Czech University of Life Sciences Prague

Faculty of Economics and Management

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Bachelor Thesis

Statistical analysis of selected indicators of farm economy

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BACHELOR THESIS ASSIGNMENT

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Economics and Management

Thesis title

Statistical analysis of selected indicators of farm economy

Objectives of thesis

The main objective of this thesis is the evaluation of selected economic indicators of farms represented in the Czech Republic and its influence on agricultural economy. The purpose of theoretical part is to discover agricultural payments in the Czech Republic and to identify important terms and definitions. Practical part will be represented by statistical analysis of important economic indicators to evaluate impact of subsidies on farms prodcution and other measures.

Methodology

Theoretical part of the thesis is represented by observation data about Common Agricultural Policy, Rural Development Programme and subsidies. The practical part of the thesis is focused on statistical analysis of certain economic indicators using time series. To achieve the main goal of the thesis and deeply understand the influence of agricultural payments in the Czech Republic, there will be a regression and correlation analyses. The data used in theoretical and practical part is from the Czech version of Farm Accountancy Data Network(FADN), annual reports from Ministry of Agriculture of the Czech Republic (Zelená zprava) and some publications from Czech Statistical Office.

The proposed extent of the thesis

30 – 40 pages

Keywords

Subsidies, agriculture, farm economy, Common Agricultural Policy, statistical analysis

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Recommended information sources

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Declaration

I declare that I have worked on my bachelor thesis titled "Statistical analysis of selected indicators of farm economy" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 15th March 2018 _____

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Statistical analysis of selected indicators of farm economy

Summary

This bachelor thesis is devoted to evaluation of selected economic indicators and the influence of subsidies on farm economy in the Czech Republic with comparison of payments in regions with different characteristics. This thesis is divided into two parts. First part of thesis, which is considered to be theoretical, is devoted to review of the Common Agricultural Policy, agricultural payments and rural development programs represented in the Czech Republic. Second part of thesis, which is analytical part, represents the evaluation of trend functions for subsidies and regression analysis of economic indicators by using statistical methods. The data used for practical part is taken from the Czech version of Farm Accountancy Data Network (FADN).

Keywords: subsidies, agriculture, farm economy, Common Agricultural Policy, statistical analysis

Statistická analýza vybraných ukazatelů zemědělské ekonomiky

Souhrn

Tato bakalářská práce je věnována hodnocení vybraných ekonomických ukazatelů a vlivu dotací na zemědělskou ekonomiku v ČR s porovnáním plateb v regionech s různými charakteristikami. Tato práce je rozdělena do dvou částí. První část teze, která je považována za teoretickou, je věnována přezkumu společné zemědělské politiky, zemědělských plateb a programů rozvoje venkova zastoupených v České republice. Druhá část práce, která je analytickou částí, představuje hodnocení trendových funkcí pro subvence a regresní analýzu ekonomických ukazatelů pomocí statistických metod. Údaje použité pro praktickou část jsou převzaty z české verze zemědělské účetní datové sítě (FADN).

Klíčová slova: dotace, zemědělství, zemědělská ekonomika, společná zemědělská politika

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List of abbreviations

AWU	Annual Work Unit
AEC	Agri-environmental and climate measures
ANC	Area with Natural Constraints
CAP	Common Agricultural Policy
CSO	Czech Statistical Office
CZK	Czech Koruna
EAFRD	European Agricultural Fund for Rural Development
EAGF	European Agricultural Guarantee Fund
EAGGF	European Agricultural Guidance and Guarantee Fund for Agriculture
EC	European Commission
EFA	Ecological Focus Area
EU	European Union
FADN	Farm Accountancy Data Network
GATT	General Agreement on Tariffs and Trade
IAEI	Institute of Agricultural Economics and Information
LFA	Less Favoured Area
LPIS	Land Parcel Identification System
NAIF	National Agricultural Intervention Fund
OLS	Ordinary Least Squares
RDP	Rural Development Progarmme
SAPS	Single Area Payment Scheme
VCS	Vol untary Coupled Support
VIF	Variance Inflation Factor
WTO	World Trade Organization
WWII	World War II

1. Introduction

Agriculture is a vital part of any economy aimed to provide population with a food and obtain raw materials for industries. Agrarian sector represents total performance of the country, where farming is possible due to natural conditions. Moreover, the development of agricultural holdings influences the balance of the country's economy and its food independence.

The members of the European Union have always been held leading positions in the agricultural production. Therefore, the Czech Republic is not the exception. Czech agrarian sector is fast-growing area, which is developed and supported by the government of the Czech Republic. Nevertheless, farmers always need an additional assistance in the form of subsidies to increase profit of the holdings and make farms more productive, releasing more output each year. Otherwise, farm owners will experience financial scarcity, which might negatively affect the economy of the country in the future.

After the accession of the Czech Republic to European Union in 2004, the Czech agrarian policy expected significant changes and standardization to the general European approach in agriculture – Common Agricultural Policy, accounting for 39% of total EU budget in 2015. (European Commission, 2016) The CAP leaded to some certain requirements to the farmer, in the return for this they could receive financial support from European government. Nowadays, besides the assistance of EU under the CAP, other agricultural funds, development and grant programmes (ex. Rural Development Programme) have been appeared, promoting a favorable economic support in the Czech region. (NAIF, 2016)

This thesis "Statistical analysis of selected indicators of farm economy" is divided into two parts: theoretical and analytical. In the first part, author focuses on the Common Agricultural Policy and its role in the Czech agrarian sector; describes mechanisms of current farm subsidies in the Czech Republic and makes an overview of rural development programmes. The second part is devoted to estimation of trend function for subsidies and evaluation of selected economic indicators, collected from FADN, in two areas with different natural conditions (non – LFA and mountain areas).

