Adewale and Aromolaran (2009) offer several explanatory reasons for lower efficiency of borrowers compared to non-borrowers in food crops including cassava, maize and yams of 240 households in Nigeria. Reasons could be due to the inappropriate loan disbursement schedule, small loan amount and lack of training on prudent use of loans taken. Similarly, Nghiem et al. (2007) found that credit has a small impact on household income and expenditure in Vietnam and the marginal effect has decreased over time.

Also, the evidence of the effects of credit from previous studies appears to be mixed. A recent systematic literature review by van Rooyen et al. (2012) concluded that credit has both positive and negative effects on the income of poor households in Sub-Saharan Africa. Saldias and von Cramon-Taubadel (2014) showed that different farm sectors in Chile reached disparate effects. Loan volume increased efficiency for crop farms but reduced efficiency for livestock farms. Surprisingly, credit constrained farms are less efficient in crop production, but more efficient in livestock production. Several studies confirmed the positive effects of credit but only for non-poor borrowers. For example, Coleman (2006) evaluated the impact of two microfinance programs in Northeast Thailand. He found that credit has a significantly positive impact on household welfare of committee members in terms of their wealth, savings, income, productive expenses and labor time. However, credit has an insignificant impact on the welfare of less wealthy clients. As noted by Ngo and Wahhaj (2012), credit has positive impacts under particular circumstances. Female empowerment is only enhanced when women have substantial skills to engage in an autonomous productive activity. It has conclusively been shown that production loans increase household welfare than consumption loans do.

Considering all of this evidence, it seems that the effectiveness of credit in fighting poverty depends strongly on certain situations. The aforementioned problem could hold true for Vietnam, a developing country in the Southeast Region of Asia. The poverty headcount rate in the country had reduced from nearly 58.1% of the population in 1993 to 20.7% in 2011 (Badiani et al., 2012). The provision of credit to rural households could be one of various explanations for the recent poverty reduction in Vietnam over time. However, there could be a case that not all al credit sources can benefit their recipients. This assumption is constructed on the basis that disparities in poverty reduction in Vietnam are still emerging since poverty intensity is substantially higher in disadvantaged areas. In addition, a key motivation for this study is that very little is actually known as to whether all rural credit sources in Vietnam are effective tools in fighting poverty. This study aims to fulfill this research gap in the existing literature by investigating the income impact of different credit sources on credit recipients.

Materials and methods

1. Materials

The Northern Upland of Vietnam representing the most disadvantaged rural area of the country is selected as a research area. It is characterized by a high proportion of rural residents (82.14%). Its poverty rate in 2012 was 23.8%, which was the highest rate among six total regions of the country (General Statistics Office of Vietnam, 2012). Although farming activities serve as the main source of livelihood for the poor in the region, these activities are characterized by a small farming scale. Rice, maize and cassava are the most common crops. A variety of pigs, cows, buffaloes, chickens, and ducks are common main species of livestock. Data of total 1338 households in 4 representative provinces in this region collected from the 2012 Vietnam Access to Resources Household Survey were used.

2. Methods

This study uses the Propensity Score Matching (PSM) to estimate the income impact of credit. The PSM method is one of the more practical ways of estimating impacts using cross sectional data. It also offers an effective way of examining

the impact of credit on multiple income indicators and results are less dependent on the function forms of econometric models (Heinrich et al., 2010). The crucial approach of PSM is to hold all factors constant as much as possible so that the difference in income for credit accessed households (treated) and credit non-accessed ones (the counterfactual or control group) is due to credit. In an attempt to make impact estimation as robust as possible, this study uses all four different matching algorithms including the nearest neighbour, radius, kernel and stratification matching. Each matching algorithm to estimate one outcome variable was repeated 5000 times with bootstrapping in order to remove the sample errors. Results from all matching algorithm were averaged in order to create estimations as robust as possible.

The estimations procedure was conducted through two main steps. In the first step, the probability was estimated through a formal probit suggested by DeMaris (2004) as follows:

$$\textit{Probability of taking out a loan}_i = F(W_i) \int_{-\infty}^{w_i} \frac{1}{\sqrt{2\pi}} exp(-S^2/2) ds \quad (1)$$

For $-\infty < w_i < \infty$; $w_i = Z_i'\alpha$

In Model 1; α is a k by 1 vector of parameters to be estimated. Z is the n by k matrix of the explanatory variables, which are selected and explained as follows:

Age of household heads and family size are the continuous variables reflecting the heterogeneity in preferences for consumption across households. These two variables are specified as determinants of the probability that a household takes out credit.

Number of helpers is used as a proxy for household social capital. This continuous variable indicates the number of persons who are willing to provide emergent assistance if a household is in need of money. Story and Carpiano (2015) showed that a better connection with helpers facilitates household social capital, which is necessary to improve the household economic situation.

Access to agricultural extensions services is a continuous variable measured as the number of contacts with agricultural extension in the last 12 months. According to Buadi et al. (2013), access to agricultural extension services such as information support, input supply, and training helps farmers manage and use resources more effectively.

Savings volumes is a continuous variable measured in thousands VND, representing household financial capital. Savings can be converted into future production investment or food consumption in transitional seasons. Households also recognize the importance of savings in coping with shocks. Savings are therefore of an interest variable of household access to credit.

Ethnicity dummy is specified as a binary variable and specified to remove the effects of differences in socio-economic conditions between the ethnic minorities and Kinh majority in Vietnam. The initial sample consists of 1338 households, 939 of them are minorities making up 70% of households. Minorities can have more disadvantages compared to the Kinh majority in terms of household endowments.

Exposure to shocks is a binary variable defined as one if the household is hit by any types of shocks and zero otherwise. Shocks have led to a decline in household income. In agricultural production, crop and livestock shocks can reduce productivity and farm income, forcing a household to lower its level of consumption. Personal shocks such as illness, accident, and death can have a negative impact on labor productivity due to poor health conditions and therefore reduce future income. Once hit with an income shock, irrespective of the cause, a household may encounter a number of disadvantages. Taking out a loan could be a likely response of household to shocks.

In this study, four different probit models were run to account for the full sample and three different credit sources. Descriptive statistics in terms of mean, standard deviation, and maximum, minimum of both explanatory and outcome variables were computed and used for household description (see Table 1 for further details).

In the survey, households were asked to approximate the amount of net income from different sources including cash and in-kind payments. Farm income was obtained from household participation in agricultural sub-sectors including crops, livestock, aquaculture and forestry. Total nonfarm income was obtained from working outside the household for private individuals, households, governmental agencies, public work programs and enterprises. Nonfarm income was also obtained from all self-employment activities of the household such as trading, services, transportation and other self-employed business. Impacts were estimated by calculating average treatment effect on treated (ATT). The empirical estimation of the effects

Variables	Mean	Std.	N.	Min.	Max.
Explanatory variables					
Age of household head (years)	47.70	13.793	1338	16	95
Number of helpers (persons)	3.42	3.88	1338	0	50
Family size (persons)	4.94	2.06	1338	1	15
Ethnicity (1= minorities)	.70	.46	1338	0	1
Exposure to shocks (1=yes)	.71	.45	1338	0	1
Number of contacts with agricultural extension (number)	1.38	2.22	1338	0	20
Savings volume (1000VND)	9587.40	34869.86	1338	34869.86	605000
Outcome variables					
Total income (1000VND)	50950.44	49858.38	1338	2390	535650
Farm income (1000VND)	29476.04	28028.24	1338	3960	380182
Non-farm income (1000VND)	21474.4	42135.37	1338	0	530250

Source: own processing

Table 1: Descriptive statistics of selected explanatory variables and outcome variables.

of credit on household income is expressed as follows:

$$ATT = \frac{1}{n_1}\sum\left[Y_1 - \sum w(i,j)Y_0\right] \quad (2)$$

ATT denotes the average effects of credit on accessed household; n_1 is the number of accessed households; Y_1 is the average income of accessed households; Y_0 is the average income of the matched non-accessed households; and *w(i,j)* are weights.

Results and discussion

1. Loan characteristics

In rural Vietnam, the supply of rural credit is currently served by two main sectors including the formal and informal part. The formal sector covers the two state-owned banks including the Vietnam Bank for Agriculture and Rural Development (Agribank) and the Vietnam Bank for Social Policy (VBSP). The Agribank was established in 1998 under the reform of the financial system and the introduction of commercial banks in Vietnam. It mainly provides loans and other financial services to agricultural and rural sectors. Since the end of 2001, it has become the leading commercial bank with the most extensive network of branches in rural areas. The establishment of the VBSP represents the governmental intervention on rural credit markets in Vietnam. The subsidised bank, established in 2002, has the mission of providing preferential credits to the poor and low income households. The lending procedure is conducted through entrusted local organizations such as women's unions and farmer's unions. Those organizations are the main channels through which preferential loans are delivered, with subsidised interest rates. The subsidised VBSP relies on guarantors as local authorities to grant loans without physical collateral security such as land titles. Borrowers should be in the list of poor households of local communes. Borrowers are exempted from borrowing fee but must be a member of savings and credit group, selected by the group and named in the list proposed to get loan with certification of local people's committee. The last sector, the informal sector, incorporates private moneylenders, private traders, relatives and friends. In this study, accessed households are divided into three sub-groups including access to the preferential, commercial and informal credit. Table 2 provides the summary of statistics for various characteristics of credit.

As shown in Table 2, credit characteristics are quite different between credit sources. The average credit volume is substantially lower in formally preferential credit compared to commercial and informal loans. The average credit amount from moneylenders is higher than that obtained from private traders, relatives and friends. Credit from the Agribank is normally required by collateral security such as land use certificate, whereas credit from private traders relies on mutual trust created through long and close relationships between themselves and borrowers. Private traders are tied to activities such as the sale of output so as to overcome the problem of incomplete information. The preferential credit from the VBSP bank relies on guarantors as local authorizes to grant loans

Sources of loan	Loan amount (1000VND)		Loan duration (months)		Monthly interest rate (%)		Collateral requirement (% of households)
	Mean	Std.	Mean	Std.	Mean	Std.	Mean
Preferential credit of the VBSP (n=259)	18947.49	17531.34	47.83	22.54	0.62	0.2	6.69
Formal commercial credit of the Agribank (n=71)	57947.89	130864.5	29.03	15.87	1.36	0.5	87.84
Informal credit (n=104)	27383.65	36461.55	14.86	9.84	0.94	0.97	4.93
Private trader (n=15)	11697.73	15050.92	4.75	1.48	3.62	1.76	0
Private money lender (n=9)	31888.88	53370.82	7	7.07	2.32	1.31	22.22
Relatives, friends (n=80)	29817.92	38573.75	17.65	11.72	0.28	0.78	0

Source: own processing

Table 2: Loan characteristics by lenders.

without physical collateral security. Free collateral loans from the VBSP are in line with the poverty targeting of the bank.

Preferential credit has the longest duration compared to the remaining credit sources. A possible explanation for this is that providing the poor with a longer duration of preferential credit enhances their ability to repay. In contrast, it seems possible that borrowers of moneylenders or private traders prefer the shorter-term financing to reduce the cost of interest rates.

The subsidised VBSP charged much lower interest rates because the bank receives subsidies from the government to provide preferential credit to the poor. Interest rates charged by moneylenders and private traders are notably higher than those by banks and other informal sources. Due to such high interest rates, borrowers may resort to moneylenders and private traders only for temporary shortages of capital or for immediate consumption needs. The interest rate charged by informal sources on average was around 0.94%, which is higher than that of preferential credit provided by the Vietnam Bank for Social Policies, but still lower than the average interest rate of the Agribank. The reason for this is that informal loans from friends and relatives account for 76.92% of the total informal loans. People tend to charge low or zero interest rates for their friends and relatives.

Table 3 describes credit use structure across credit accessed household groups. Mainly, credit was used for livestock production, house purchase or building, and payment of educational fees. Still, a small proportion of recipients used credit for unproductive purposes such as purchasing family food or paying for school fees and medical fees. It is possible that allocating credit for such purposes leads to positive impacts on the education of children and health of family members. However, the long-term effects tend to be in excess of estimation in this current work. Also, credit was used differently depending on their source. For instance, while the majority of preferential credit was used to finance farming activities, formal commercial credit was also used for nonfarm investment. The difference can be explained in part by the higher profitability when investing in nonfarm activities such as small trading. Short-term needs such as health expenses are normally financed by informal sources such as moneylenders, relatives and friends.

2. Household characteristics influencing access to different credit sources

Table 4 presents the estimated four probit models describing participation in the overall credit, commercial, preferential and informal credit program respectively. In each model, the dependent variable is a binary variable with a value of 1 if a household took out credit and zero otherwise. Table 4 only reports relevant variables, which significantly influence participation in the credit intervention. This helps to avoid exacerbating the common support problem of unnecessary variances of the impact estimates in the second stage of the Propensity Score Matching (Heinrich et al., 2010). The table shows that statistics such as LR Chi squared, p-value yield encouraging results. The rates of correct classification in four models are estimated to be 67.41%, 94.69%, 80.64% and 92.23% respectively.

Results show that number of helpers, frequency of accessing agricultural extension services, age of household heads, amount of savings, and exposure to shocks were found to significantly influence

Loan use purposes	Formal credit		Informal credit		
	Preferential (n=259)	Commercial (n=71)	Private trader (n=15)	Private money (n=9)	Relatives, friends (n=80)
Rice	2.46	2.7	0	0	1.98
Other crop	1.06	2.7	0	0	2.97
Livestock	33.1	18.92	12.5	0	15.84
Nonfarm activity	2.11	14.86	0	22.22	9.9
Repay other loans	0.35	2.7	0	0	0
Build/buy house	11.97	18.92	12.5	22.22	12.87
Buy land	2.46	0	0	0	0
Buy another asset	4.23	1.35	0	0	7.92
Pay for wedding/funeral	1.06	1.35	12.5	0	3.96
Education expenses	12.68	6.76	0	11.11	5.94
Health expenses	1.76	1.35	12.5	11.11	7.92
General consumption	4.93	8.11	25	11.11	10.89
Other	21.83	20.27	25	22.22	19.8
Total	100	100	100	100	100

Source: own processing

Table 3: Credit use purposes by sources of loans (% of households).

Predictors	Full sample		Commercial credit		Preferential credit		Informal credit	
	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value
Intercept	1.006	2.06**	-1.281	-11.46***	-0.1226	-0.21	-0.0236	-0.03
Log (Number of helpers)	0.2007	4.14***	0.3244127	3.79***	0.1881	3.40***	0.135	1.97**
Ethnicity (1= ethnic minorities)	-		-0.5608	-4.71***	0.3109	2.78***	-0.5022	-4.38***
Log(Number of contacts with agricultural extension)	0.1506	2.42**	-		-		-	
Log(Age of household heads)	-0.4307	-3.43***	-		-0.4427	-3.04***	-0.3882	-2.12**
Log(Savings volumes)	-0.0521	-5.82***	-0.033	-2.42**	-0.0404	-3.90***	-	
Exposure to shocks (1= yes)	0.2925	3.52***	-		0.2492	2.50**	0.3628	2.88***
Log(Family size)	-		-		0.3517	3.29***	-	
Number of observations	1338		1338		1338		1338	
Prob > chi2	0		0		0		0	
LR chi2(3)	-		42.53		-		-	
LR chi2(4)							31.87	
LR chi2(5)	72.64		-		-		-	
LR chi2(6)	-		-		79.88		-	
Pseudo R2	0.0429		0.0766		0.0608		0.0436	
Correctly classified (%)	67.41%		94.69%		80.64%		92.23%	

Note: ***significant at 1%, **significant at 5%, * significant at 10%
Source: own processing

Table 4: Probit estimation of household characteristics influencing access to credit.

access to overall rural credit. In addition, these factors affected credit access differently depending on each credit source. The most intriguing results to emerge from the analysis of credit access are as follows: Age of household heads and the number of people who could extend emergency help explain the probability at which credit has been accessed. Younger household heads are more likely to receive credit. Perhaps those households demonstrate active participation in local mass organizations such as women's unions or farmers' unions. The younger heads could be more active in obtaining information regarding credit sources, farming technologies and business opportunities. Family size is perceived to be associated with accessing preferential credit. This could be explained

by the fact that larger households tend to be poorer ethnic minorities who receive a focus of preferential credit programs. Exposure to shocks may very well increase demand for loans, because households seek credit in order to smooth consumption when they have been hit by a negative income shock. The ethnic minority community was observed to be more likely to access preferential credit but less likely to receive commercial and informal credit. Analysis further revealed that households receiving extension services are more likely to take out loans. In addition, households which are able to accumulate a larger amount of savings are less likely to access credit in general.