2. Objectives and methodology

2.1. Objectives

The main objective of this thesis is to identify the influence of selected subsidies on farm economy in the Czech Republic with comparison of payments in areas with different characteristics of agricultural land. Moreover, this thesis is also aimed to confirm hypothesis that agricultural subsidies perform different functions in farm economy. The purpose of theoretical part is to discover principles and mechanisms of the Common Agricultural Policy and structures of current agricultural payment schemes in the Czech Republic within the framework of the CAP. Theoretical part also includes principles of agricultural policy before the accession of the Czech Republic to the European union. Practical part is devoted to evaluation of trend functions for subsidies and statistical analysis of selected economic indicators to identify the impact of agricultural payments on farm's income. The data used in theoretical and practical part is from the Czech version of Farm Accountancy Data Network **(**FADN), annual reports from Ministry of Agriculture of the Czech Republic (Zelená zprava) and Czech Statistical Office.

2.2. Methodology

Theoretical part of the thesis is represented by observation data about Common Agricultural Policy, Rural Development Programme and subsidies received from various sources such as books, journals and internet sources. The practical part of the thesis consists of comparison of trend function for subsidies. To achieve the main goal of the thesis and deeply understand the influence of agricultural payments in the Czech Republic, there will be a regression analysis of selected economic indicators using time series. In regression analysis, we also are going to check assumptions of regression model. Data for practical part was collected form the Czech version of FADN.

2.2.1. FADN

Farm Accountancy Data Network (FADN) is a specialized instrument for estimating the income of agricultural farms in EU. It also serves as a supporting tool of the CAP, showing "real" economic situation of agricultural holdings. FADN was introduced in 1965, when European Economic Commission (EEC) established a legal framework with Council

Regulation 79/65/EEC for this organization. In the Czech Republic, FADN began its activity in 1994, when the Institution of Agricultural Economics and Information (IAEI) organized research of agricultural performance using selective surveys. After that, in 2003 the Ministry of Agriculture of the Czech Republic issued a resolution to introduce the official department of FADN in the Czech region. FADN publications represents the most important economic indicators of survey published by EU institutions in the form of Standard Output of EU FADN. Final reports and results of research are publishing every year. From a statistical approach, reported values can be recognized as average values. For comparing data, values are shown in the form of relative indicators, converted to 1 hectare of agricultural land. Also, the data doesn't contain holdings without agricultural land. (Selection survey of economic results of farms in the FADN CZ, 2015)

Table 1: Methods of calculating the basic economics indicators

<table>
<tr><td colspan="3">Total output</td><td rowspan="2">Balance current subsidies and taxes</td></tr>
<tr><td>Output crops and crop products</td><td>Output livestock and livestock products</td><td>Other output</td></tr>
<tr><td colspan="2">Intermediate consumption</td><td colspan="2" rowspan="2">Gross farm income</td></tr>
<tr><td>Specific costs</td><td>Farming overheads</td></tr>
<tr><td></td><td>Depreciation</td><td colspan="2">Farm net value added</td><td>Balance subsidies and taxes on investment</td></tr>
<tr><td colspan="2"></td><td colspan="2">External factors</td><td rowspan="2">Family farm income</td></tr>
<tr><td colspan="2"></td><td>Wages</td><td>Rent paid</td><td>Interests</td></tr>
</table>

Source: FADN

Standard distribution of FADN sample exists according to type of farming (field crops, milk, grazing livestock, mixed, granivorous), production region (corn growing region, beet growing region, potato growing region, potato-oat growing region, mountain growing region), economic size (small, medium, large, very, large) and less-favoured areas (not in LFA, in not mountain area, mountain area).

2.2.2. Time series and linear trend

Time series are dataset collected from the past to present and cover a certain period. In time series one unit is measured during the period, which can be represented annually, quarterly, monthly, weekly, daily, etc. (Bubáková, 2014) The main components of time series are linear trend, cycle and seasonality. Linear trend can be defined as systematic tendency for time series to increase or decrease. Trends may change over time with varies in magnitude and direction thus we try to express tendencies of latest data to predict future changes in time series. (Becketti, 2013) Linear trend line equation:

$$\boldsymbol{y = mx + b},$$

where y is *dependent variable*, x is *independent variable*, m is a *slope of trend line*, b is constant, which equals to y value, when x is equals to 0.

When modelling a trend function, we use an estimation technique called Ordinary Least Squares method, which is represented by minimizing the sum of squared residuals:

Formula 1: Sum of squared residuals

$$\sum_{i=1}^{n} \left(Y_i - \hat{Y}_i\right)^2 = \sum_{i=1}^{n} (\hat{\varepsilon_i})^2$$

where Y_i is observed value, $\hat{Y}$ is predicted value, $\hat{\varepsilon_i}$ is estimated error

2.2.3. Regression analysis

Regression analysis is a statistical technique used for analyzing multifactor data, recognizing functional relationships between variables. In regression, there is always a dependent variable, which varies according to the changes in independent variable. In other words, changes in values of variables are explained by changes in other variables. (Bubáková, 2014) Linear regression model, which we will use in our analysis, can be expressed as:

Formula 2: Function of multiple variables

$$\boldsymbol{y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p + \varepsilon} \quad ,$$

where y is *dependent* or *explained* variable, $\beta_0, \beta_1, \ldots, \beta_p$ are *regression parameters*, $x_1, x_2, \ldots, x_p$ are *independent* or *explanatory* variables, ε is *a random error*

In regression, the standard steps are to collect data, fit a model and then evaluate goodness of fit by using statistical methods such as t – Test, F test and coefficient of determination.