3. Income impact of different credit sources on accessed households

This study focuses on total household income and its components to examine impacts of credit. Regarding household income, there are household observations (outliers), which are distant from the other observations. Those outliers can distort impact estimators and yield unreliable results. For this reason, visualization through a box-plot is used to detect outliers. It is therefore a total of 114 household observations of outlays that are removed to smooth data for better comparisons. When examining the income impacts of a particular source of credit, households with access to other financial sources are excluded. For instance, in order to separate the impact of subsidized credit, 56 recipients of Agribank credit, and 91 recipients of informal credit are removed from analyses. Similarly, this procedure is conducted in estimating income effects of other credit sources. Table 5 provides results obtained from the Propensity Score Matching.

For full sample, the credit recipients had increased for total income of 13.96%, for per capita income of 15.65%, and nonfarm income of 32.50%. All those coefficients are statistically significant at a 5% level of statistical significance. Although credit has a positive impact on farm income, the coefficient is very small and statistically insignificant.

The other finding is that different credit sources perform differently. The evidence shows that the income impact of commercial credit lies in the level of 23.64% of total income, 33.65% of per capita income, and 65.22% of total nonfarm income. Commercial credit decreases total farm income of accessed households by 27.85%. This could be explained by the fact that commercial loans were mainly used for financing nonfarm activities such as trading, services, transportation and other self-employed business. This main credit use purpose can be due to the higher returns when investing in nonfarm activities which suffer fewer natural and biological risks (floods, droughts, crop and animal diseases). Rates of income impact of informal credit are 18.82% of total income and 14.85% of per capita income. All those coefficients are statistically significant at a 5% level of statistical significance. In contrast,

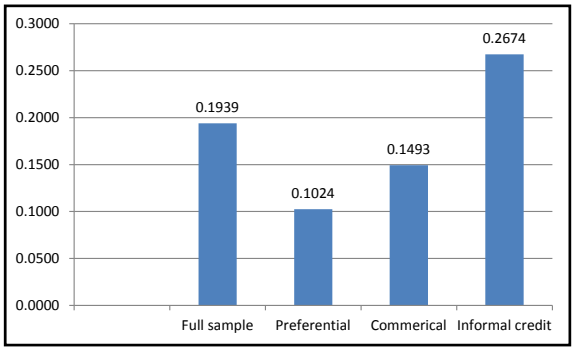
Household income	Indicators	Full sample	Formal credit		Informal credit
			Preferential	Commercial	
Total income	1000 VND	5071.41***	1939.59	8653.86**	7323.41**
	% change	13.96%	5.41%	23.64%	18.82%
	t-statistics	3.20	1.00	2.47	2.28
Per capita income	1000 VND	1300.50**	216.27	3516.87**	1414.08
	% change	15.65%	3.01%	33.65%	14.85%
	t-statistics	2.51	0.45	2.16	1.61
Total farm income	1000 VND	23.34	343.39	-4211.70**	1283.32
	% change	0.19%	1.66%	-27.85%	7.39%
	t-statistics	0.15	0.25	-2.10	0.74
Total non-farm income	1000 VND	3655.58**	1117.32	9300.27**	4150.89
	% change	32.50%	12.17%	65.22%	32.92%
	t-statistics	2.43	0.63	2.51	1.33
Number of treatment		362	229	54	79
Number of control		647	567	615	584

Note: * Significant at 10%; ** significant at 5%; *** significant at 1%
Source: own processing

Table 5: Average income impact of credit on accessed households.

there are positive but not statistically significant increases of all total income components associated with recipients of preferential credit.

All mentioned coefficients measure the absolute magnitude of impact, which refer to the difference in mean of income between credit recipients and non-recipients with similar characteristics. However, it is also relevant to examine the relative impact per unit of loan amount. The total income impact per unit of loan is calculated by taking the income difference divided by the corresponding amount of credit (Figure 1).



Source: own processing

Figure 1: Total income impact per VND million of credit amount.

As Figure 1 shows, considering all four different matching algorithms, one million VND of credit volume increased household income by 0.1939 million VND. Similarly, the impact of one unit of credit volume on household income was also calculated for different credit sources. A comparison of the impact per unit of loan volume reveals that informal credit tends to have the greatest impact on household income, followed by commercial credit and preferential credit. The governmental financial intervention via preferential credit is necessary to reach the poor but does not significantly change household income.

It is helpful to further explain how informal and commercial credits are supplying more proficiently than preferential credit. Provision of commercial credit has substantially enhanced total household incomes, especially nonfarm income. These results could be explained by the fact that the Agribank better fulfills the credit demand of households on the basis of market principles. The bank is a profit-oriented organization, which may be somewhat limited by serving the wealthier rather than the poor. In addition, accessed households of the Agribank appear to use credit for financing nonfarm activities, which suffer fewer risks compared to farming activities. The positive effects this credit source can explain the increasing share of commercial credit in rural credit market during the last two decades.

Regarding the preferential credit, a number of other previous studies evaluating its effects observed consistent results with those in this study. For instance, Dufhues and Buchenrieder (2005) indicated that the provision of preferential credit represents an attempt by the government to broaden access in general. However, this increase in outreach is in conjunction with an increase in access to credit for non-creditworthy households, resulting in decreased repayment rates or limited welfare impact. Findings in this study complement those of Banerjee et al. (2009), who argued that by charging a reduced rate below the inflation level, the preferential credit program discourages savings and encourages low return investments - the purchase of durables for consumption purposes for instance. As a consequence, preferential credit does not contribute to increasing household income, at least in the short term. A recent study by Saint-Macary and Zeller (2012) involved the efficiency of rural credit policy in Yen Chau, a mountainous district in Northern Upland of Vietnam. Accordingly, preferential credit has been found to be inefficient in reducing poverty and improving agricultural growth. In another major study, Barslund and Tarp (2008) reported that a "one size fits all" method to scaling up preferential credit is not going to be the most advantageous. The expansion of preferential credit requires careful consideration for the need for credit in areas where access is presently low. The inefficiency may have been caused by the supply-driven credit program, (as opposed to demand-driven) which led to credit rationing and misallocation. The subsidized bank naturally performs as a government organization carrying out credit distribution policies, which are highly dependent on administrative and political uncertainties. Under such conditions, preferential credit does not react to the high demand for frequent credits to fund consumption and purchase agricultural input.

The finding in this study confirms the role of informal credit in improving total household income. The findings of the current study support the previous research on the role of informal credit. For instance, Cuong and Van den Berg (2011) concluded that informal credit in Vietnam was rather worthwhile, as it narrowed the poverty rate of recipients by 8%. Informal credit remains an essential source of credit for the poor in Vietnam. This view is also supported by Khoi

et al. (2013) who argues that formal and informal coexist in rural areas of Vietnam. Similarly, Lainez (2014) suggests that informal credit is a necessity rather than an evil in the country. It may be that participants in informal credit markets benefitted from good access to information between lenders and borrowers originated from social relationships within social relationships. Due to a magnificent level of trust, the informal sector can supply adaptable loan contract terms regarding maturity, interest rates and repayment mode. In the same vein, a study by Barslund and Tarp (2008) conducted in four provinces of Vietnam notes that informal credit includes private money lenders, friends and relatives, representing about one third of all loans. Poor rural households persist with informal networks and relatives. In this study, the larger portion of loans is from relatives and friends in total informal loans. These results support the argument of Cuong (2006) which indicated that money lenders were crowded out by the formal credit sector because of competition.

Conclusion

Provision of credit to rural households has increased their total income, per capita income and nonfarm income. It is apparent from this study that overall rural credit has contributed to the remarkable achievement in poverty reduction of Vietnam in the last two decades. However, various types of credit affected recipients differently. Strong evidence of positive impact was found when households received commercial credit from the Agribank. In addition, informal credit is still an important component in the credit system and plays a role in improving household income. However, the impact of preferential credit was not very encouraging. A clear benefit for households in the intervention of preferential credit could not be identified in this analysis.

Provision of commercial credit has enhanced household incomes, and there is therefore a definite need for the expansion of this credit source. Continued efforts are needed to make those loans more accessible to the poorer households. However, the challenge is how to improve the willingness of a profit-driven bank to increase credit size as well as spread out credit to the poorer households. The other implication from this study is that the limited role of preferential credit in improving household incomes might not be attributed to preferential credit itself. Preferential credit is very important to reach the poor who are constrained to access commercial credit from the banking system. However, in order to improve effectiveness, preferential credit schemes should be improved in terms of a reduction in administrative procedures, timely credit delivery to make credit more appropriate to the seasonality of farming activities, and the cash flow of income and expenditure of the poor. Those serve as a base for improving the creditworthiness of the poor. At the same time, by improving quality of credit attributes, the subsidized bank might be able to attain financial sustainability and target the poor concurrently. The final implication from this study is that informal credit plays a role in helping households fulfill capital demand for production and smooth consumption fluctuations. Informal credit responds to the capital needs of households in a timely manner.

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Identification and Valuation of Public Goods within the Vertical of Cattle Breeding

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Abstract

The paper identifies and discusses the production of public goods in the vertical of cattle breeding. The cattle breeding vertical was divided into four basic levels – producer, processor, retailer, and consumer and main public goods were determined and discussed. Moreover, it provides the methods for the valuation of public goods. The method is applied in the estimation of manure shadow price. Using the fitted multiple output distance function with two market and one non-market output and applying the Lagrange method and the Shephard's dual lemma the shadow price of manure was calculated. The results show that the shadow prices differ significantly among the groups of farmers. This especially holds for the classification of groups according to the size and technology of production.

Keywords

Public goods, externality, cattle breeding, production, shadow price.

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Introduction

Production of agricultural commodities is associated with a considerable number of externalities or goods that match the definition of public goods. Literature very often cites examples of externalities, e.g., in the form of grazing biomass by cattle for landscape maintenance, pollination of fruit trees to produce honey, etc., are closely linked to agricultural activities. Discussions of the role of agriculture in the production of public good began to evolve especially towards the end of the 20th century, as the professional and general public became aware of the externalities in agricultural production and began to pay more attention to the expanding spectrum of agrarian policy instruments. Specifically, it is about externalities associated with and inseparable from the production of agricultural commodities. The source of information about the associated aspects is according to Shumwaye et al. (1984) in Lankoski and Ollikainen (2003) where mutual technical dependence on inputs is enhanced by fixed or quasi-fixed inputs, such as the soil. The very link of the agricultural sector onto the soil may be viewed as one of the causes for the origin of externalities, both positive and negative, so often associated with agricultural activities.

The situation is similar even in other fields of the agricultural and food processing sectors, where activities are differentiated into crop and livestock production that are characteristically associated with different types of externalities with specific causes and consequences each. The next part of the study focuses on livestock production, primarily cattle breeding both for meat and dairy production, whereby the main objective was to identify individual examples of externalities related to this field, while distinguishing their characteristics, in order to achieve a theoretical overview of the origin and classification of public asset using real examples of agricultural production. Moreover, another aim of the paper is to provide the method and the example of the valuation of chosen public good in the cattle breeding. Choosing the commodity vertical of cattle breeding is entirely intentional here, as cattle being a typical representative of the meat vertical constitutes the majority and irreplaceable segment of the livestock production in agricultural production practically in all European countries, including the Czech Republic. Moreover, the chosen vertical is relatively broad, so that it is possible to identify – as part of the processes of a segmental market (both pricing and production – see, e.g., Malý (2013)) – a broad scale of public goods from various production and processing

processes. Finally, the chosen public good for valuation serves entirely as an example that can be used for valuation of any public good which is directly produced by particular agricultural activity.

Materials and methods

Generally, an externality may be defined as an event that is considerably beneficial (or wasteful) to the person or persons who are not fully entitled to take part in the decision-making that leads, directly or indirectly, to the given event (see Maede, 1973). Pillet et al. (2000) add that externalities are from the broader perspective defined as "spillovers", i.e., effects outside commercially measurable parts of economic activities. During the transformation of the above view of agriculture, it is possible to define as situations where the activities of agricultural enterprises impact on the condition of the environment, social and spatial structure of the region or country and on the welfare of the people who do not participate in the decision-making about the given event. According to Anderson (2000), it becomes a non-commercial net benefit that agricultural producers give to the rest of the society. In the Czech environment, externalities were defined, e.g., by Kršková (2007), as by-effects of production which do not pass through the pricing system of the enterprises' primary activity, i.e., they are not included in the price of the good that the originators of the externalities produce.

From the perspective of possible consequences, production and consumption externalities may be divided into negative externalities, were the activities of one participant cause decline of another participant's benefit (i.e., cause external expenses), and positive externalities, where the activities of individuals of the society increase the benefits of another entity (i.e., lead to external profit or saving). The examples of above-mentioned externalities associated with agricultural activities have been selected as random models which however have something in common in the sense of positive externality. According to Burrell (2011), there exist very few positive externalities whose assurance is linked to the production of agricultural commodities, as the production of agricultural commodities is far more often associated with negative externalities.

Public goods were defined the first time by Samuelson (1954) as goods having the property of non-exclusivity and non-rivalry. Non-rivalry goods are, according to Špalek (2011) indivisible in consumption, meaning that an increase in the number of consumers will not increase the variable costs of the given goods' production, hence the benchmark costs. Moreover, non-rivalry goods are consumed by all consumers in equal quantities, so that the volume of consumption is forced in a way upon the consumers by the provider. Non-exclusivity of consumption means that the consumer cannot be barred from consuming the goods. The impossibility of excluding certain goods from consumption is often due to technical infeasibility, yet there exist economic reasons for exclusion – namely, high costs. The above definition of public goods based on non-rivalry and non-exclusivity was fundamental for a number of studies dealing with these issues (e.g., Miceli, 2005; Cooper et al, 2009; Jongeneel et al., 2010; Slee and Thomson, 2011; Burrell, 2011; Harvey and Jambor, 2011). On the basis of the above aspects, Burrell (2011) in the end suggests to define agricultural public goods as separable (independent) outputs of such agricultural activities as may be increased independently of the augmentation of the production of a certain agricultural commodity.

Based on the above definitions of both concepts – externality and public goods – it is evident that that they overlap to some extent. OECD (2001) solves this terminological overlap by differentiating the outputs of agricultural activities into market and non-market ones, which subsequently include both externalities as well as public goods. OECD (2001) furthermore presents examples of production relations for selected non-market outputs, see Table 1.

Many other authors, e.g. Madureira and Santos (2012) and Kaley et al. (2011) count non-market outputs specified in Table 1 among basic agricultural public goods and complement them with climate stability, resistance to floods and fires, see Table 2, which contains an account of basic agricultural public goods, as well as their definitions.

The extent of assurance of the above goods varies by type of agricultural activity. For instance, extensive cattle breeding, combination of animal and crop production, and ecological agriculture ensure a greater scope of public assets than intensive agricultural production. Maciejczak and Zakharov (2011) define the scope of public goods ensured by individual agricultural practices, see Table 3.

Non-market outputs	Market production				Other commercial activities	Direct assurance of public goods
	Fixed inputs	Variable inputs	Farm technology and practice	Market outputs		
Landscape	Use of arable land, agricultural buildings		Silos, greenhouse, stables, irrigation	Crops	Buildings and equipment for agrotourism	Upkeep of agricultural buildings, meadows
Biodiversity	Use of arable land	Use of agro-chemicals	Intensity of breeding, soil cultivation, harvesting technology	Crops	Charging for access to specific ecosystems	Wetlands and other specific environment, corridors for wild animals
Soil quality	Soil cultivation		Rotation of crops, breeding intensity, irrigation	Crops, field coverage		Permanent field coverage
Water quality	Cultivation of eroded soil	Use of pesticides and fertilizers	Storage and application of fertilizers, concentration of animals	Crops, field coverage	Charging for access to clean water in rivers and lakes	Permanent field coverage, protective zones
Air quality	Cultivation of eroded soil	Use of pesticides	Storage and application of fertilizers	Crops and animals, field coverage		
Vitality of rural areas	Demand for laborers				Adequate income	
Food safety	Sustainability of production capacity (soil, basic herd)	Sustainability of production capacity (seed production)	Technology diminishing health risks	Food supply	Sales and marketing	Sustainability of soil fertility, genobank
Animals welfare	Stables	Fodder	Technology of transport and slaughter, access to free range			

Source: Author's elaboration as per OECD (2001)

Table 1: Examples of relations in production.

Public asset	Definition
Climate stability	Degree of ecoregion's capability to retain suitability (climatic conditions prevailing current parameters) for biological varieties and ecosystems contained today. (Watson et al., 2013)
Biodiversity	Variability of living organisms, including dryland, sea, and other aquatic ecosystems and ecological complexes (Bartkowski et al., 2015). Degree of biodiversity (McNeely, 1988 in Cairns and Lackey, 1992).
Water quality and accessibility	Stable supply of non-contaminated water (Kaley & Assoc., 2011).
Soil fertility	Capability of the soil to meet required natural requirements or soil behavior in natural condition. (Volchko et al., 2013) Result of pedologic processes arising from the complexity of interactions between living (biological) and non-living (physical and chemical) soil components using universal forces impacting on substance and energy (de Groot et al., 2002).
Air quality	Clean, clear, non-contaminated air meeting given criteria (British Columbia, 2015)
Resistance to floods and fires	System's capability to absorb disorders and to reorganize itself in response to being exposed to changes, as well as ability to retain basic functions, structure, identity, and feedback. (Walker et al., 2004)
Cultural agricultural landscape	Visual phenomenon comprised of tangible attributes, including geomorphology, earth surface, and cultural development (Moran, 2005). Unique geographical region (Swanwick and Assoc., 2007). Ecological infrastructure that supports ecological processes and functions, with a cultural dimension arising from long-term influence of man and technology (Madureira and Santos, 2012).

Source: Author's elaboration

Table 2: Main agricultural public goods (staples) and definitions thereof.

Public asset	Definition
Vitality of rural areas	Availability of a certain level of economic opportunities, minimum level of services and infrastructure, human capital and functional social networks to guarantee long-term sustainability livability and attractiveness of rural areas as good places for living, work, and leisure (Kaley et al., 2011). Attractiveness of life in the country for rural and urban population (OECD, 2001).
Animals‘ welfare	Elimination of suffering of animals and preservation of their good physical and mental condition (Webster, 1994). Combination of physical and mental health of animals ensured by harmonious existence of animals in a certain environment (Hughes, 1976, in Carenzi and Verga, 2009).
Food safety	Availability of food any time any place (Kaley and Assoc., 2011). Status quo where all people always have physical and economic access to healthy food of adequate nutritional quality and quantity to satisfy their dietologic needs for quality and healthy life (OECD, 2001). Reduction of diseases and pathogens, measured by decline of the probability of health risks, for which customers are willing to pay more money (Stenger, 2000).

Source: Author’s elaboration

Table 2: Main agricultural public goods (staples) and definitions thereof (continuation).

	Landscape	Biodiversity	Water quality	Water availability	Soil fertility	Climatic stability	Air quality	Resistance to floods	Resistance to fire
Production of crops with low nutritional requirements	x	x	x	x	x	x		x	
Use of own fertilizers		x	x		x	x		x	
Animal grazing	x	x	x		x		x		x
Limitation of herbicides	x	x	x	x	x		x		
Manual weeding	x	x	x		x	x	x		
Lower percentage of arable land	x	x	x		x			x	
Limitation of pesticides		x	x	x	x		x		
Mixed production with rotation	x	x	x		x				x
No-cultivation economy			x	x	x	x			
Breeding of local breeds	x	x			x				
Minimization of mechanical technology		x			x				
Genetic selection for higher productivity		x				x			
Intensive breeding of dairy cows		x				x			
Production of biogas from animal waste			x			x			

Source: Author’s elaboration as per Madureira and Santos (2012) and et al. (2011)

Table 3. Scope of public goods by individual agricultural practice.

However, agricultural production does not lead to assurance of the above goods in the positive sense. As there also exist situations where the impact of agricultural activities on biodiversity, water and air quality, etc., is negative, therefore Madureira and Santos (2012) differentiate the impact of agriculture on public goods into positive and negative, see Table 4. This is corroborated by Burrell (2011).

The presented tables (especially 2 and 4) indicate that the contents of some public assets overlap or act as links in the assurance of other public assets, such as quality and availability of water and biodiversity, biodiversity and cultural landscape, soil fertility and cultural landscape, etc. Many of them have a very complex character, such as biodiversity which is the result of the sustainability of agricultural landscape, activities related to the soil and agricultural practices. Simultaneously, however, landscape may be harmed by agricultural practices, e.g., concretely, intensive agricultural production, breeding of very concentrated livestock etc.

Effect	Public asset	Cause
Negative	Biodiversity	Intensification of agricultural production, change in the use of land
	Water quality	Intensive use of fertilizers and pesticides
	Availability of water	Depletion of water sources for irrigation
	Soil quality	Intensive use of pesticides, herbicides and fertilizers
	Air quality	Intensive livestock production, emission gases
	Climatic stability	Emission of greenhouse gases
	Cultural landscape	Intensive agricultural production reducing biodiversity
Positive	Cultural landscape	Increase of biodiversity due to use of land, composition of commodities, agricultural practice
	Soil and water quality	Extensive agriculture
	Climatic stability	Depositing of carbon in soil Substitute of fossil fuels
	Resistance to fire	Soil management, extensive grazing meadows
	Resistance to floods	Soil management
	Vitality of rural areas	Creation of work conditions and subsequent income
	Food safety	Growing offer of food

Source: Author's elaboration as per Madureira and Santos (2012)

Table 4: Dominant impact of agriculture on selected public assets.

Apart from defining public goods related to agricultural activities as such, it is important to quantify their values (prices), which can be used for determining the amount of subsidies to the production of the given commodity. In this paper, we introduce the application of theory of production and a parametric approach – Stochastic Frontier Analysis (SFA) – to quantify the value of a particular public good. The chosen public good for valuation serves in this paper entirely as an example or demonstration, respectively, which can be used for a valuation of any public good which is directly produced by particular agricultural activity. The manure was chosen for the reason of data availability. The application of theory of production and SFA provides the advantage over the methods as e.g. cost calculations that it takes into consideration the farm technology.

We assume that the production process can be well approximated by a translog multiple output distance function. Thus, considering a joint-production process in which a farm employs the input vector $x \in \Re_+^I$ to produce the output vector $y \in \Re_+^J$ (milk, other animal products and plant products) and vector of public goods $g \in \Re_+^K$, the production technology can be expressed by the output possibility set $P(x) = \{(y,g): x \text{ can produce } (y, g)\}$. The output possibility set is assumed to be closed, convex and bounded by isoquant defined as $IsoqP(x)=\{(y,g):(y,g)\in P(x),\lambda(y,g)\notin P(x),\lambda>1\}$. The output vector *(y, g)* must belong to the output possibility set *P(x)*, but it need not to be located on its outer frontier. A radial measure of the distance from output vector *(y, g)* to *IsoqP(x)* is Shephard's output distance function (1):

$$D_O(x,y,g) = inf\{\theta > 0: (y/\theta\,, g/\theta) \in P(x)\}, \quad (1)$$

where θ is the value of the output distance function that measures the maximum degree by which *(y, g)* can be proportionally increased given *x* (see Zhou et al., 2014). This function is estimated using Stochastic Frontier Analysis (SFA) in translog functional form which incorporates the weak disposability assumption:

$$\begin{aligned} lnD_O(x,y,g,t) = {} & \alpha_0 + \textstyle\sum_i \alpha_i\, lnx_i + \sum_j \alpha_j lny_j \\ & + \alpha_g lng + \alpha_t t + \tfrac{1}{2}\textstyle\sum_i \sum_{i'} \gamma_{ii'} lnx_i lnx_{i'} + \\ & \tfrac{1}{2}\textstyle\sum_j \sum_{j'} \gamma_{jj'} lny_j lny_{j'} + \tfrac{1}{2}\gamma_{gg}(lng)^2 + \tfrac{1}{2}\gamma_{tt}t^2 + \\ & \textstyle\sum_i \sum_j \beta_{ij} lnx_i lny_j + \sum_i \beta_{ig} lng lnx_i + \\ & \tfrac{1}{2}\textstyle\sum_j \delta_{jg} lng lny_j + \sum_i \beta_{it} t lnx_i + \sum_j \beta_{jt} t lny_j \\ & + \beta_{gt} t lng, \end{aligned} \quad (2)$$

where *t* denotes time vector.

Defining $-lnD_0(x,y,g,t)=u$ and allowing for a stochastic noise, together with the imposition of the linear homogeneity in outputs (similarly to Hadley (1998) by normalizing the outputs by one of output, the output distance function leads to the following form:

$$-lny_1 = \alpha_0 + \sum_i \alpha_i \, lnx_i + \sum_{j-1} \alpha_j ln\frac{y_j}{y_1} + \alpha_g ln\frac{g}{y_1} + \alpha_t t + \frac{1}{2}\sum_i \sum_{i'} \gamma_{ii'} lnx_i lnx_{i'} + \frac{1}{2}\sum_{j-1} \sum_{j'-1} \gamma_{jj'} ln\frac{y_j}{y_1} ln\frac{y_{j'}}{y_1} + \frac{1}{2}\gamma_{gg}(ln\frac{g}{y_1})^2 + \frac{1}{2}\gamma_{tt}t^2 + \sum_i \sum_{j-1} \beta_{ij} lnx_i ln\frac{y_j}{y_1} + \sum_i \beta_{ig} ln\frac{g}{y_1} lnx_i + \frac{1}{2}\sum_{j-1} \delta_{jg} ln\frac{g}{y_1} ln\frac{y_j}{y_1} + \sum_i \beta_{it} tlnx_i \sum_{j-1} \beta_{jt} tln\frac{y_j}{y_1} + \beta_{gt} tln\frac{g}{y_1} + u + v, \quad (3)$$

where $u \sim i.i.d.N^+(0, \sigma_u^2)$, $v \sim i.i.d.N(0, \sigma_v^2)$ and are independently distributed to each other.

According to Shephard (1970) there exists a duality between the output distance function (ODF) and revenue function. Färe and Grosskopf (1998) show that "the revenue function can be derived from the output distance function by maximization with respect to outputs":

$$R(x,p) = \max_{(y,g)}\{py + rg : D_O(x,y,g) \leq 1\}, \quad (4)$$

where $p \in \Re_+^M$ is the price vector of desirable outputs and $g \in \Re_+^K$ is the shadow prices vector of public goods.

Appling the Lagrange method and the Shephard's dual lemma, and following Färe and Grosskopf (1998) the shadow price of public goods can be calculated from (4) as follows:

$$r = r_y \frac{\partial D_O(x,y,g)/\partial g}{\partial D_O(x,y,g)/\partial y}, \quad (5)$$

where r_y is the shadow price of output that is assumed to be the same as market price p.

The analysis uses an unbalanced panel data set drawn from the FADN database provided by the European Commission. The data covers the period from 2004 to 2011. Information on cattle breeding in the Czech Republic (4020 cases) are used.

In the empirical part of the paper we estimate Shephard's ODF with two traditional outputs (milk (y_2) and other market products from plant and animal production (y_1)) and one public good (manure (y_3)). To solve the collinearity problem between milk and manure, we used milk in monetary value deflated by price index and we involved price index into the equation (5). The inputs were represented by labour (x_1), land (x_2), capital (x_3) and material and energy (x_4). Labour is represented by the total labour measured in AWU. Land is the total utilised land. Capital is the sum of contract work and depreciation. Outputs as well as inputs (except for labour and land) are deflated by price indices on each individual output and input (2005 = 100). The price indices are taken from the EUROSTAT database. The ODF was estimated in form of Random Parameter Model by maximum likelihood method in software Limdep 9.0.

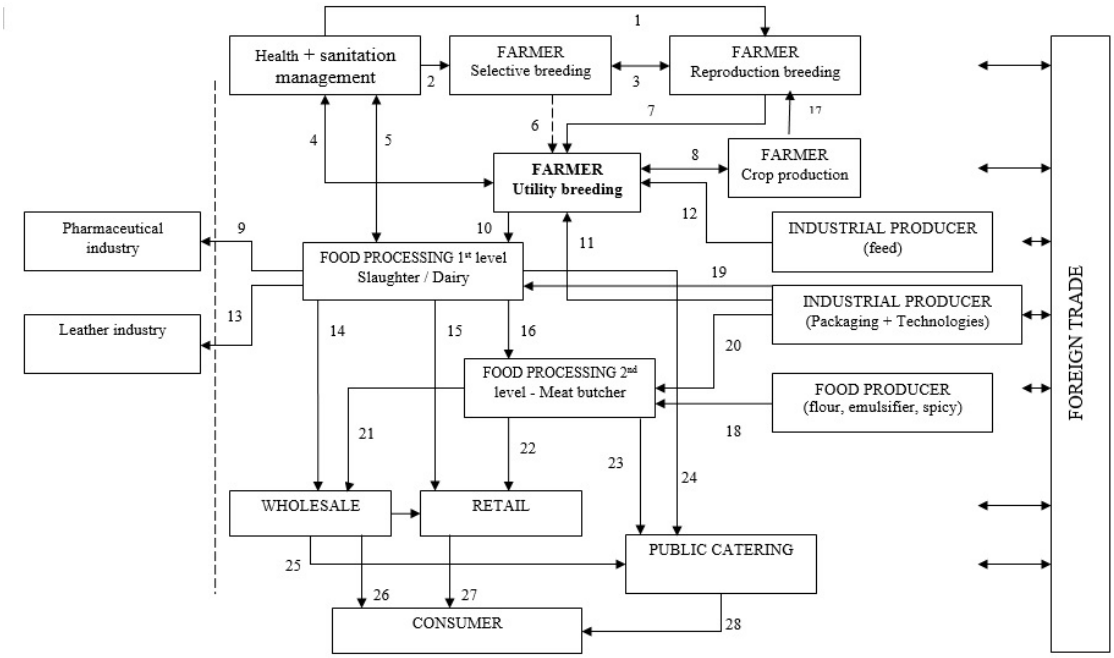
Results and discussion

In order to reach the main objective, i.e., identification of public goods involved in the given agricultural activity, it is advisable to analyze the vertical first and then declare the adequate models of public goods on the level of the defined segments. For these purposes, Scheme No. 1 was derived, which characterizes in a simplified form the commodity vertical of beef meat and the structure of the vertical under study, so that individual production processes could be allotted to individual segments.

For the sake of simplicity, the whole vertical was divided into four basic levels – production, processor, retailer, and consumer (thus forming so-called "baseline" elements), whereby further segments of the vertical were detected on each level, which had the character of input/ output agents necessary for proper functioning of the basic elements. Parts of the segments were natural and financial flows could generate effective public assets in the course of their realization. However, such effects could also be the consequence of natural (own) activities of the given element of the vertical during production as the very purpose of its existence, and in the form of a secondary (associated) effect to its main activity.

On the basis of the above notion, it was subsequently possible to identify individual types of public assets as per Table 2 and allocate to them Table 3 and Scheme 1 concrete processes of the analyzed vertical with an adequate example of the public good in the area of cattle breeding. Finally, it is possible to use Table 4 for dividing identified public goods into positive or negative categories.

The first generally defined public good is climatic stability, i.e., the ecoregion's capability to remain permanently suitable for the current varieties or complex ecosystems. This production good involves activities comprising all basic elements of the vertical, but is primarily the result of activities in the area of production input segments. Positive effect may be observed during careful crop production of fodder base realized through appropriate seeding methods, so that the soil properties are regularly restored



Source: Author's elaboration (Number of individual processes can uniquely identify the individual streams for eventual quantification of their volume.

Scheme 1: Cattle Breeding Vertical.

and the soil is not depleted. Simultaneously, appropriate agrotechnical interventions prevent excessive occurrence of weeds, which may have a positive effect on the creation of further public goods, such as soil fertility, landscape maintenance, resistance to floods, availability of water, and water quality. Negative effects of cattle breeding on climatic stability can be defined by negation of the foregoing methods, or can be found, e.g., in breeding stations that in today's consumer-oriented society concentrate primarily on augmentation of productivity (both meat and dairy) of farm animals. This may lead to a loss of the original breeds, both on the level of breeding and utility breeds, in the sense of intensification of production that generates greater requirements on the production and quality of fodder, which in turn leads to a greater burden on the soil as well as fodder production, mostly in the form of a high production of nitrogen or other elements and gases, as well as animal waste that affects the ecoregion's natural capability of restoration.