(Chatterjee, Hadi, 2006) We will also use regression assumptions, which will help us to determine the significance of model: normality test (identifies whether residuals are normally distributed or not), homoscedasticity (explains the size of error term differs from values of explanatory variable), multicollinearity (condition of high correlation among regressors), autocollinearity (correlation between residuals). All statistical calculations have been carried out in SAS Enterprise Guide application.

2.2.4. Correaltion analysis

Correlation analysis is a statistical method used for identifying relationship and its strength between two continuous variables, represented by numbers. The possible association between two indicators is measured by finding correlation coefficient. If there is a correlation found, it means that two variables are dependent on each other. Correlation can be positive or negative:

- Positive – both variables increase
- Negative– one variable decreases, while another increase

Pearson product-moment correlation coefficient (PPMCC) measures this relationship and it ranges from -1 to +1, where -1 is *strong negative correlation* and +1 is *strong positive correlation.*

Formula 3: Pearson product-moment correlation coefficient for sample

$$r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2}},$$

where n is *sample size*, x_i and y_i are *the samples with index i*, $\bar{x}$ and $\bar{y}$ are the *sample mean*

Formula 4: Pearson product-moment correlation coefficient for population

$$\rho_{x,y} = \frac{\mathrm{E}[(x-\mu_x)(y-\mu_y)]}{\sigma_x\sigma_y},$$

where E is *expectation*, x and y are *random variables*, μ_x is the *mean* of x, σ_x is *standard deviation* of x, σ_y is *standard deviation* of y

Usually, if:

- r<0,3, it means that there is *low* dependency between variables
- 0,3<r<0,7, it means that there is *medium* dependency between variables
- r>0,7, it means that there is *high* dependency between variable

3. Theoretical part

3.1. Agricultural policy of the Czech Republic before accession to the European Union (1999-2004)

The agrarian sector of the Czech Republic has undergone through series of dramatic changes in the last decades. After Velvet Revolution in 1989, when communist authorities were overthrown, and Czechoslovakia was divided into two different states, the need for a new agrarian policy has grown since the Czech Republic lost the volume of production, existed before the revolution. Moreover, in the new country with a decrease of population also experienced significant reduction of labor force in agriculture. According to the Czech statistical office, in 1990 the number of employees in agrarian sector was around 540 thousand people, while in 2000 this number has fallen by almost 5 times and represented by 115 thousand of workers. (Vaněk, Nová, 2002)

Overall, there was a decrease of competitiveness of the Czech agriculture since 1991 with growing indebtedness of agricultural holdings (in seven years loss of production exceeded 40 billion CZK). (Brabenec, Šařecová, 1999) The price instability of primary agricultural products, low protection of agrarian market, low support of export of agriculture, continuous changes of legislation, the lack of budget financing and disadvantageous position within the framework of WTO leaded to unfavorable situation in the Czech agrarian sector, what motivated the Czech government to introduce the new concepts of agriculture.

When the European Union decided to include the Czech Republic to the group of European countries who will be admitted to the union after 2003, the Ministry of Agriculture of the Czech Republic released a document "The concept of agrarian policy for the period before the accession of the Czech Republic to the European Union", which was prepared in May 1999. The main goals of this concept were to stabilize the business environment for entrepreneurs in agriculture by adopting it to the conditions of the EU, to achieve the competitiveness of agriculture among the world and provide information to the EU about national interests of agrarian sector. (Ministry of Agriculture of the Czech Republic, 2002). This document defines the strategic intentions and national interests for the development of the Czech agrarian sector, assuming two basic stages: *revitalization* and *adaptation*. The first phase had to focus on economic rehabilitation of agrarian sector, while second should result in a substantial turnaround in the efficiency of production. (Brabenec, Šařecová, 1999)

3.1.1. Revitalization stage (1999-2001)

The first stage, which is called revitalization, was introduced by Ministry of Agriculture of the Czech Republic in 1999 and continued its activity before 2001. Revitalization concept was focused on the recovery and stabilization of the Czech agrarian sector and institutional preparation to the accession to the EU. The most result of agriculture during this stage was the achievement of positive economic performance of agrarian sector. (Ministry of Agriculture of the Czech Republic, 2002).

The main objectives of the first stage were to solve some internal development issues of the Czech agriculture, eliminate the most serious obstacles to development in the current reform process and stabilize the sector in common before adapting it to the EU conditions. At the same time, this stage included institutional development of the sector according to the National Programme for adoption in the agriculture sector, which provides preparation, verification and implementation to the Common Agricultural Policy. For this purpose, the National Agricultural Intervention Fund was established by Ministry of agriculture at the early stage of the revitalization phase. (Ministry of Agriculture of the Czech Republic, 2002).