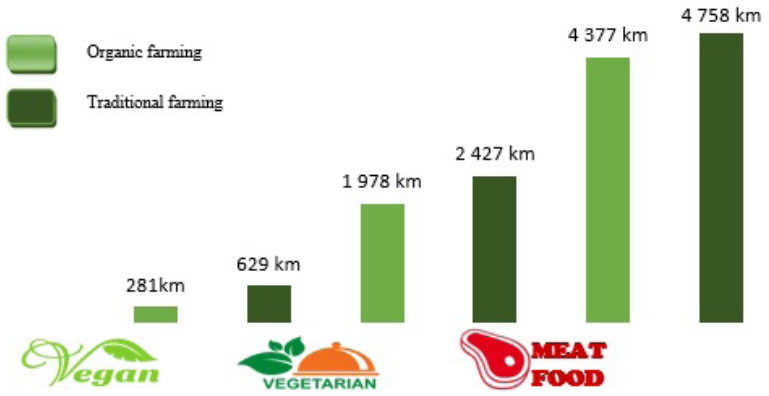
Biodiversity (variability of ecosystems), as another example of a public goods, comprises probably the most numerous groups of determinants, which take part in the creation of the studies vertical's segments, in the form of both positive and negative effect. On the production level, a positive externality that has a positive effect on biodiversity is, e.g., breeding of animals from the genetic reserve or grazing of the animals at the breeding stations, thereby regularly restoring the environment for numerous plants and animals. The same function can be achieved by certain land cultivation processes, soil preservation processes, appropriate application of fertilizers, minimization of the use of mechanical technology and other intervention measures taken by the producers of fodder crops. Moreover, food processors may also help improve biodiversity, e.g., by demanding products from specific types of farm animals (meat from certain breeds, milk with high fat content, milk with low content of allergens, products from specific breeds of other farm animals – sheep, goats, etc.), retailers or even end customers, too, may transpose their positive influence, as sufficiently strong impulse can force primary producers and processors to meet their requirements. On the other hand, too specialized production or demand may have a negative effect of biodiversity, e.g., in the form of genetic selection in highly cultivated species (breeding and commercial reeds), intensification of dairy cow breeding (utility breeds), augmentation of required qualitative parameters of meat breeds (meat processors), extension of the shelf life of products (based on the requirements of meat and delicatessen processors), or transposed or assorted demand (consumers).

The quality and availability of water is a common public good that has the ability to generate (in both forms, again) especially the production part of the vertical. Cattle breeding in itself helps maintain natural water streams, improves the retention capability of grazing meadows, absorb adequate quantities of water/precipitation and last but not the least solves the problem of processing farm fertilizers, thus impacting on the quality of water as well. On the contrary, inadequate management of farm fertilizers and other auxiliary products in livestock production may affect water quality considerably. Similarly, on the level of the suppliers of inputs (especially fodder) inappropriate (i.e. high) use of herbicides and pesticides may impact directly on the quality both of surface and underground water. Increase in the percentage of arable land cultivation or expansion of the production of wide-furrow crops may affect the production of the analyzed asset, especially in terms of water supply. Yet another way in which cattle breeding significantly impacts on the production of the studied public asset is high consumption of water for the cattle. Certain sources (e.g. Vegan 2010) claim that the production of one kilogram of beef consumes about 15,000 liters of water, compared to the production of one kilogram of grain that requires mere 450 liters of water (Holm and Jokkala 2009). This much higher consumption of water puts a great burden on the availability of water sources, as they are exploited too intensively.

Moreover, cattle breeding impacts significantly on yet another public asset in the area of soil fertility, due to crop fertilizers that subsequently penetrate into the soil in the form of animal fertilizers, thus enriching the soil with nutrients and enhancing its fertility. However, there are other aspects related to animal breeding that have a negative effect. The very production of farm fertilizers may – in high concentration that is typical for current farms – have a negative effect, because it leads to high concentration of certain elements in the soil, which therefore gradually loses fertility, especially in the case of plants that are sensitive to animal fertilizers. Moreover, their application in the soil is usually accompanied by the use of heavy machinery that packs the soil and causes deterioration of its properties from the perspective of fertility. Regular fertilizing with manure is necessary for retaining soil fertility (the usual cycle is approx. one application every 3-4 years, whereby grain crops require about 20 t, root crops 30-35 t, annual forage and oil seed 25-30 t, and vegetables about 40 t per ha-1, etc.). However, late fertilizing, inappropriate application of manure/dung, or other errors in agricultural primary production deprive the soil of moisture and cause nitrogenous depression which in turn reduces fertility. Cattle grazing, too, requires grass meadows, which may appear to be counterproductive, if inappropriately maintained, especially in the CR where absence of active care is quite typical. Last but not the least, let us mention the production of fodder crops, both as volume forage and grains grown in uninterrupted sequences, which again causes soil degradation and decline of its fertility. Involved in the foregoing aspects may also be the processing part of the vertical that – if highly concentrated regionally (as the case happens to be in the CR, e.g. in milk) – where regional demand leads to concentrated livestock production with all the consequences for the soil fertility possible.

Air quality is probably the most frequently discussed public asset at this time, because cattle breeding accounts for a major share of greenhouse emissions due to industrial and commercial uses of livestock. It is estimated that 9 % of the total emission rate of carbon dioxide is caused by human activities related to livestock breeding (Holm and Jokkala 2009). Of course, CO_2 is not the only greenhouse gas generated by cattle breeding. The atmosphere is also burdened by methane that contributes to global warming 23-times more than CO_2, whereby one cow produces about 600 liters of methane per day. Here again, according to Holm and Jokkala (2009), the share of the meat industry in the global emissions of methane is generally 35 – 40 %! Even more burden for the environment, in terms of the quality of the atmosphere, is accountable to by nitrous oxide which is generated when oxygen comes into contact with nitrogen. The share of livestock breeding in the overall emissions of nitrous oxide, due to human activities, is 2/3. According to FAO, the animal (meat) industry is responsible for about 18 % of all greenhouse gases generated by human activities (Holm and Jokkala, 2009).

Resistance to floods and fire can be another example of public assets indirectly affected by cattle breeding. The resistance is a natural capability of the system to absorb disorders in water circulation or natural defense of the landscape against the outbreak of fire. The effect of raising cattle is noted indirectly, primarily in the form of a negative effect on the availability of water in the country. Although cattle grazing may have a certain positive effect, it may under certain circumstances be one of the factors contributing to extensive natural or man-caused fires.



Note: BMW CO2 equivalent emissions (119g CO2 / km)

Source: The foodwatch report on the greenhouse effect of conventional and organic farming in Germany, 2008

Scheme 2: The greenhouse effect of different sorts of food (inh./y.) – in kilometres by car.

Cultural agricultural landscape is multifaceted and very complex phenomenon that is viewed as a widely-known and frequently cited example of a public asset, which professional often associate with elements of biodiversity. It is mainly a visual phenomenon comprised of landscape elements, containing the dimension of biodiversity, as well as the cultural dimension created by long-term human activities. Of course, cattle breeding has a major share in its production. The negative consequences can be seen above all in the consumption of meat that has gone up considerably over the last 50 years, thus leading to more intensive cattle breeding in both categories of use. This in turn led to a substantial expansion of the use of grazing meadows at the expense of other landscape elements that in the end form a constantly diminishing portion of agricultural land. Simultaneously, cattle breeding is very often referred to as the main factor in the upkeep of the countryside (biomass), whereby land cultivators (farmers) participate secondarily in other landscape-forming processes in the form of other auxiliary activities, e.g., grass mowing, maintenance of local roads, orchards, wooded areas, etc. As a side benefit, this practice helps reduce the emissions of gases by sparing the use of technology that would have to be used otherwise, as well as reduction in the use of chemicals (pesticides) that would have to applied, if the grazing meadows were used for intensive crop cultivation, along with a number of other effects.

The vitality of rural areas is characterized primarily by minimal availability of services, infrastructure of human capital, and functionality of social networks – these are additional public assets where the effects of cattle raising are double-sided. Negative consequences are accountable to aging technology that is still based on ancient prejudices or outdated know-how that does not provide for implementing modern elements of infrastructure in transport or information. The result is that the existing infrastructure is used excessively – unfortunately, without timely renovation from local sources. A possible side-effect of this approach might be the aesthetic effects of livestock breeding that may be accountable for the decline of population in rural areas or may be considered an obstacle to population expansion, especially of the younger generation. On the other hand, however, cattle breeding is in many regions (especially in those with harsher natural conditions) one of the few sectors that are capable of adapting to the given conditions and facilitate social integration of the population. In connection with the impact of agricultural producers or product processors, this sector can create favorable conditions for employment opportunities, thus at least help preserve the occupancy of rural regions.

Cattle breeding is closely associated with yet another example of a public asset – animal welfare that is based on the combination of physical and mental health of animals. In this context, we can mention a number of externalities, most of which are highly dependent on human activities and capabilities or at least on willingness to preserve the given conditions. Violation of these principles diminishes the commented asset´s production, whereas support of these principles or increase

of standards quite logically ring about positive effects. As the aforesaid indicates, the welfare of animals is determined by the human factor. Therefore, identification of the relevant processes is based on conditional phenomena. Generally, it may be said that animal slaughter is perceived as certain form of suffering, which clearly denies the principle of animal welfare. On the other hand, however, modern (meaning humane) methods of slaughtering animals have greatly improved the situation in this area, as the requirements on breeders continue to become stricter, along with ever higher hygienic and spatial standards of livestock raising – all of which constitute positive factors in the production of the studied public asset.

Food safety is the last defined public asset whose relation to cattle breeding is indisputable. Meat is considered an irreplaceable (or very briefly expendable) food component. Hence, meat production is an inseparable part of human activities and, as such, it is accompanied by certain processes an all levels of the vertical. Qualitative as well as sensory parameters of meat are basic factors that form part of the food palette and assurance of an adequate quantity of nutrients, by extension food safety. Cattle breeding is a vertical that produces red meat that is rich in elements which are essential for the human organism. Moreover, it is desirable or even irreplaceable, so that the very act of cattle breeding is viewed as a positive element in the assurance of food safety. The following comparison of the ratio of land taken up by meat production with the possible effect of food production counters the above statement. For instance, Véda (2001) says that land where one ton of beef is produced would over the same time interval produce 10 to 20 tons of crops for direct human consumption. This may be a good example of negative exploitation of land that could under different circumstances generate a greater volume of food. A certain form of a negative impact may also be seen in the pricing aspects, because achieving the commented asset is related not only to a physical, but also economic availability/accessibility of food products, whereby it is questionable, whether the current production of beef is acceptable price-wise for the whole population spectrum. Last but not the least, let us mention the existence of problems with the assurance of food safety in terms of risks to human health. In particular, due to several fairly recent cases of infected beef, it is evident that cattle breeding might be viewed as a sector that has the potential to impact significantly on the safety of food, if supervision fails, and consequently be regarded as a source of problems leading to depletion of the public assets under study.

In order to attain the other objective, i.e., to quantify the shadow price of the public good produced by dairy cattle breeding, we used the parametric approach to estimate the multiple output distance function (MODF). The results of fitted translogarithmic MODF are provided in Table 5.

First, we start with the discussion on the quality of fitted model. As far as theoretical consistency is concerned, the estimated model should inherit the properties of an output distance function. According to Coelli et al. (2005) the output distance function should be non-decreasing, positively linearly homogenous and convex in outputs, as well as decreasing and quasi convex in inputs. That is, the monotonicity requirements for outputs imply: $\alpha_{y2} > 0$, $\alpha_{y3} > 0$ and $\alpha_{y2} + \alpha_{y3} < 1$; and for inputs: $\alpha q < 0$ for q = x1, x2, x3, x4. Table 5 shows that these conditions are met. Moreover, convexity in inputs requires $\gamma_{qq} + \gamma_q^2 - \gamma_q > 0$ for q = x1, x2, x3, x4. This condition holds for all inputs evaluated on the sample mean. Furthermore, the majority of estimated parameters are significant even with 1 % significance level.

Since all variables are normalised in logarithm by their sample mean, the first order parameters of outputs represent the share of outputs y2 and y3 in the total output and the first order parameters of inputs the production elasticities. Thus, the results show that the share of plant and other animal production in total output is around 12 % pointing to the high specialization of farms. The share of y3 shows the importance of manure in the dairy production as a by-product.

As far as the elasticities of inputs are concerned the production elasticity for materials inputs (material and energy) has the highest values and the elasticity for capital is the lowest. Labour and land has approximately the same impact on the production. As far as economies of scale are concerned, no indication of economies of scale (the sum of the elasticities is about one) was estimated for the average dairy farm in the Czech Republic. Thus the farms produce in optimal scale evaluated on the sample mean.

Technological change is not pronounced. However, the estimates of parameter β_{it} and β_{jt} are statistically significant even with 1 % significance level. The parameter sigma provides information about the joint variation of uit and vit. Lambda is the relation between the variance of u_{it} and v_{it}.

	Means for random parameters				Non-random parameters		
	Coefficient	Standard Error	p-value		Coefficient	Standard Error	p-value
Constant	-0.16167***	0.00500	0.0000	TT	-0.00020	0.00100	0.8454
T	0.00088	0.00092	0.3411	Y2	0.12344***	0.00722	0.0000
X1	-0.21516***	0.00512	0.0000	Y3	0.35966***	0.00749	0.0000
X2	-0.21716***	0.00664	0.0000	Y2T	-0.01198***	0.00274	0.0000
X3	-0.04450***	0.00413	0.0000	Y3T	0.01553***	0.00302	0.0000
X4	-0.51867***	0.00741	0.0000	Y22	0.13807***	0.01587	0.0000
	Scale parameters for distr. of random parameters			Y33	0.18704***	0.02293	0.0000
Constant	0.16221***	0.00208	0.0000	Y23	-0.08429	0.01898	0.0000
T	0.00518***	0.00080	0.0000	X1T	0.00840***	0.00235	0.0004
X1	0.02519***	0.00442	0.0000	X2T	-0.00250	0.00286	0.3819
X2	0.07935***	0.00406	0.0000	X3T	-0.00663***	0.00146	0.0000
X3	0.01123***	0.00292	0.0001	X4T	0.00076	0.00332	0.8189
X4	0.07462***	0.00574	0.0000	X11	-0.01272	0.01410	0.3671
	Variance parameter for v +/- u			X22	-0.16227***	0.00773	0.0000
Sigma	0.016909	0.00255	0.0000	X33	-0.00599	0.00535	0.2629
	Asymmetry parameter, lambda			X44	-0.10232***	0.02704	0.0002
Lambda	2.01024	0.10980	0.0000	X12	0.08488***	0.01219	0.0000
				X13	-0.02024***	0.00681	0.0029
				X14	-0.05019***	0.01721	0.0035
				X23	-0.04103***	0.00627	0.0000
				X24	0.11161***	0.01429	0.0000
				X34	0.05877***	0.00844	0.0000
				Y2X1	0.00383	0.01240	0.7572
				Y2X2	0.05763***	0.01165	0.0000
				Y2X3	-0.02379***	0.00711	0.0008
				Y2X4	-0.01452	0.01635	0.3745
				Y3X1	0.04859***	0.01404	0.0005
				Y3X2	-0.08265***	0.01424	0.0000
				Y3X3	0.02624***	0.00819	0.0013
				Y3X4	0.02855	0.01853	0.1233

Source: Authors‘ calculations

Table 5: MODF - Parameter estimates.

Variable	Mean	Std. Dev.	Minimum	Maximum	Cases	Missing
TE	0.893168	0.054111	0.455595	0.980349	3818	0
PMAN	1.246721	1.677119	0.000627	19.67848	3818	0

Source: Authors‘ calculations

Table 6: Descriptive statistics of technical efficiency and shadow price of manure.

Thus, the parameter indicates the significance of TE in the residual variation. Since lambda is highly significant and higher than one, the estimates indicate that efficiency differences among dairy producers are important reasons for variation in production (see Table 6).

Appling the Lagrange method and the Shephard's dual lemma we calculated the shadow price of manure. The average value of manure is 1.24 EUR per tonne. However, the variation in the sample is large, with standard deviation of 1.68. Moreover, the distribution is skewed to larger values. The shadow prices differ significantly among the groups of farmers. This especially holds for the classification of groups according to the size and technology of production. Thus, the shadow price is significantly determine by the farm characteristics and technological heterogeneity.

Conclusion

The paper identifies and discusses the production of public goods in the vertical of cattle breeding. Moreover, it provides the methods for the valuation of public goods. The method is applied in the estimation of manure shadow price.

The cattle breeding vertical was divided into four basic levels – production, processor, retailer, and consumer (thus forming so-called "baseline" elements), whereby further segments of the vertical were detected on each level, which had the character of input/output agents necessary for proper functioning of the basic elements. Among main public goods, which production consequences were revealed and discussed, belong: the ecoregion's capability to remain permanently suitable for the current varieties or complex ecosystems; biodiversity (variability of ecosystems); the quality and availability of water; public goods in the area of soil fertility; air quality as a probably the most frequently discussed public asset at this time, because of cattle breeding accounting for a major share of greenhouse emissions due to industrial and commercial uses of livestock; resistance to floods and fire; cultural agricultural landscape; the vitality of rural areas characterized primarily by minimal availability of services, infrastructure of human capital, and functionality of social networks; animal welfare based on the combination of physical and mental health of animals; and food safety.

Furthermore, the paper presents the application of theory of production and parametric method SFA to calculate the value of public goods. This approach has the advantage over other methods as e.g. cost calculations that it takes into consideration the farm technology that is crucial with respect to the nonlinearity of production process and significant farm heterogeneity. We provided the valuation of public on the example of the manure. However, this way we can calculate the value of each public good which is directly produced by agricultural production.

Specifically, the fitted multiple output distance function with two market outputs and one non-market output – manure as a representation of public good, in our case, shows that the shadow price differs significantly among the producers depending on several factors (e.g. size, production technology). That is, the policy makers should take into the consideration different production characteristics, technology and production environment in the discussion of the price which should be paid for public goods in general.

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Internet of Things (IoT) in Agriculture - Selected Aspects

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Abstract

Article analyzes chosen aspects of Internet of Things (IoT) in general and in regards to its specific uses in agriculture, which is one of the areas where IoT is commonly implemented. It serves as a primary delve into the issues of IoT as part of the grant received from Internal Grant Agency of Faculty of Economics and Management at CULS Prague called "Potential use of the Internet of Things, with emphasis on rural development and agrarian sector". Article overviews IoT equipment categorization, platforms, standards and network solutions. It focuses on network infrastructure, which is the foundation for IoT implementation. The specific environmental conditions of Czech Republic are also taken into account. Lastly, basic development trends of IoT are defined.

Keywords

Internet of Things, IoT, sensor, Precision Agriculture, Smart Agriculture, standards, protocols, networks.

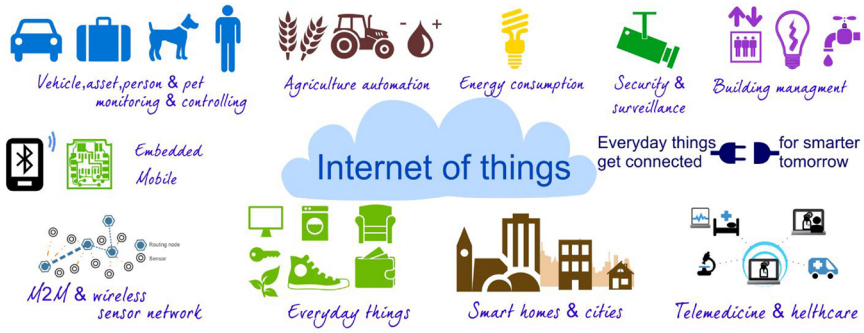
Stočes, M., Vaněk, J., Masner, J. and Pavlík, J. (2016) "Internet of Things (IoT) in Agriculture - Selected Aspects", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 1, pp. 83 - 88. ISSN 1804-1930. DOI: 10.7160/aol.2016.080108.

Introduction

IoT is an environment where objects, animals or people are equipped with unique identifiers capable of data transmission over Internet network without the need for human-human or human-computer interaction (Gluhak et al., 2011). According to Juniper Research (Juniper Research, 2015) over 13,4 billion device were connected to the internet as part of IoT in 2015 and there is expected increase by 185% to 38,5 billion devices by year 2020. IoT has uses is almost every area of modern society (Vermesan and Friess, 2013). Among the major areas are Smart Health Care, Smart Cities, Smart Industry, Autonomous Vehicles, Smart Agriculture, Precision Agriculture, Smarth Homes and others (Shang et al., 2015; Khan et al., 2012) – see figure 1.

IoT has great potential and is one of the key areas for future development of internet services. Major IT companies and most countries are keen to explore IoT issues. New uses of IoT are being searched for and established, but most of the effort is in the area of solution standardization (Jazayeri et al., 2015). Issues of IoT are part of the Digital Agenda for Europe (European Commission, 2016). As part of European research and innovation framework HORIZON 2020, it is expected that over 140 billion EURO will be invested in technologies connected to IoT just between 2016 and 2017 (European Commission, 2015). In March 2015 European Commission initiated creation of Alliance of Internet of Things Innovation (AIOTI). The goal of this alliance is to establish close cooperation between European Commission, stakeholders and parties related to IoT on innovation and standardization of IoT practices (European Commission, 2016). In Czech Republic, there is no conception that would deal with issues of IoT on government level.

One of the major problems today is the fractured nature of platforms and communication protocols which leads to incompatibility issues between various IoT devices and between different areas where IoT is implemented (Al-Fuquaha et al., 2015; Atzori et al., 2010). In precision agriculture IoT is well established, but only proprietary solution are being deployed, which leads to issues with compatibility and connection between different devices (Ojha et al., 2015; Vermesan et al., 2013). There is need to search for new solutions which would use devices compatible based on open standards and platforms. Many devices that are at least partially based on open hardware are now on the market with prices significantly lower than proprietary solutions (Fisher et al., 2015).



Source: http://www.engineersgallery.com

Figure 1: IoT fields.

Materials and methods

Article analyzes issues of modern IoT methods and usage in general and in the area of agriculture and serves as a base analysis study for the grant given by Internal Grant Agency of Faculty of Economics and Management (FEM) at Czech University of Life Sciences Prague (CULS). Main goal is to analyze current state of IoT and its potential in areas of rural development and agriculture in Czech Republic. This endeavor follows long term research goals of Department of Information Technologies at FEM CULS Prague and establishes new research opportunities based on current trends. It aims to compile methodic approaches, where the most important ones in terms of project solution are:

- defining and evaluating selected platforms suitable for use in IoT
- analyzing standards and protocols applicable in IoT
- categorization and classification of devices being used in IoT
- analyzing specifics if IoT usage in agrarian sector and similar fields
- specifying trends and opportunities for development of IoT in agrarian sector and rural development
- synthesizing obtained knowledge and proposing process of confirmation by establishing prototypes of model solution for both software and hardware part of IoT

The aforementioned represents defining of suitable technological platforms usable in IoT as well as classifying IoT devices into categories, defining and exploring implementation trends in IoT with regards to agriculture and specifics of Czech Republic environmental conditions. Prototype application solution will be developed as part of the project to determine the usability of various methodic approaches. These approaches represent a broad view upon the dynamic developing field of IoT. Research on such scale have not yet been conducted and put to use in Czech Republic. Yielded results should fill the information gaps in this area. Research is mainly focused on analyzing currently used methods and tools in IoT for data transfer and processing in agricultural sector. Experimental evaluation will test the actual impact of problematic issues for purposes of usage in agriculture. Main practical benefit of this research will be the identification of technological and technical limitations of IoT based on evaluation of actual real world implementation.

Results and discussion

IoT protocols, platforms and standards

Issues of IoT are currently being focused on by many companies, which see this area as a potential for future growth. This leads to emergence of new platforms and proprietary solutions. Compatibility of such devices is problematic which lead to creation of many alliances that focus on dealing with compatibility issues and are trying to enforce their solution and technologies for general usage (Intel® Internet of Things Solutions Alliance …). Apart from commercial solutions there are many community efforts trying to take advantage of open source software and open hardware. (Mesas-Carrascosa et al., 2015)

One of the examples of utilizing open hardware and software in IoT in agriculture is project Farm Bot (FarmBot, 2016), which focuses on creating humanity's open-source automated precision farming machine - see Figure 2.

Source: https://farmbot.io/

Figure 2: FarmBot.

Most of IoT devices are based on Single Board Computer concept, which possesses necessary computing power, satisfactory dimensions, is easily expandable and utilizes open source solutions while having low energy requirements. These devices are generally based on ARM processor architecture (Advanced Reduced instruction set computing Machine). Specially developed versions on operating systems exist for these devices for both Linux and MS Windows platforms.

IoT networks

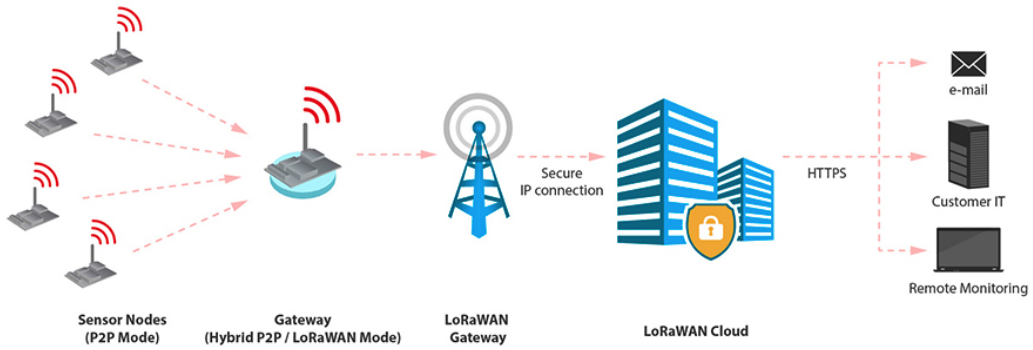
Connection to the internet is a base necessity of proper IoT device operation, in many casing such connection is wireless. Connection technologies that being deployed use various standards and can be classified based on several distinct parameters. The most common classifications for wireless connections are based on:

- energy consumption
- uplink data rate
- downlink data rate
- packet size
- devices per access point
- topology
- range
- end node transmit power
- frequency band
- channel width

IoT comprises of many technologies that very originally developed for different purpose like GSM, LTE, Bluetooth, Wi-Fi but also uses many technologies and networks specifically designed for use in IoT. Those are for instance SigFox, LoRaWAN, IEEE P802.11ah (low power Wi-Fi), Dash 7 Alliance Protocol 1.0, RPMA, nWave (Quinnell, 2015). The main characteristic of network specifically designed for IoT usage is their low energy consumption. It is estimated that new technologies will be able to operate for many years maybe even decades using only simple battery. That is because unlike older technologies where the data transfer was the most energy demanding, newer devices have much lower consumption in that area and the most energy consuming part of the device is the sensor itself.

Figure 3 represents topology of IoT network using LoRaWAN (LoRa Alliance, 2016) technology. Data is obtained from devices using gateway which forwards it to the cloud, where it is stored and then transferred to end users through API. This communication model allows for secure and relatively easily expandable network. The main disadvantage of this type of solution is the time delay necessary for the data to be stored in cloud after being obtained (for instance from thermal sensors) and the final data usage or display. This delay can be very limiting and in some cases can render this solution completely unusable (building security etc.).

The fundamental requirement of IoT usage is network infrastructure. Due to historical development there is significant difference between Czech Republic and other developed in terms of high speed internet infrastructure (both cable and wireless). For purposes of IoT development a specialized infrastructure has to be established.



Source: https://www.cooking-hacks.com/

Figure 3: LoRaWAN schema.

At present time, three alternative networks are being established in Czech Republic that are specifically focused on servicing IoT devices. Company Czech Radio Communications is building a wireless network based on LoRa technology (České Radiokomunikace, 2016). Mobile operator T-Mobile is building a SigFox based network (Pospíšil, 2015) in cooperation with SimpleCell Networks. Third subject is Things Ltd, which is building a LoRaWAN technology based network with help of local internet service providers. The last named network might become partially free of charge.

Networks are being constructed in non-licensed range by private sector which could results in problems similar to those of high-speed internet and outdoors Wi-Fi in many areas of Czech Republic. The absence of government level policies in this sector will likely cause Czech Republic to further lag behind other countries.

IoT device classification

In general, any device connected to the internet fall into the IoT category. With that in mind, there are many distinct devices, which can be further classified based on many criteria:

- purpose of use
- type of internet connection
- type of device (sensor, server etc.)
- device dimensions
- energy consumption

IoT development trends

IoT devices can be used in almost every area of human activity and accordingly in almost every area the issues of IoT are being dealt with. It is estimated (Juniper Research, 2015), that by 2020 approximately 38.5 billion devices will be connected to the Internet.

Current IoT trends are:

- development of network technologies specific to IoT
- security
- minimizing energy consumption (increasing longevity of devices not plugged in)
- miniaturization of devices
- device integration (for instance during manufacture, eliminating the need for retrofitting)
- creation of user friendly solutions for IoT control and settings
- development of devices based on open hardware

IoT in agriculture

Devices that are currently designated as IoT are impleted in agriculture for many years now. There are mostly proprietary solutions where devices are integrated into agricultural machinery and therefore their usage is closely linked to the machine manufacturer. Major development in this area is expected in the near future, because of many projects that focus on open solutions that would eliminate compatibility issues of proprietary devices. For instance project FarmBot or MIT Media Lab Open Agriculture Initiative (“OpenAG”) both deal with these issues (Open Ag Data Alliance, 2016).

Conclusion

Internet of Things (IoT) issues are more increasingly important and experience dramatic development in many areas. Such development brings many new technological innovations as well as generated new problems. Vast quantities of IoT devices in use or still in development need to be categorized based on their usage, type, internet connection, place of implementation etc. One of the important

places of usage is agrarian sector and countryside in general. It belongs to one of the more "traditional" areas of IoT implementation, but there is still a lot of room for further development.

Concerning IoT platforms and standards, there is a push towards open source software and also open hardware, which unlike proprietary solutions deals better with device and protocol compatibility issues. Deploying such solutions could broaden the implementation possibilities of IoT as well as decrease the implementation costs and establish stronger foundations for cooperation.

Apart from increase of amount and variety of devices in use, the major development areas of IoT are: development of network technologies specific to IoT, security, miniaturization and device integration, minimizing energy requirements, software functionality support and user friendliness, usage of open source software and open hardware devices.

The absence of government-level or at least ministry-level conception for IoT in Czech Republic will surely negatively impact further development in the area (similar to what nonexistence of broadband strategy caused in the past). The state basically resigned on conceptual solution and all activity is relegated to private sector without strategic coordination. Therefore Czech Republic is expecting to lag behind other developed countries in EU and in general. That makes current issues of IoT in dire need of more focus. Results obtained will be developed in further articles as well as forwarded to government institutions such as Czech Republic Ministry of Agriculture.

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Differences of Financial Management Strategy of Central European and Russian Milk Processors

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Abstract

The aim of this article is a detailed investigation of financial performance of milk processing companies of Central Europe and the Russian Federation before the Russian embargo. An investigated object is a data base of accounting reports of 5 countries over the period of 2009 – 2013. The number of selected companies is 370. The article also involves a short review of the dairy industry condition. In order to compare financial performance of two regions 4 types of criteria i.e. profitability ratios, turnover ratios, liquidity and capital structure were implemented. The differences between the Visegrad group and the Russian Federation were tested through Kolmogorov-Smirnov test at the significance level of 0.05. The main difference between the financial performances is the following: profitability (ROCE) of Russian companies is 3 times higher than in the Central Europe, stock turnover ratio is 2 times lower in the Russian Federation, and credit period is 4 days shorter. Generally speaking, the key difference is higher profitability of Russian companies which may be associated with reduced cost component, different technology of production of dairy products as well as with different capital structure.

Keywords

Dairy industry, milk processing, financial analysis, controlling, statistical analysis.

Špička, J. and Kontsevaya, S. R. (2016) "Differences of Financial Management Strategy of Central European and Russian Milk Processors", *AGRIS on-line Papers in Economics and Informatics*, Vol. 8, No. 1, pp. 89 - 102. ISSN 1804-1930. DOI: 10.7160/aol.2016.080109.

Introduction

Milk processing industry is one of the most important branches in the food industry because milk and milk products are essential parts of the human diet. Consumption of milk is increasing all over the world (Gulaeva and Trystsina, 2010). Like the vast majority of raw material industries, viability of the dairy industry depends on its ability to adapt to some changes and minimize negative consequences. The successful adaptation of the dairy industry is critical to addressing the global challenge of providing a secure supply of food globally (Buys et al., 2014).

The dairy market largely lacks flexibility: neither producers, nor processing companies are able to respond to market changes at a proper pace. The bargaining position of the processing companies against producers is relatively strong (Rozsa, 2014). Taking managerial decisions on the basis of financial performance analysis of the industry is quite relevant to managers of companies belonging to the dairy industry (Kostina, 2009). There has been published only few investigations devoted to financial performance analysis in milk processing sector (Mejstříková and Mezera, 2011; Alborov et al., 2012; Rozsa, 2014).

The article concerns milk processors as the middle phase of the dairy vertical. They sell the production to retailers. Retailers are big international companies with strong bargaining power towards milk processors and milk producers. So, milk processors balance their economic position between suppliers and retailers. Moreover, European vertical of milk production and processing is influenced by the Common Agricultural Policy. Milk producers (farmers) are supported through direct and indirect operational subsidies. Farmers are not able to generate profits without current subsidies (Doubek et al., 2012; Foltínová and Špička, 2014). Milk processors are often medium and large companies which could be supported mainly by investment subsidies. However, more and more

farmers start to build their own milk processing capacities. Having analyzed such companies in the work, Stephenson (2006) states that their financial conditions and profitability are similar with milk production companies. As a solution of the problem of low profitability, Donnellan and Keane (2015) propose transferring of milk producers to the countries with better climate conditions and less costs consequently.