In the revitalization, the main elements of market organization under the EU rules was gradually replacing the market regulation system, existed at that time. This approach facilitates and accelerates the adaptation processes in the next stage. Simultaneously, aid under Government Decree providing for support programmes of 1999 was focused on non-productive functions of agriculture, activities contributing to preservation of landscape and less-favoured areas. (Ministry of Agriculture of the Czech Republic, 2002)

The main tools of revitalization were described in the pillars of agricultural policy.

1. Pillar A (Market Regulation and Income Support) - gradual introduction of the organization of the main commodity market, an improvement of agri-trade conditions and the increase of direct payments to farms.
2. Pillar B (Environmental Measures) – supporting arable lands.
3. Pillar C (Modernization and transformation of agricultural enterprises) - modernization and diversification of agricultural and food holdings, completion of privatization and development of market structure.
4. Pillar D (Preparation for the EU accession) - building institutions according to EU requirement and increasing support for common services for farms. (Ministry of Agriculture of the Czech Republic, 2002)

3.1.2. Adaptation stage (2001-2004)

The primary function of adaptation concept during the period from 2001 to 2004 were preparation of farmers and agricultural entrepreneurs of the agrarian sector of the Czech Republic for the conditions of European market, an efficient use of structural funds and other European resources for agricultural, rural and environmental development. In the adaptation phase, market organization for the major commodities was implemented in comprehensive way, including compensations and bonuses, as well as support for less-favoured areas and environmental aids. The adaptation stage was considered as a phase, approaching to instruments, operating in the EU. (Ministry of Agriculture of the Czech Republic, 2002).

The main objectives of adaptation were:

- to achieve the competitiveness of agrarian sector in the Czech Republic by improving the efficiency of production
- to ensure a sufficient level of return on capital in agricultural holdings and increase income of farmers
- to create conditions for providing acceptable food price for consumers with qualitative indicators, which can be comparable to European standards
- to provide environmental methods for agriculture, especially in areas with unfavorable conditions, to integrate agriculture with rural development and preserve cultural heritage
- to establish alternative opportunities for employment in agrarian sector by diversifying farming activities (Ministry of Agriculture of the Czech Republic, 2002)

As well as the previous stage, adaptation concept was divided into pillars:

1. Pillar A (Market Regulation and Income Support) – financial aid for farms in the market and for farms in less-favored areas
2. Pillar B (Environmental Measures) - social order and payment of public goods provided by agriculture in the field of environment and rural development
3. Pillar C (Modernization and transformation of agricultural enterprises) - modernization of agricultural enterprises, diversification of agricultural activities and development of market structure
4. Pillar D (Preparation for the EU accession) - providing general services for farms and completing the institutional structure of the agrarian sector in line with EU requirements (Ministry of Agriculture of the Czech Republic, 2002)

3.2. Czech Republic and the European Union

From 1st of May 2004 the Czech Republic became a member of the EU. After the accession, the EU created a foundation of the modern history of Czech agriculture. The basic conditions of Czech agriculture as a part of European agrarian policy were based on agreement between the CR and the EU, adopted in the summit in 2003. The Czech government has developed the concept of agrarian policy in the Czech Republic, which was divided into 4 parts. The first part, which was called "Formulating the basic strategy – the vision of the Czech agriculture" contained global problems, which might affect the agrarian sector. The second part "Agricultural policy of the Czech Republic in the EU" focused on the structure of direct and other support for farmers. "The concept of agricultural policy of the Czech Republic after the accession to the EU", which was the third part, formulated characteristics of own agricultural policy in the Czech Republic in 2004-2013 period. The last part was called "Expected impacts of the concept of agricultural policy after the EU accession on economy of the Czech Republic and structure of the Czech agrarian sector" and was represented by description of possible scenarios of the Czech agriculture in the future. Therefore, the strategy of the new concepts reacts to global problems, issues within the EU and the Czech Republic, focusing on rural development. (Fojtíková, 2009)

This concept defines 3 main stages, in which important reforms took place. During the first "Entry stage" (2004-2006), Singe Area Payment Scheme (SAPS) was applied in the Czech Republic as a simplified type of direct payments. Moreover, there were two structural programmes implemented in the Czech agrarian sector – Horizontal Rural Development Programme (HRDP) and Operational Programme, which were aimed to develop rural areas. The second stage "Adaptation"[1] was in the period from 2007 to 2010 and represented by transformation of SAPS payments, which are based on regional implementation, with the option of applying conditions related to cross-compliance and voluntary advisory systems for farmers. Furthermore, within the framework the first Rural Development Programme 2007-2013, which the European Commission confirmed in June 2007, the Czech Republic received more than 3.5 billion euro during this period, from which 2.8 billion are granted by the EU (80% of subsidies) and the rest is from national sources of the Czech Republic. At the stage of settlement (2011 – 2013), the Czech agricultural policy within the framework of

[1] This stage is not connected to the concept of the agricultural policy in the Czech Republic before the accession to the EU

the concept fully obeyed the reforms of the CAP and the structure of single payments scheme applied as in the previous period, but with the condition of implementation of cross-compliance and modulation support. (Fojtíková, 2009)

Overall, the Czech agrarian sector is experiencing a breakthrough since the accession of the Czech Republic to the EU. This leaded to free market relations with the European Union, on the other hand, competition from other EU member states has developed. Concerning the economic results of the agriculture, it shows positive aspects in recent years. For the period from 2001 to 2015, the profit from agriculture varied around 17 billion CZK per year, except the year 2014, when the income from Czech agriculture peaked around 23.3 billion CZK. (businessinfo.cz, 2016)

The farm's income is increasing thanks to subsidies, provided by the EU. The main criteria for receiving financial aids, which are affected by changes in the structure of agrarian sector, were adapted to the behavior of agricultural farms in recent years. Subsidies improve the economic situation in agriculture and increase farm's income. Another effect of subsidy is decreasing of pressure on production process, which leads to significant increase in effectiveness and volume of output. Finally, increase in payments to farmers moves a technological progress in agriculture, modernizing old equipment to advanced. (businessinfo.cz, 2016)

The new concept also influenced the production. This is explained by profitability of the agricultural output, which is affected by prices for producers and high competition.

Table 2: Changes in production of the Czech agriculture after accession to the EU

	Before accession to the EU (average of 2001-2003)	2015	Change
Total cereals (th. ha)	1547,1	1403,4	-9,3%
Wheat (th. ha)	808,1	829,8	2,7%
Barley (th. ha)	512,0	365,9	-28,5%
Maize (th. ha)	67,6	93,6	38,5%
Potato (th. ha)	42,8	22,7	-47,0%
Rape oil (th. ha)	302,7	366,2	21,0%
Sugar beet (th. ha)	77,6	57,6	-25,8%
Vegetables (th. ha)	20,4	9,2	-54,9%
Fruits (th. ha)	17,9	15,6	-12,6%
Pigs (th.heads)	3465,8	1559,6	-55,0%
Livestock (th.heads)	1525,3	1407,1	-7,77%
Poultry (th.heads)	29,6	22,5	-24,0%

Source: businessinfo.cz

3.3. Common Agricultural Policy

3.3.1. Preconditions for establishment of the Common agricultural policy

In the middle of the 20th century, agrarian sector of the EU experienced difficulties related to the aftermath of WWII. Countries in Europe were still unable to provide agricultural production thus there was a need in common effective mechanism for controlling and regulating food supply for European population.

Initially, the suggestion to establish the common standards of the agricultural market was made by the European Commission. The main characteristics of the CAP were already defined in the Rome Treaty of 1957 (Part 3, Title II, Articles 32 to 38). At the beginning, six countries: Germany, France, Italy and Benelux union (Belgium, the Netherlands, Luxeemburg), who were the initiators of this idea, individually defended their agricultural sectors and couldn't come to some arrangement. After long negotiations, the principles of agricultural policy began to function only since 1968, which had to help to achieve an increase in agricultural production in the postwar period and provide the food sovereignty of the Member State. (Jedlička, 2004)

The main goals in the beginning of CAP were:

- increasing agricultural productivity through technical development and optimal use of factors of production, especially in labor
- ensuring a decent standard of living for population of rural areas by increasing the farmers' income
- stabilization of markets
- regular supply of agricultural products
- ensuring a reasonable price for consumers

Methods and principles of the CAP operation are based on the common agricultural market, supporting common prices and allowing a free trade of agricultural products between Member States. The second principle is that production in the EU countries occurs due to competitiveness, which declines world prices of agricultural output to protect European farmers from import duties. Furthermore, it is based on financial solidarity[2], in which all member states contribute to reimbursement of the CAP costs. (Jedlička, 2004)

[2] Financing from a common fund

3.4. Major changes in the CAP from the late 19th to early 20th centuries

3.4.1. Macsharry reform (1992)

In the beginning of 1990s, there was a need in reforming the CAP due to some outdated methods of policy-making. The CAP encountered with that the policy ceased to perform its initial mission and some financial tools were overloaded. At the same time, there were ongoing multilateral negations about the exemption of strict limitation in world trade conducted between 1986 and 1994 within Uruguay Round of GATT. (Ministry of Agriculture of the Czech Republic, 2014)

Macsharry reform leaded to obligations of reducing subsidies that affects price changes and necessity to support income of farmers. New arrangements increased grants related to factors of production and they didn't depend on total output were given directly to producers. The reform was mainly directed to two sectors of production – cereal growing and beef production, where costs were the highest. Therefore, when implementing new policy instruments, the importance of price support took a back and the area of cultivated land was limited, however the decrease in farmers' incomes was compensated by direct payments. (Jedlička, 2004)

3.4.2. Agenda 2000 (1997)

Despite the positive aspects of MacSharry reform in 1992, expenditure under the CAP was still around 40 billion euro, which have been resulting in proposal to adopt a comprehensive Agenda 2000 by the European commission. This reform was focused on issues, which the European Union might encounter in the 21st century. Agenda 2000 also made a wager for the importance of rural development. (Ministry of Agriculture of the Czech Republic, 2014)

The reform was divided into 3 parts. The first part discussed about internal mechanisms of the CAP. It also contained recommendations about the creation of financial budget for 2000-2006. The second part was represented by proposals of enhanced pre-accession strategy, including accession partnership and extended participation of candidate countries in common programs such as the CAP. The third part was directed to the study of impact of enlargement on the EU policies. These parts were supported by twenty legislative proposals of the European Commission in 1998 and all legislative acts were adopted by the European Council in Berlin in 1999. (Jedlička, 2004)

3.4.3. Mid-term Review (2003)

Continuing the problem of competition of European farms on market, the CAP was subjected to reform in 2003. The main aim of mid-term review was not only to improve the competitiveness within the EU, but also outside of the union by granting subsidies for producers, at the same time complying with quality of products and environmental protection. Thanks to this reform, agricultural entrepreneurs could focus on decision-making, based on market targets and consumer's needs instead of producing goods that are unnecessary for the market. (Ministry of Agriculture of the Czech Republic, 2014)