Before the Russian embargo in 2014, there were quite significant trade flows with milk and milk products between the European Union and the Russian Federation. Import to export ratio of Russian foreign trade with milk and milk products decreased from 47.6 % to 8 % between 1991 and 2001. Then, it increased to 29.2 % in 2011 (Svatoš et al., 2014). Russia has been a net importer of milk and milk products from the European Union. Currently, Russia wants to increase its self-sufficiency in agricultural commodities and food products. For example, it intends to increase the domestic self-sufficiency in milk and milk products from 80 % to 90.2 % by 2020 (Petrick, 2015)[1]. But the Russian dairy industry has faced many problems. A stabilisation in livestock numbers, improvement in the quality of milk, an increase in the marketability of milk from private farms, and the World Trade Organisation negotiations are important determinants for the future outlook of the Russian dairy sector (Turjansky et al., 2014). Since 2015, Russia changed priorities in the agricultural policy towards support of dairy genetics (Petrick, 2015). Alternatively, the European dairy market experienced deep economic crisis in 2008 and 2010 and currently it has to deal with the abolition of milk quotas and low prices. As it is still not possible to evaluate the impact of the Russian embargo on financial results of milk processors, we focus on the pre-embargo period to reveal differences in financial management and condition between the Central European and Russian milk processors.

Currently the market has been influenced by major dominant companies at the dairy market. For example, the Czech Republic has loose oligopoly competition in the milk processing market. Barring the leading market players, there is also a large number of small and medium companies so called "oligopoly hem" operating either on the whole market or regionally. The same situation is in Slovakia. Špička (2015) reveals that the biggest Polish milk processors are cooperatives unlike Czech and Slovak companies which are owned by one major national or foreign investor. A cooperative character of Polish milk processing companies means that they are more closely related to farmers – milk producers and can better deal with transfer pricing. The investigation of the dairy market in Hungary (Perekhozhuk et al., 2011) proves the fact that some major companies keep the biggest part of the market. It prevents the other companies in the dairy industry from normal development. The biggest Russian milk processors are groups owned by big foreign parent companies such as PepsicoInc. and Danone.

The aim of the article is to compare financial performance of the Central European and Russian milk processors in the period 2008 – 2013. It covers the period before the Russian embargo since there is a lack of data in 2014. However, authors plan to compare the corporate economic situation before and after the Russian embargo as soon as the individual financial statements will be available. The article involves the following key items:

1. The assessment of current condition of the dairy industry in the Central Europe and the Russian Federation is presented.
2. The description of the market concentration in milk and milk products in the Central Europe and the Russian Federation is presented.
3. Scientifically based statistical selection from accounting data of individual companies of milk processors in Central Europe and Russian Federation has been done.
4. Financial condition assessment of the dairy industry has been measured and the distributions of the financial indicators have been compared through a statistical hypothesis testing. A difference in the financial performance and its reasons has been identified.

Material and methods

The description of the dairy market in the region V4 and the Russian Federation was based on the official data from Eurostat, Faostat and national statistical offices. Region V4 represents the Visegrad group (Czech Republic, Slovakia, Poland and Hungary). The analysis of the market concentration followed data from Euromonitor International (Passport)

[1]http://www.iamo.de/fileadmin/user_upload/Bilder_und Dokumente/06-veranstaltungen/icae-mailand_2015/ICAE_ symposion_Martin_Petrick/03_Petrick.pdf

database. The market was divided into three market segments of the milk processing industry: i) milk and drinking milk products, ii) yoghurt and sour milk products, and iii) cheese.

Since the differences in financial performance of milk processors in the Central Europe (V4 countries) and the Russian Federation are evaluated in the article, the individual data of milk processors from five countries were gained from Amadeus database. The database contains comparable harmonized accounting data of individual companies in all branches. We selected panel data from NACE Rev. 2 (Code C10.5) Manufacture of the dairy products with available accounting data in all years from the five-year period 2009 – 2013. A basic dataset contains 176 companies from the Central Europe and 194 companies from the Russian Federation. The Table 1 describes the basic dataset by region. Size of a company is measured by turnover (operating revenues) and total assets in thousands EUR. Profit is measured by Earnings before Taxes (EBT) in thousands EUR.

Russia	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Turnover	194	29926.6	125145.1	88.49507	1533166
Assets	194	18413.88	87006.63	52.93281	905851.2
EBT	194	1180.954	6909.798	-3548.823	92806.04
V4	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Turnover	176	38366.6	79348.72	146.3368	656532.3
Assets	176	19530.71	62933.96	153.0361	755787.6
EBT	176	756.842	3266.836	-13953.93	35798.39
Total	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Turnover	370	33941.3	105807.5	88.49507	1 533166
Assets	370	18945.13	76407.73	52.93281	905851.2
EBT	370	979.2141	5484.415	-13953.93	92806.04

Source: Amadeus database, own calculation

Table 1: Key features of the basic dataset (thousands EUR).

To check the representativeness of the dataset, it was necessary to compare the sample with total population in each region. Table 2 provides facts about the share of the sample in total population and turnover in the Czech Republic (CZ), Slovakia (SK), Poland (PL), Hungary (HU) and the Russian Federation (RU).

	Number of companies	**Turnover, thousands EUR**
CZ – sample	29	1013.6
CZ – population	178	1719
CZ – share (%)	**16.29%**	**58.96%**
PL – sample	115	4 547.5
PL – population	523	7375.7
PL – share (%)	**21.99%**	**61.66%**
SK – sample	15	427.1
SK – population	189	653.6
SK – share (%)	**7.94%**	**65.35%**
HU – sample	17	764.3
HU – population	106	948.1
HU – share (%)	**16.04%**	**80.61%**
RU – sample	194	5805760
RU – population	1192	10 751 420
RU – share (%)	**16.27%**	**55.99%**

Source: Eurostat, Amadeus database, own calculation

Table 2: Sample size in total population and turnover in 2013.

The comparison of the sample and the population shows that the sample represents quite low share of population but majority share of turnover. It means that the sample generally covers larger companies. So, the conclusions of the article can be generalized for the market leaders being not small milk processors.

The market concentration in the milk processing industry used CR_4 indicator that calculates a sum of total market share of the four largest companies in the industry. Concentration ratios are usually used to show the extent of market control of the largest companies in the industry and to illustrate the degree to which an industry is oligopolistic. The CR_4 ratio was calculated from company shares of sales value not from brand shares.

The financial performance of milk processors between the two regions is assessed through ten financial ratios. Since we used financial ratios, not absolute values, we have not solved the problem of local currencies and exchange rates. Moreover, the time period 2009 – 2013 facilitates data processing because the Russian rubble experienced strong depreciation in 2014. Following financial indicators were selected for comparison. The construction of financial indicators respects the ratios in the User Guide of the Amadeus database (Bureau van Dijk, 2015). They represent all important aspects of corporate financial performance.

A) Profitability ratios
- Return on Capital Employed (ROCE, %) = (Profit before tax + Interest paid) /(Shareholder funds + Non-current liabilities) * 100
- Return on Assets (ROA, %) = (Profit before tax / Total assets) * 100
- Profit margin (%) = (Profit before tax / Operating revenue) * 100

B) Turnover ratios
- Stock turnover (x) = Operating revenue/ Stocks
- Collection period (days) = (Debtors/ Operating revenue) * 360
- Credit period (days) = (Creditors/ Operating revenue) * 360
- Assets turnover (x) = Operating revenue / Total Assets

C) Liquidity and capital structure
- Current ratio (x) = Current assets/ Current liabilities
- Liquidity ratio (x) = (Current assets – Stocks) / Current liabilities
- Solvency ratio (Asset based, %) = (Shareholders funds / Total assets) * 100
- Gearing (%) = (Non-current liabilities + Loans) / Shareholders funds * 100

Each financial indicator was calculated as a mean of the period 2009 – 2013. It means that one value of each indicator per one company entered the statistical analysis.

The dataset passed through cleaning process. Outliers were detected separately for each indicator and region (V4, the Russian Federation) in order to prevent any distortions of statistical testing. So, the test for each financial indicator follows different number of observations. Outliers were detected and removed through visual assessment of box plot diagrams.

To test the differences between the two regions, tests of statistical hypotheses were applied. The appropriate choice of statistical test depends on results of normality distribution test and variance-comparison test. The Shapiro–Wilk normality test (S-W test) is based on Shapiro and Wilk (1965) with a new approximation accurate for $4 \leq n \leq 2000$ (Royston, 1992).The Shapiro–Wilk test utilizes the null hypothesis principle to check whether a sample came from a normally distributed population. If the p-value of the Shapiro-Wilk test is less than the chosen alpha level ($\alpha = 0.05$), then the null hypothesis is rejected and there is evidence that the data tested are not from a normally distributed population.

The two-group variance-comparison test (V-C test) performs tests on the equality of standard deviations (variances). If the p-value of the variance ratio test is less than the chosen alpha level ($\alpha = 0.05$), then the null hypothesis of equal variance between the two groups is rejected.

Since the results of assumption tests show that the data has mostly non-normal distribution and there are not equal variances of indicators between the two regions, we choose two-sample Kolmogorov-Smirnov test (K-S test) to determine if there are any differences in the distribution of variable for the two groups. K-S test, nonparametric tests of hypotheses, is fairly powerful for alternative hypotheses that involve lumpiness or clustering in the data. The directional hypotheses are evaluated with the statistics

$$\begin{aligned} D^{+} &= \max_{x}\{F(x) - G(x)\} \\ D^{-} &= \min_{x}\{F(x) - G(x)\} \\ D &= \max\left\{\left|D^{+}\right|, \left|D^{-}\right|\right\} \end{aligned} \quad (1)$$

Where *F(x)* and *G(x)* are the empirical distribution functions for the sample being compared. The p-value for this statistic may be obtained by evaluating the asymptotic limiting distribution. If the p-value of the K-S is less than chosen alpha level ($\alpha = 0.05$), there is a significant difference (one-side or two-side) between the two regions.

Let *m* be the sample size for the first sample, and let *n* be the sample size for the second sample. A corrected p-value was obtained by modifying the asymptotic p-value by using a numerical approximation technique:

$$\begin{aligned} Z &= \Phi^{-1}(P_{\alpha}) + 1.04/\min(m,n) + 2.09/\max(m,n) \\ &\quad - 1.35/\sqrt{mn/(m+n)} \\ p - value &= \Phi(Z) \end{aligned} \quad (2)$$

Where $\Phi(.)$ is the cumulative normal distribution.

Statistical tests were processed automatically in software Stata SE 12.

Results and discussion

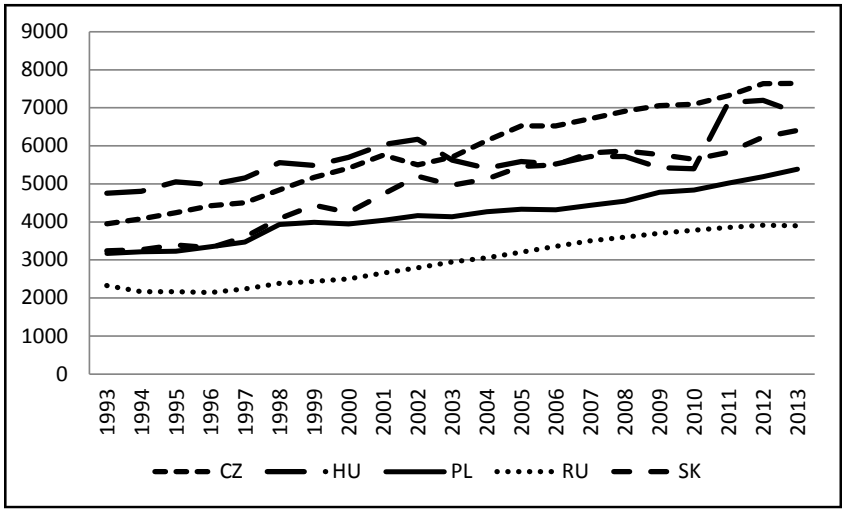
Table 3 provides brief overview on the Russian and the Central European dairy sector.

In European countries, averagely a half of the area is used for agricultural needs and in the Russian

Categories	CZ	PL	HU	RU	SK
Country area, sq.km.	78 870	312 680	93 030	17 098 250	49 030
Agricultural area, sq.km.	42 190	144 100	53 400	2 168 400	19 280
Agricultural area, %	53.49	46.09	57.4	12.68	39.32
Number of cows, th. heads	373	2 361	256	7 766	150
Number of cows, per 1sq.km. of agricultural area	8.83	16.38	4.79	3.58	7.77
Production of milk, th tons	2 849	12 718	1 758	30 286	959
Implementation of milk (fresh milk for sale for processing), th tons	2358.42	9921.66	1364.23	19 700	826.64

Source: Faostat, clal.it, own calculation

Table 3: Assessment of the current state of the dairy industry of Russia and Central Europe (V4 countries) in 2013.



Source: Faostat, own calculation

Figure 1: Milk yield per cow kg per year (1993-2013) in 5 countries.

Federation the agricultural area is only 12.68%. In spite of the fact, that the Russian Federation has the biggest number of cows (7 766 th.Heads), the number of cows per 1 sq.km. is the lowest (i.e. 3.58 cows). The biggest number of cows 16.38 th.heads per 1 sq.km. is in Poland. It has the leading position in milk production in Europe 12 718 th.tons.

Fig.1 demonstrates the dairy cow production in 5 countries during 11 years. Milk yield per one cow has been increasing over the period and the Czech Republic (index 2013/1993 =193.5) and Slovakia (index 2013/1993 =197.8) keep leading position. In 2013, the average milk yield was 7 644 kg/ cow in the Czech Republic. The third rank in the dynamic of the milk yield had Poland with 70.1% increase from 1993 to 2013. The lowest milk yield was 3900 kg/cow in the Russian Federation (index 2013/1993 =167.4). Low livestock yield in the Russian Federation is caused by insignificant number of high-producing brood cows in a core herd and poor conditions of material and technical facilities of the agriculture. Poor climate conditions do not significantly influence low milk yield currently. For instance Finland is the country with poor climate conditions having the milk yield 8 222 kg/cow. Overall increase of the milk yield in all countries was caused by nutrition improvement and welfare conditions. The welfare improvement has been supported by investment subsidies in the EU countries.

Import and export of milk is presented in Table 4. It obviously has quite big share in overall milk production. There are a lot of transnational companies among milk processors. This initial point of interest clearly highlights the importance of this research.

The Czech Republic and Poland are milk exporters. Their export is two or three times bigger than import. In Slovakia and Hungary export is approximately equal to import. In the Russian Federation import is about 18 times more than export. Quantitatively, the Russian Federation produces and imports

	CZ	PL	HU	SK	RU
Import	665.32	1113.74	442.08	455.23	5206.59
Export	1459.99	3484.47	504.24	494.74	280.356
Balance	794.67	2370.73	62.16	39.51	-4926.234

Source: Faostat, clal.it, own calculation

Table 4: Foreign trade – milk and milk products expressed in milk equivalent in 2013 (th.tonnes).

milk most of all countries and its export of milk is the least one among other countries. It may be concluded that the Russian Federation, being the biggest milk producer, does not satisfy internal needs in milk and it has to purchase milk abroad. At the same time other investigated countries in Europe produce enough milk and export it.

Since the market concentration affects the profits of the market players, the concentration ratio of the four biggest companies (CR_4) has been measured in four Central European countries in 2011 and 2014 to see changes in time.

Country	Drinking milk products	Yoghurt and sour milk products	Cheese
Czech Republic	37.26	47.59	46.12
Poland	62.92	64.69	46.5
Slovakia	68.6	66.68	53.77
Hungary	53.98	56.62	57.28
Russia	56.66	51.1	17.15

Source: Faostat, clal.it, own calculation

Table 5: Concentration ratio of the milk processing industry in 2013 (%).

The concentration analysis shows that Russian markets as well as Central European markets (except the Czech Republic) are highly concentrated. The market has a character of oligopoly. The cheese market in Russia is highly fragmented since Russian consumption of cheese is highly dependent on imports.