This reform was focused on the following sections:

- Decoupling – introduction of the principle that farmer receives single payment instead of multiple payments (i.e. payments, which have no relation to the real agricultural production)
- Cross – compliance - supporting standards at the farm level, based on statutory requirements of doing agricultural activity such as animal health, environmental protection etc.
- Modulation – direct support to farmers within the framework of Rural Development
- Degressivity – applies only to farms with payments more than €5000. Farms with payments below €5000 are exempted from this measure
- Rural Development – support of rural regions, predominantly improving the quality of food, increasing the welfare of farmers and introducing modern technologies for agrarian sector. Moreover, since the Mid-term review of 2003, support for young farmers, small and large agricultural holdings have been carried out in the framework of Rural development.
- Advisory support - common standards for agricultural activity has been introduced together with advisory support, assisting producers in applying agricultural environment, food quality and animal health, i.e. cross-compliance standards
- The separation of European Agricultural Guidance and Guarantee Fund (EAGGF) into two independent institutions: European Agricultural Guarantee Fund (EAGF) – focuses on financing of direct payments and European Agricultural Fund for Rural Development – focuses on funding of rural development of the EU

(Ministry of Agriculture of the Czech Republic, 2014)

3.4.4. Health Check (2008)

Following changes of the CAP have affected in 2008 when European commission issued Health Check reform, which brought additional measures for farmers. This reform did not introduce any significant changes; however, it improved some methods of response to market changes, which facilitated of managing agricultural activity for farmers. In the framework of Health Check, the following agreements have been reached:

- mandatory rate of modulation was set at 10% from 2013
- a complete exclusion of farms with payments from €100000 to €300000 from progressive modulation
- additional progressive modulation for agricultural holding with payments more than €300000 accounted for 4%
- financial rate of modulation funded by the European Union – contribution of the EU 75% at base rate; contribution of the EU 90% in convergence throughout a region (i.e. the whole Czech Republic outside of Prague)
- increased support for sensitive areas in agriculture - comprehensive payments for selected sensitive areas were established at the level up to 3.5%
- financing of Rural Development Programme from additionally modulated resources – these measures are related to adaptation of a climate changes, renewable resources, water management, biodiversity and innovative approaches.

(Ministry of Agriculture of the Czech Republic, 2014)

3.4.5. The CAP after 2013

First call for following reform was introduced in 2011, when European commission presented a legislative set of documents contained proposals for following annual financial framework of the CAP, including open-ended questions about direct payments, structure of market, rural development and horizontal issues. These suggestions were based on continued debates about the future of the CAP. (European Commission, 2009)

After lengthy discussions, the Council, the European Commission and the Parliament were able to agree and reach a compromise. The substantive session of the European Parliament, which was held from 18th to 21st of November 2013, officially adopted financial framework of the CAP for 2014-2020. (Ministry of Agriculture of the Czech Republic, 2014)

3.5. The CAP in the Czech Agriculture

The Czech Republic is a country located in central Europe with an area of 78867 km^2, where about 54 of land is considered to be agricultural. By the year 2016, the total population of the Czech Republic was 10.5 million, where about 2.2 million of people (21% of the entire population) live in predominantly rural regions. Nowadays number of agricultural holdings has halved since 2003 and the agrarian sector mainly consists of large-size farms, where 17.6% of holdings have more than 100 hectares (compared to 2.7% of average in the other EU countries). The Czech Republic shows dynamic increase of value of production/holding with 14.3% of growth per year (by contrast, EU-15 has 3.5% of growth). (European Commission, 2016)

In the period of 2007-2013, the EU funded around 6,5 billion euro in the Czech agrarian sector aimed to support farmers' income, enhance the conditions of Czech agricultural holdings and provide high-quality food for population. In the coming years (until 2020), the European funds within the framework of the CAP will grant more than 8 billion euro to Czech farms and rural sectors. In addition, the Czech government is willing to adapt direct payments and programs for rural development to country's specification. Referring to direct payment, they have always been the key element for the enhancement of agricultural farms. In 2014, more than 28000 farmers and agricultural holdings of the Czech Republic were granted around 880 million euro in total of direct subsidies. Concerning market-related measures, in the same year the EU invested about 15 million euro in important sectors of agricultural production: fruit, vegetable and wine productions. Thanks to imposition of national resources in agrarian sector, implementation of environmental measures and rural development, the Czech agriculture was able to upgrade and improve the agricultural performance of 1500 farms, to establish employment with 1500 jobs, to attract around 1400 young farmers, with total fund of 76 million euro to invest in more than 750 municipalities for modernization of rural areas. (European Commission, 2016)

For administrating funds of the CAP in the Czech Republic, there was a need in Agrarian payment agency. The Ministry of Agriculture of the Czech Republic solved this problem and now this function is performed by National Agricultural Intervention Fund (NAIF), which is focused on payments of market organizations, intervention measures and grants for export subsidies. In other words, NAIF manages 1st (Direct payments) and 2nd (Rural Development) pillars of the CAP. (European Commission, 2016)

3.6. 1st Pillar - Direct Payments

Direct payments became one of the main financial support after accession of the Czech Republic to the European Union under regulations of Common Agricultural Policy (CAP). At the beginning, they were originally introduced as compensation for the decline price support in the framework of the CAP in 1992. However, direct payments are provided to farmers only since the accession of the Czech Republic to the European Union in 2004 and awarded in the framework of various market organizations (Jedlička, 2016)