The specific feature of Polish milk processors is that there are strong cooperatives like SM Mlekpol, SM Mlekovita and OSM Lowicz. They are the biggest and most modern dairy cooperative operated in Poland and the top dairy processors in Europe. The cooperative character offers specific supplier-customer relations. It brings the dairy industry in profitable position by comparison with other countries because the transfer prices between producers and processors are set differently. In other Central European countries, the cooperative character of milk processors is not usual. The conditions in the Czech Republic are so that efficient dairy cooperatives may be established (Ratinger and Bošková, 2013). However, establishment of the cooperatives requires modification of traditional mode of farmers' cooperation. Currently farmers are not completely ready for dairy cooperatives. The important aspect here is negative experience in establishment of such cooperatives in past though in the end of 19th century and in the beginning of 20th century there were efficient agricultural cooperatives in the Czech Republic and Slovakia. The situation about agricultural cooperatives in Poland is quite different. Since 19th century and before World War II agrarian cooperation traditions were very strong in Poland. After communists being in, the cooperatives were saved but became more bureaucratic and subordinated to the government. In fact they lost their functions. Then the cooperatives were recreated after capitalists being in. Unfortunately the cooperatives cannot be recreated soon. It takes time to establish the relations and links. Agricultural cooperatives in Poland are not so strong as in Denmark and Norway (Chloupková et al., 2003).

In order to complete the picture of the market structure in selected countries, the following part lists the major market players in 2013.

The Czech Republic:

- Drinking milk products: Madeta a.s., Olma a.s., Mlékárna Kunín a.s., Bohemilk a.s.
- Yoghurt and sour milk products: Danone a.s., Olma a.s., Zott s.r.o., Mlékárna Kunín a.s.
- Cheese: Madeta a.s., Pribina s.r.o., Lactalis CZ s.r.o., Bel Sýry Česko a.s.

Poland:

- Drinking milk products: SM Mlekpol, SM Mlekovita, Jeronimo Martins Polska SA, OSM Lowicz.
- Yoghurt and sour milk products: Danone Sp zoo, Bakoma Sp zoo, Zott Polska Sp zoo, Jeronimo Martins Polska SA.
- Cheese: Hochland Polska Sp zoo, SM Mlekovita, SM Mlekpol, Mleczarnia Turek Sp zoo.

Slovakia:

- Drinking milk products: Rajo a.s., Tatranská Mliekareň a.s., Coop Jednota Slovensko s.d., Tesco Stores SR a.s.
- Yoghurt and sour milk products: Rajo a.s., Senoble Central Europe s.r.o., Danone a.s., Milk-Agro spol. s.r.o.
- Cheese: Milex NMNV a.s., Syráreň Bel Slovensko a.s., Levické Mliekárne a.s., Milsy a.s., Bánovce nad Bebravou.

Hungary:

- Drinking milk products: Sole-Mizo Zrt, Alföldi Tej Értékesítoés Beszerzo Kft, Friesland Campina Hungária Zrt, Tesco-Globál Áruházak Zrt.
- Yoghurt and sour milk products: Danone Kft, Sole-Mizo Zrt, Zott Hungária Kft, Alföldi Tej Értékesítoés Beszerzo Kft.
- Cheese: Pannontej Zrt, Sole-Mizo Zrt, Tolnatej Zrt, Óvártej Zrt.

Russia:

- Drinking milk products: Danone Russia Group of Cos, Wimm-Bill-Dann Produkty Pitania OAO, Magnit OAO, Molvest ZAO.
- Yoghurt and sour milk products: Danone Industriya OOO, Wimm-Bill-Dann Produkty Pitania OAO, Danone Russia Group of Cos, Molvest ZAO.
- Cheese: Valio St Petersburg ZAO, Hochland Russland OOO, Lactalis Vostok ZAO, Wimm-Bill-Dann Produkty Pitania OAO.

ROCE is a first indicator that was calculated in the two regions. It is the important indicator of profitability. It explains how much profit does the company generate from long-term own and external capital employed. So, it is the important indicator for investors. Table 6 contains results of assumptions tests and K-S test.

The statistical test clearly shows that ROCE of milk processors in Russia is significantly higher than in the Visegrad group. The expected return of capital depends on inflation. In Russia there was 9% inflation officially and 15-20% unofficially over a period of 2009 - 2013[2]. Business in Russia is associated with high risks. High ROCE provides confidence to owners since the higher risk the higher ROCE should be.

Another explanation of the difference results from the capital structure. When we compare ROCE indicator that contains shareholders' funds and long-term debt with ROA indicator which calculates with the total capital (short-term and long-term), we can identify differences in the structure of the capital employed. Russian milk processors has higher share of long-term liabilities and loans to shareholder funds. They have also higher costs of interests paid. It is clearly demonstrated by the indicator gearing in Table 7. Big volume of the long-term capital in Russia is caused by snowballing increase of credits in 2009 – 2013.

Table 8 presents ROA. It measures the profit gained from one monetary unit of total assets (i. e. short-term and long-term assets). In other words, ROA gives an idea as to how efficient management is at using its assets to generate earnings.

ROA is higher in Russia than in the Visegrad group. However, the difference is not as big as in ROCE. From one hand a high value of ROCE may seem attractive to the investors and demands investments of money. However, big value of ROCE points at big volume of long-term capital as well but not

[2] Source: www.gks.ru

S-W test	**Obs**	**W**	**V**	**z**	**p-value**
RU	179	0.96006	5.412	3.863	0.0001
V4	154	0.97964	2.423	2.009	0.0223
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	24.421	1.416	18.939	21.628	27.215
V4	7.454	0.55	6.83	6.367	8.542
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.0112	0.98	-	-	
V4	-0.5378	0	-	RU > V4	
Combined	0.5378	0	0	RU ≠ V4	

Source: Amadeus database, own calculation

Table 6: Statistical tests of ROCE (%).

S-W test	Obs	W	V	z	p-value
RU	172	0.87666	16.144	6.351	0.00000
V4	151	0.89092	12.765	5.775	0.00000
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	177.006	12.425	162.958	152.479	201.533
V4	47.267	3.134	38.510	41.075	53.459
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.0058	0.995	-	-	
V4	-0.4643	0.000	-	RU > V4	
Combined	0.4643	0.000	0.000	RU ≠ V4	

Source: Amadeus database, own calculation

Table 7: Statistical tests of gearing (%).

S-W test	Obs	W	V	z	p-value
RU	173	0.97287	3.569	2.906	0.00183
V4	164	0.97344	3.336	2.744	0.00303
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	4.575	0.481	6.327	3.625	5.524
V4	3.316	0.33	4.224	2.665	3.967
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.0591	0.555	-	-	
V4	-0.1471	0.026	-	RU > V4	
Combined	0.1471	0.052	0.04	RU ≠ V4	

Source: Amadeus database, own calculation

Table 8: Statistical tests of the ROA (%).

at extra profitability. It is reasonable hypothesis for Russia and proved by below calculations of ROA and profit margin which values do not extremely differs in Russia and in Europe. ROA depends on profit margin and assets turnover. So, both indicators are tested in following parts of the article.

Profit margin is expressed as a percentage and, in effect, measures how much out of every monetary unit of sales a company actually keeps in earnings. It is strongly affected by input-output efficiency, price setting and cost management. Table 9 compares profit margin in the Visegrad group and the Russian Federation.

Higher ROA (and ROCE) can be explained by significantly higher profit margin of Russian milk processors against V4 group. It means that Russian milk processors gain more profit from one unit of sales.

In the Russian Federation high profit margin is obtained due to cost management mainly. Large milk processing companies with well-developed management system are transnational (e.g. Pepsico). However, decreasing the operating costs on milk products plays a big role. Fresh milk is bought for the low price from a manufacturer. Then, different cost-cutting inputs, such as a palm oil, a milk powder and others are implemented in manufacturing process to make the products cheaper. Russian legislation does not prevent it. This way increases profit but quality of the products intended for final consumer is decreased. Turjansky et al. (2014) confirms it.

Second determinant of ROA is assets turnover. Generally speaking, the higher the asset turnover ratio, the better the company is performing, since higher ratios imply that the company is generating more revenue per monetary value of assets. Fast moving consumer goods, such as milk and milk products, usually have higher asset turnover ratio than other branches. The assets turnover is often lower when profit margin is higher. Table 10 indicates if there are some differences between the two regions.

S-W test	Obs	W	V	z	p-value
RU	166	0.97649	2.985	2.492	0.00635
V4	143	0.98395	1.793	1.32	0.09339
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	2.308	0.211	2.721	1.891	2.725
V4	1.032	0.112	1.335	0.811	1.252
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.0463	0.72	-	-	
V4	-0.2874	0	-	RU > V4	
Combined	0.2874	0	0	RU ≠ V4	

Source: Amadeus database, own calculation

Table 9: Statistical tests of profit margin (%).

S-W test	Obs	W	V	z	p-value
RU	190	0.96426	5.099	3.739	0.00009
V4	169	0.99136	1.113	0.245	0.4032
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	2.253	0.091	1.25242	2.074	2.432
V4	2.4023	0.063	0.818	2.278	2.527
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.2192	0	-	RU < V4	
V4	-0.0856	0.269	-	-	
Combined	0.2192	0	0	RU ≠ V4	

Source: Amadeus database, own calculation

Table 10: Statistical tests of assets turnover ratio (x).

The assets turnover is significantly higher in the Central European countries. It means that Central European countries process more intensively fresh milk and produces more fresh milk products than Russian milk processors which are specialized in production of powder milk and keep higher stocks. We could verify the hypothesis about different stock management through the indicator stock turnover.

Stock turnover measures the number of times when an inventory is sold or used in a time period such as a year. A low rate may indicate a strategy when higher inventory levels occur in anticipation of rising prices or expected market shortages. Stock turnover can also differ depending on production technology. Table 11 tests the differences of stock turnover between the two regions.

Stock turnover ratio shows the different production technology and stock management in Russian milk processors. Stock turnover of Russian milk processors is significantly lower (11.48 times per year) than in Central Europe (20.33 times per year).

In European countries, the major part of the stock is fresh milk which must be used immediately. In the Russian Federatio milk powder with long storage life of one year and more plays more important role in technology of production of milk products than in Europe.

Next financial indicators, collection period and credit period, evaluate a quality of corporate debt management. The collection period measures an average period between the events when a producer sells outputs and when producer receive the payment from its customers. The shorter period has the better impact on cash flow. Table 12 compares the collection period.

The mean collection period varies between 36 and 37 days. It is slightly longer in the Central European milk processors than in the Russian Federation. However, the difference is not so big to make conclusions about different debt management.

The credit period is the time frame between the events when a producer purchases inputs

S-W test	Obs	W	V	z	p-value
RU	182	0.96644	4.613	3.501	0.00023
V4	152	0.97587	2.840	2.368	0.00895
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	11.480	0.517	6.977	10.460	12.500
V4	20.325	0.782	9.641	18.780	21.870
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.4325	0.000	-	RU < V4	
V4	0.0000	1.000	-	-	
Combined	0.4325	0.000	0.000	RU ≠ V4	

Source: Amadeus database, own calculation

Table 11: Statistical tests of stock turnover (x).

S-W test	Obs	W	V	z	p-value
RU	174	0.96351	4.825	3.595	0.00016
V4	170	0.99402	0.775	-0.581	0.71934
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	36.410	1.477	19.477	33.495	39.324
V4	37.001	1.082	14.110	34.864	39.137
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.1511	0.020	-	RU < V4	
V4	-0.1013	0.171	-	-	
Combined	0.1511	0.039	0.030	RU ≠ V4	

Source: Amadeus database, own calculation

Table 12: Statistical tests of collection period (days).

and when the producer's payment is due. It should be longer to positively change cash flow. The credit period is a good picture of relationship between milk processors and their suppliers (cattle farmers). Table 13 describes the results of credit period testing.

Credit period depends on the relationship between milk processors and milk producers. If there is a strong position of milk processors towards milk producers (farmers), milk processors can afford to keep longer credit period. However, if the milk processor is a cooperative of milk producers, the credit period should be shorter. Like collection period, credit period is longer in the Central European companies than in the Russian Federation.

When Russian milk producers do not manage their cash inflows and outflows carefully, their money could be devalued quickly due to the economic conditions, high inflation and increasing fuel prices. For instance, an agricultural company can buy more fuel if it is paid right away than in case of big delay. Many companies prefer to work under prepayment conditions as well when providing goods, works and services. It explains the big role of short credit in the Russian Federation. Additionally, the culture of good relations intended for long term cooperation between producers and milk processors is missing as a rule.

Next two indicators measure the short term solvency of the milk processors. Current ratio (Table 14) and liquidity ratio (Table 15) reflects the net working capital management of the companies. The current ratio expresses how many times the current liabilities are covered by short-term current assets.

There is no statistically significant difference of current ratio between the Central European countries and the Russian Federation. It means that milk processors in both regions have the same strategy of net working capital management. The mean values are above 1.1 which is below the recommended interval for industrial companies (1.6 – 2.5, Kislingerová et al., 2007). However, the milk industry generally has lower liquidity

S-W test	Obs	W	V	z	p-value
RU	155	0.94374	6.733	4.331	0.00001
V4	158	0.97353	3.221	2.659	0.00392
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	27.898	1.160	14.437	25.608	30.189
V4	31.306	0.784	9.858	29.757	32.855
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.2738	0.000	-	RU < V4	
V4	-0.0777	0.389	-	-	
Combined	0.2738	0.000	0.000	RU ≠ V4	

Source: Amadeus database, own calculation

Table 13: Statistical tests of credit period (days).

S-W test	Obs	W	V	z	p-value
RU	152	0.95537	5.252	3.763	0.00008
V4	171	0.96788	4.183	3.266	0.00054
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	1.173	0.032	0.399	1.109	1.236
V4	1.160	0.036	0.470	1.089	1.231
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0398			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.0585	0.577	-	-	
V4	-0.1001	0.199	-	-	
Combined	0.1001	0.395	0.345	-	

Source: Amadeus database, own calculation

Table 14: Statistical tests of current ratio (x).

because of the specific character of processing the perishable material - raw milk.

Table 15 presents the results of Liquidity ratio. The indicator subtracts inventories from current assets because they are the least liquid part of the working capital. So, the comparison between the current ratio and the liquidity ratio indicates the level of stocks in the company.

Liquidity ratio is higher in the Central European milk processors. Since there were no differences of current ratios, the results show the Russian milk processors have higher stocks of products. This is consistent with the conclusions formulated for stock turnover, which is significantly lower in Russian milk processors. The level of stocks and stock management is a key difference between milk processors in Central Europe and the Russian Federation.

Last indicator, solvency ratio (Table 16), depends on the capital structure of the company. It compares shareholders' funds to total assets. The higher is the indicator, the higher is the rate of company's self-financing through equity. Kislingerová (2010) concludes that companies with higher share of equity were more viable during the crisis period since they were not dependent on external capital and they did not bear the cost of debt service.

It can be concluded that Central European countries have higher share of equity in the total capital. The milk processing industry in the EU was strongly affected in the crisis period 2008 – 2009 and the companies reduced the amount of bank loans.

Opposite trend has been observed in the Russian Federation. The credit boom took place in the investigated period. According to the statistics of Bank of Russia the financial crisis did not influence strongly on Russian banking. In a period 2008 – 2009, an amount of provided credits was by 45% more than before crisis. In 2013, number of provided credits was by 58% more than in 2009. Increasing of the amount of the provided credits enabled new bank credit facilities and declining of the requirements to the credit users.

S-W test	Obs	W	V	z	p-value
RU	161	0.98530	1.818	1.360	0.08689
V4	173	0.96992	3.957	3.141	0.00084
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	0.639	0.022	0.277	0.596	0.683
V4	0.845	0.030	0.389	0.787	0.904
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.2440	0.000	-	RU < V4	
V4	0.0000	1.000	-	-	
Combined	0.2440	0.000	0.000	RU ≠ V4	

Source: Amadeus database, own calculation

Table 15: Statistical tests of liquidity ratio (x).

S-W test	Obs	W	V	z	p-value
RU	193	0.93878	8.855	5.009	0.00000
V4	170	0.99078	1.195	0.406	0.34247
V-C test	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
RU	34.144	1.694	23.539	30.802	37.486
V4	43.424	1.223	15.949	41.009	45.839
Ratio = sd(RU) / sd(V4)		H0: ratio = 1;HA: ratio != 1; p-value = 0.0000			
K-S test	**D**	**p-value**	**corrected**	**Significance (α = 0.05)**	
RU	0.3383	0.000	-	RU < V4	
V4	-0.0676	0.437	-	-	
Combined	0.3383	0.000	0.000	RU ≠ V4	

Source: Amadeus database, own calculation

Table 16: Statistical tests of solvency ratio (%).

Conclusion

The aim of the article is to compare financial performance of the Central European (V4) and Russian milk processors in the period 2008 – 2013. It covers the period before the Russian embargo. The Russian Federation has been a net importer of milk and milk products. However, it attempts to increase the self-sufficiency in agricultural commodities and food products.

The analysis revealed significantly higher profitability of Russian milk processors. The big gap in ROCE is a consequence of different capital structure of the Russian and the Central European milk processor. Russian milk processors use significantly higher share of long-term debt and loans to shareholder funds. The main reason is that the financial crisis did not appear in the Russian Federation to such an extent as in Central Europe. So, the Russian milk processors have continuously increased the bank loans in that period. Alternatively, the use of debt in the Central European countries was sharply reduced in the crisis period and Central European milk processors had better solvency than Russian companies.

Overall, the profitability measured by ROA was significantly higher in the Russian Federation than in Central Europe. It was caused by higher profit margin of Russian milk processors. The main reason of higher profit margin is different cost management in Russian milk processors who buy fresh milk at low price from farmer and use cost-cutting technology of milk processing. However, it has negative impact on quality of Russian milk products which has been frequently discussed issue. The specific features of milk production establish different stock turnover ratio which is significantly lower in the Russian Federation.

Concerning debt management, Russian milk processors had shorter credit period than the Central European companies. It is caused by the fact that many companies in the Russian Federation prefer to work under prepayment conditions as well when

providing goods, works and services.

Finally, the analysis did not prove any significant difference in liquidity expressed by current ratio. It means that milk processors in both regions have the same strategy of net working capital management. However, liquidity ratio that does not take into account inventories is significantly lower in the Russian Federation as a consequence of different stock management between the two regions. The skimmed milk powder which is used more by Russian milk processors for production of milk products requires different stock management than fresh milk.

The opportunity for next research would be the impact analysis of increasing self-sufficiency of the Russian Federation and the Russian embargo on financial management strategy of the Central European and Russian milk processors. However, the effects can be analysed when the sufficient number of financial statements will be available.

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Towards Framework for Economic Value of Analytical Systems in Agriculture: Proposal of Research

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Abstract

An important criterion for agricultural businesses and farmers who make investment decisions is the profitability of their investments. If the profitability criterion is applied to investments in analytical systems, problems arise with determining the exact value of such criteria. Special approaches for assessing the benefits of such systems must be used to cope with this problem. This paper focuses on the economic evaluation of analytical systems, whose economic impact in agriculture is unclear. Two main types of research approaches are identified: normative approach and positive approach to the evaluation of analytical systems. These approaches can be used to identify the benefits of analytical systems for agricultural activities, and to express their economic value for the management of agricultural enterprises. A new research process and research phases for the design of a conceptual framework for analytical systems' economic evaluation in agriculture is proposed based on this theoretical and research background.

Keywords

Analytical systems, economic value, decision support, information systems, agriculture.

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Introduction

In connection with the agricultural business owners' awareness of their economic performance, the usage of analytical systems supporting decision making in agricultural activities is rising. Farmers themselves are constantly facing investment decisions which may improve their agricultural activities results. The profitability is an important criterion for the investment decision, but in the case of investment in analytical systems, it is not possible to determine it. The cost of the analysis systems (i.e. the cost of hardware, software, and to some extent staff costs) are represented by the market price. However, the benefits of the system (i.e. performance effects on the agricultural business) cannot be expressed directly. A measure identifying the yield development of analytic system can be used as an objective approach for evaluating the profitability of analytical systems. The result is better decision making about the analytic systems investment.

Analytical systems

Analytical systems in agriculture are used to support strategic decision making and for detecting hidden information for easy understanding and anticipating the needs of the farmers. The analytical system generally consists of three components (Ugolnitskii and Usov, 2008): a data storage component (database with analytical functions), a database of models (the models, methods, and simulated processes) and an expert system.

The data storage component is a cluster of databases containing all available data about the entire system and the problem to be analysed.

The model database contains separate models of subsystems and models describing the properties of the studied objects.

The expert system represents the knowledge base of control models (i.e. the database of specific agricultural situations prediction results, and a database of knowledge, experience and intuitions of experts in the field of agricultural activities). The first part contains known information from already existing control models (subsystems). This part includes a database of the prediction results of specific agricultural situations, obtained by using a previously created scenario. The second part of the expert component uses information, models and data based

on knowledge, experience and intuition of experts in the field of agricultural activities. This section should be continually acquiring new data.

Currently, the most commonly used type of analytical systems are systems based on the principles of *Business Intelligence* (Chaudhuri et al., 2015, Azevedo and Santos, 2009, Tyrychtr et al., 2015). Business Intelligence is a set of processes, applications, and technologies that aim to effectively and efficiently support the decision-making processes in the company.

The data, information and knowledge storage in analytical systems may be addressed through the design of the so-called multidimensional databases. *Multidimensional databases* are suitable for storing (multidimensional) analytic data, which are most commonly used to carry out various analysis and reports required for the decision making (for example Tyrychtr et al., 2015b). Data in a multidimensional databases are organised using a data cube. The data cube is a data structure for storing and analysing large amounts of multidimensional data (Pedersen, 2009). The data cube consists of dimensions and measures. A *dimension* is a hierarchically structured set of values which provide the categorical information characterizing a particular aspect of the data (Pedersen, 2009b). *Measures* (indicators) of the cube are mainly quantitative data, which are the subject of the analysis.

Evaluation of investments

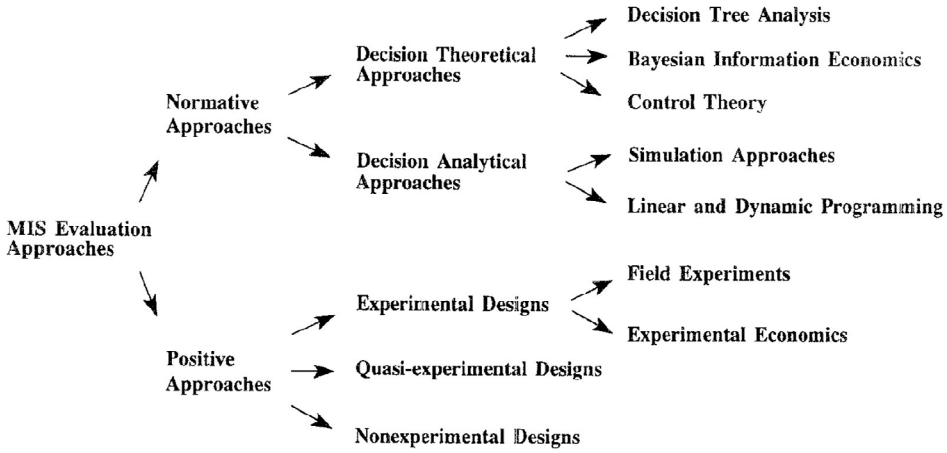
This paper deals with the problem of evaluation of investments in analytical systems. Analytical systems form a special category of systems – focusing primarily on decision support, while other systems typically have more features (such as the processing of operational data and other specific operational functions). For example, the automated weed system senses if a weed is present to deliver a precise amount of chemical spraying only the weed or the automated milking systems, which collect information on daily milk yield and feeding, provide farmers with the information about individual performance of each cattle (in order to support decision -making about inseminations and exchange of cattle). The reduced costs resulting from these applications are obvious and may act as a motivation for investing in such system. On the contrary, operating costs reduced due to the use of the analytical system are modest, which means that most of the advantages of the analytical system must come from the less tangible benefits. Therefore, the evaluation of the investment to the analytical system must go beyond the traditional analysis of costs and revenues.

The standard method for the evaluation of investment is the cost and revenue analysis. For example, the investment in job cuts is assessed by comparing the performance of employees with the expected performance of the machines. On the basis of a comparison of labour costs with amortisation, interest and maintenance costs the appropriate investment is selected. However, this traditional approach is difficult to use for the evaluation of analytical systems, primarily due to a wide range of decisions and actions which may be affected by information from the analytical system (King et al., 1990) and the key role of the user of the system (Hamilton and Chervany, 1981). There distinguish three levels of benefits (Parker et al., 1988): tangible, quasi-tangible and intangible benefits. This classification of quasi-tangible and intangible effects is more visible – allowing a better evaluation of alternative investments into analytical systems.

In general, the problem of information systems evaluation is addressed in many publications outside of agriculture (Kleijnen, 1980, Kleijnen, 1984, Hamilton and Chervany, 1981, Banker and Kauffman, 1989, Kauffman and Weill, 1989) and only a few in the field of agriculture (King et al., 1990, Streeter and Hornbaker, 1993). Based on the available literature, it is possible to identify two main types of research approaches (Fig. 1), (Verstegen et al., 1995): normative and positive approaches.

Normative approaches provide a theoretical examination of the expected or desired profitability of the analytical systems on the basis of the net revenues from their functions (e.g. better decisions on labour savings) and on some predetermined decision-making criteria (Kleijnen, 1980). Normative approaches are further distinguished in decision-making based on theoretical approaches (analysis of the decision-making trees, Bayesian information economics, theory of control) and decision making based on the analytical approaches (simulation, linear programming and dynamic programming).

Positive approaches investigate the expected profitability through empirical studies. Examples are experimental, quasi-experimental, and non-experimental designs. In the context of the experimental design group it is possible to distinguish between the field experiments and experimental economics.



Source: Verstegen et al., 1995

Figure 1: A classification of evaluation approaches.

Normative approaches are currently considered as limited due to their potential in practice. On the contrary, positive approaches depends greatly on the availability and quality of the data base and the type of analytical intent. Experimental economics is considered to be an interesting alternative as means of streamlining decision making in the highly controllable environment. All of these approaches must be reviewed in the context of analytical systems in agriculture.

The purpose of this paper is to present a research process aimed to create a conceptual framework for the identification of the economic value of analytical systems for agricultural entities.

Materials and methods

Relevant publications were identified after searching scientific databases: Web Of Science, Scopus, ScienceDirect and SpringerLink. Screening of titles, abstracts and conclusions was performed independently by all co-authors. Studies defining the problems of evaluation of information systems investments were requested in order to be included in the review. Studies linked with the issue of evaluation of investment in specific types of systems, applications, and technologies in the agriculture (e.g. geographic information system, specialized automated systems, etc.) were rejected from the review. Mainly the following search terms were used: analytical systems, investments in information systems including the field of agriculture, economic value of information systems, economics of information systems and Business Intelligence.

Results and discussion

Based on the review of the relevant and existing research in the area of evaluation of investment in analytical systems in agriculture, the following shortcomings of the current situation were identified.

Identification of the shortcomings of the current state

- No comprehensive survey evaluating the state of analytical systems in the field of agriculture has been processed yet.
- There is a considerable amount of issues accompanying the operation of analytical systems activities on a highly skilled level.
- The economic potential of analytical systems and their contribution to agriculture has not been described yet
- No attention has been paid to the research in the area of the conceptual framework for the economic evaluation of analytical systems.
- With the development of computer and information literacy of the managerial staff in the agricultural enterprises, greater acceptance of new analytical systems can be expected in the future, which requires the analysis and reflection of new ways of working with analytical data in the agricultural sector

In this paper, a new research procedure is proposed to cope with these problems. It specifies the individual methodological phases of this research issue:

1. *Analysis of the analytical systems state in agriculture*. A questionnaire survey among the agricultural enterprises and small farmers should be performed at this stage. After the survey, a basic exploratory analysis of survey results must be carried out to verify the dependencies by using the Pearson and M-V Chi-square test, which will be used to verify the connection between the structure of the company and the use of analytical systems. The working and statistical hypotheses must be formulated. The analysis will follow the previous research (Tyrychtr et al., 2015), which was focused only on a narrow type of analytical systems – Business Intelligence.
2. *Identification of performance indicators.* At this stage, it is necessary to analyse the capabilities of analytical systems in various sectors of agriculture. The economic and performance indicators of analytical systems are identified, including the expert and knowledge based subsystems.
3. *Classification of evaluation approaches.* In this phase, the evaluation approaches to determine the economic value of analytical systems for decision support in agricultural enterprises are classified. The methods of information systems evaluation are applied (Banker and Kauffman, 1989, Hamilton and Chervany, 1981, Kauffman and Weill, 1989, Kleijnen, 1980, Kleijnen, 1984), including methods focused on applications in agriculture (King et al., 1990, Streeter and Hornbaker, 1993). Two main types of research approaches will be applied in this research: normative and positive approaches. Normative approaches provide a theoretical examination of the expected or desired profitability of the analytical systems on the basis of the net revenues from their functions and on some predetermined decision-making criteria (Kleijnen, 1980). Normative approaches are further distinguished in decision-making based on theoretical approaches (analysis of the decision-making trees, Bayesian information economics, theory of control) and decision making based on the analytical approaches (simulation, linear programming and dynamic programming). Positive approaches investigate the expected profitability through empirical studies. Examples are experimental, quasi-experimental, and non-experimental designs. All of these proposals must be examined in the research
4. *Application of analytical systems.* A draft of the possible applications of analytical systems including expert and knowledge based subsystems is proposed and the benefits of such systems for agricultural enterprises are defined. Within this phase, specific scientific methods (simulation, mathematical methods) and modelling techniques (multidimensional databases, knowledge and process modelling) are used.
5. *Design of a conceptual framework.* The above phases and their synthesis allow the design of a new conceptual framework for the economic evaluation of analytical systems in agriculture.
6. *Acceptance.* The objective of this phase is the systematic experimentation with the design process of a new conceptual framework.
7. *Application.* The newly created and adopted conceptual framework is validated in real standardized agricultural enterprises and farms.
8. *Approval.* This dynamic phase takes place together with the application phase. The goal of this phase is the maintenance of the new conceptual framework in order to adapt it in the constantly changing environment of the various analytical systems.
9. *Research evaluation.* The benefits of the newly proposed conceptual framework are evaluated on the basis of the outputs of the research plan.

To comply with the above procedure, it is appropriate to diversify and to specify the stages of the research. The following Table 1 shows the stages in accordance with the project management of research.

The expected benefits of the proposed research procedure

The design of a new conceptual framework for the economic evaluation of analytical systems allows enhancing the efficiency of agricultural enterprises. The resulting conceptual framework will streamline the decision-making of agricultural enterprises in the area of investments in analytical systems.

Title	Description
Literature review	Collection of the underlying data for the analysis, the study of scientific articles and professional publications, formulation of hypotheses.
Preparation of the survey and data base	Preparation of the data base for the analysis of the evaluation of the analytical systems economic value and the preparation of the questionnaire survey for agricultural managers.
Analysis and evaluation of data	Cleaning, sorting and statistical evaluation of the data from the questionnaire survey of the state of analysis systems in agriculture.
Classification and analysis of evaluation approaches	Classification and analysis of the strengths and weaknesses of the evaluation approaches for determining the economic value of analytical systems.
Dissemination of preliminary results	Publication of articles about the state of analytical systems in agriculture and their economic evaluation. Presentations at conferences.
Evaluation of analytical systems	Evaluation of analytical systems, including expert and knowledge based subsystems and their benefits to agricultural entities.
Design of conceptual framework	Design of a new conceptual framework and its evaluation.
Dissemination of results	Publication of articles, active participation in conferences and seminars.

Source: self-authored

Table 1: Suggested research stages.

The main benefits of the proposed research are the following:

- The project will evaluate the state of analytical systems in the field of agriculture.
- The evaluation approaches, possible analytical systems applications in agriculture and their economic potential and contribution to agricultural enterprises will be classified.
- A new innovative conceptual framework for the economic evaluation of analytical systems in agriculture will be designed.
- • The research plan will efficiently and effectively support the business activities at the level of the strategic management of agricultural enterprises in relation to the economic aspects of analytical systems.

On the basis of the above mentioned benefits of the proposed research procedure, agricultural subjects will be able to invest in economically beneficial analytical systems which will enable obtaining of analytical data through special outputs in a more efficient way. For example, to track information about total production, costs or consumption over time for the whole enterprise or its part, perform different types of analysis (factor – factor, breeding optimisation, the analysis of the efficiency of plant protection products, etc.) and create additional special analytical outputs which provide additional economic benefits.

The newly created concepts in economic evaluation of analytical systems are supposed to provide methodological support for a better design of agricultural analytical systems, agricultural expert systems and knowledge based systems and to contribute to the overall efficiency of agricultural enterprises and the entire agricultural sector of the Czech Republic.

Conclusion

In this paper, a new research procedure for the design of a conceptual framework for analytical systems' economic evaluation in agriculture was proposed. There was used theoretical and research background to map the current state of evaluation approaches regarding analytical systems in agriculture, and to elicit future research avenues in terms of design science framework for economic value of analytical systems in agriculture. According to the performed literature review and previous research, the area of analytical systems in the field of agriculture appears as a prospective research subject.

Purposes of this paper was threefold: the literature review may help economical informatics researchers get an overview of this active research domain; proposal of research facilitates the understanding of different research streams; finally, the proposed future topics may guide researchers in identifying promising research avenues.

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