Since the appearance of direct payments in the Czech Republic, 24,5 billion was paid in total, from which around 900 thousand CZK were from state budget and the rest was from the EU fund. The last reform in 2013 significantly changed the structure of direct payments in the Czech Republic for the period 2014-2020, providing multicomponent payments for farmers. (NAIF, 2016)

As it has been already said, these payments are provided in the Czech Republic by European funds and controlled by National Agricultural Intervention Fund (NAIF). All certain conditions which farmer must perform in the Czech Republic are described in the Government Regulation for direct payments to farmers № 50/2015. (Ministry of Agriculture of the Czech Republic, 2017)

Types of main direct subsidies represented in the Czech Republic:

- Single Area Payment Scheme (SAPS)
- Green Direct Payment Scheme (Greening) – payments aimed to improve climate quality with basic environmental protection
- Payments for young farmers – payment related to increasing the interest of young people in agrarian industry
- Voluntary Coupled Support – payments for sensitive sectors in agriculture
- National payments – subsidiary element of SAPS

The main principle of granting direct payments to farmers based on the number of hectares cultivated in agricultural land. According to statistics, the average payout of direct subsidies in the Czech Republic is amounted €267 per hectare, which is slightly below the average considering EU countries. The amount of support farmers receive is not bound by agricultural production, however it provides to farmers with sufficient protection from fluctuations in market prices. (European Commission, 2017)

3.6.1. Single Payment Area Scheme(SAPS)

SAPS is one of the most significant agricultural payments, which covers the largest portion with up to 55% of total direct subsidies in the Czech Republic. In 2016, the EU funds granted €455.8 million (at the exchange rate 1€=27.027 CZK, it was 12,181 million CZK). (NAIF, 2016) The purpose of SAPS is to support farmers and provide a stable profit for them. All certain conditions of SAPS are described in the Czech Government Regulation for direct payments to farmers № 50/2015. (Ministry of Agriculture of the Czech Republic, 2017)
The applicant must follow next conditions to receive a SAPS payment according to application (NAIF, 2016):

- minimum area of land must be at least 1 hectare and agriculturally managed
- the applicant must prove the presence of legal relation with agricultural firm, i.e. be an entrepreneur in agricultural sector according to the Act on the agriculture
- the applicant must be in condition of "active farmer"
- the applicant must declare agricultural land he owns and register it in Land Parcel Identification System (LPIS)
- the applicant follows the requirement of cross-compliance during the calendar year
- in the case of permanent grassland, farmer must correct all deficiencies, including a removal of biomass from the grassland by 31th of July (new conditions have been adopted since 2016)
- if the applicant grows cannabis on the area, for which farmer requests a SAPS payment, he must provide a recognition certificate of cannabis plant and the purpose of its growth (NAIF application, 2016)

3.6.2. Greening

In the new programme of the CAP, the structure of direct payments in the EU has significantly changed, focusing on protection of the environment and improvement of climate in agrarian sector. There were some additional agricultural concepts of SAPS issued in the reform of CAP in 2013. One if this concept is called "greening". Nowadays, greening represents 30% of total direct subsidies and included in SAPS as a supplementary payment for farmers. (European, Commission, 2017)

The main objects of greening can be divided into 3 parts: crop diversification, ecological focus areas (EFA), conservation of permanent grasslands.

1. *Crop diversification* includes:
    - expansion of crop range
    - reorientation of sales markets
    - the development of new types of production to improve production efficiency
    - obtain economic benefit
    - prevent bankruptcy

Crop diversification affects farmers, who own arable lands with an area more than 10 ha. Farmers with an area of between 10-30 ha must grow at least two different crops, farmers over 30ha must cultivate at least 3 different crops. The cultivation of main crop must cover not more than 75% of arable land. If farmer grows two main crops, the cultivation must not go beyond 95% of arable area. (European, Commission, 2017)

2. *Ecological Focus Area* – an agricultural area, where landowner implements farming practices directed to enhancement of climate and natural environment. The main objective of EFA is to protect and improve biodiversity on farms.

    There are some features of land specification, which meet EFA requirements:
    - fallow land
    - margins
    - catch crops
    - green cover
    - nitrogen fixing crops
    - hedges
    - agro-forestry (Rural payments and services, 2018)
3. The main requirement for *permanent grasslands* is that proportion of disbanded arable areas must not exceed 5% in total. If the ratio passes 5%, farmers must convert areas of permanent grassland, which were previously converted to other uses. National and regional governments are responsible for maintaining the ratio of these lands to the total agricultural area. Moreover, farmers receive a ban on ploughing in environmentally valuable grasslands. (European, Commission, 2017)

3.6.3. Payments for young farmers

Payments for young farmers is an additional form of SAPS. The main aim of this payment is to provide a young farmer with financial support for initial period of agricultural activity[3]. A farmer must be registered as a person, who performs agricultural activity for less than 24 months in case of young payment scheme application. (NAIF, 2016)

The payment for young farmers is granted for a maximum 90 ha (based on the number of hectares to which the applicant has been granted a SAPS payment) up to five years and can apply for individuals or legal persons. This period is shortened by the number of years that have elapsed since the establishment of the "young farmer" in the first application for payment for young farmers. Applying for young farmer payment scheme, agricultural entrepreneurs must provide the information about fulfillment of all conditions. It's not possible to apply as individual and at the same time be a shareholder of corporation, which also applies for young payments scheme. An individual must obtain next requirements:

- a person who has reached the age of 18 at the time of applying for a grant and is not older than 40 years
- has reached a minimum agricultural qualification or under some conditions take leading positions in the management or administration of agricultural holding/farm

Legal entity (in addition to the fulfillment of the above conditions):

- performs effective and long-term control over an agricultural corporation with respect to management decisions, profits and financial risks in the relevant calendar year for filing an application for payment to young farmers (NAIF application, 2016)

During the start of the process the applicant must carry out activities such as training, purchasing or renting land and animals, including their registration in relevant registers or providing other material components necessary for agricultural practices. The end of this process is signing of grant agreement between the applicant and the NAIF, which is based on the assessment of the submitted business plan and the fulfillment of all entry conditions for young farmer scheme. (Ministry of Agriculture of the Czech Republic, 2015)

In 2016, there were 4259 applications for this payment. The rate was set at 878.64 CZK per hectare. By the end of 2016, 3611 applications from 2015 were paid out in the total amount of 59723 thousand CZK. (NAIF, 2016)

[3] Livestock and crop production

3.6.4. Voluntary Coupled Support (VCS)

Voluntary Coupled Support is an additional element of Single Area Payment Scheme, aimed to support most sensitive sectors of production in agriculture, which face some difficulties in production. For the period of 2014-2020, the government of the Czech Republic decided to allocate funds with 15% of direct subsidies. In the average, this amount represents about 3.46 billion CZK. (Ministry of agriculture of the Czech Republic, 2017)

The main requirements for farmer are:

- minimum area is 1 ha of agricultural land
- be an entrepreneur in agriculture according to § 2e to 2ha of the Act on Agriculture
- an applicant must be in condition of "active farmer"
- the land, an applicant owns, must be declared and registered in LPIS
- farmer must grow a crop or have animals, required for VCS
- farmer complies cross-compliance during the calendar year(NAIF application, 2016)

In 2016, farmers could apply for specific subsidy measures that support sensitive sectors in the Czech Republic: potato used for starch production, potato for consumption, fruit, vegetables, hops, beet, protein crops, meat of calves, cows for production a milk, sheep and goats. (NAIF, 2016)

Table 3: Rates for sensitive sectors in 2017

Sensitive sector	Rate (CZK/unit)
Potato used for starch production	13743.06
Hop	15965.20
Fruits with more handling	12932.59
Fruits	7940.85
Vegetables with more handling	11462.28
Vegetables	4083.80
Potato for consumption	4776.85
Sugar beet	6540.43
Protein crops	2989.64
Calf meat	8560.25
Dairy cow	3597.20
Sheep and goats	3402.87

Source: Ministry of Agriculture of the Czech Republic (2017)

3.6.5. National payments

Another complementary element of Single Area Payment Scheme (SAPS) is National payment or Top-up subsidies, which are fully covered by the Czech government. The role of national aids goes beyond elementary payment scheme, allowing to increase the level of direct support. All conditions of national payments are prescribed in Government Act №112/2008. (zakonyprolidi.cz, 2008) The main requirements of Top-up payments for farmers are the same as for SAPS and submitted together with single application, usually by 15 May of the relevant calendar year with NAIF. In the case, where applicant is not granted to the SAPS payment in current year, he doesn't receive a top-up payment. (Ministry of agriculture of the Czech Republic, 2013)

By the end 2016, 1 application from 2009 was paid out in the aggregate amount of 10 thousand CZK and 4 applications from 2012 in total of 44 thousand CZK. (NAIF, 2016)

The financial support is granted for agricultural land in the following areas of production:

- payments for hops
- payments for ruminants
- payments for sheep breeding or goat rearing
- payments for suckler cows
- payments for potatoes

(Miroslav Slatinský, 2016)

3.7. 2nd Pillar - Rural Developm ent Programme

3.7.1. Rural Development Programme 2007-2013

Primary rules of Rural Development Programme 2007 – 2013 are established in Regulation of Council № 1698/2005. According to this document, RDP must achieve following goals: to establish conditions for educated population, to develop domestic market and to ensure sustainable business environment, to increase labour force in rural, to provide a stable development in agriculture. Moreover, RDP 2007-2013 promotes enlargement and diversification of economic activities in agrarian sectors aimed to improve condition of farms and decrease a level of unemployment in rural areas. In general, the concept should help for members of the EU to make a link with the main European priorities, set out in Gothenburg and Lisbon conferences. (NAIF, 2016)

This programme is operated in the Czech Republic according to National Strategic Rural Development Plan, based on on the EU main strategic prioreties with an emphasis on economic growthand sustainable rural development. The basic structure of the Program has 4 axes and their focus is as follows:

- Axis I aims to improve the competitiveness of agriculture and conditions of business environment, funding more than 20% of EAFRD financial resources
- Axis II has a common goal of increasing biodiversity, protecting the environment and provide support in areas with natural handicaps
- Axis III describes improving the quality of life in rural sector and diversifying agricultural economy
- Axis IV aims to help local inhabitants of rural micro-regions through the "bottom-up" principle to develop their own development strategy for the territory in which they live and to support projects for their development - the LEADER method

(Ministry of agriculture of the Czech Republic, 2006)

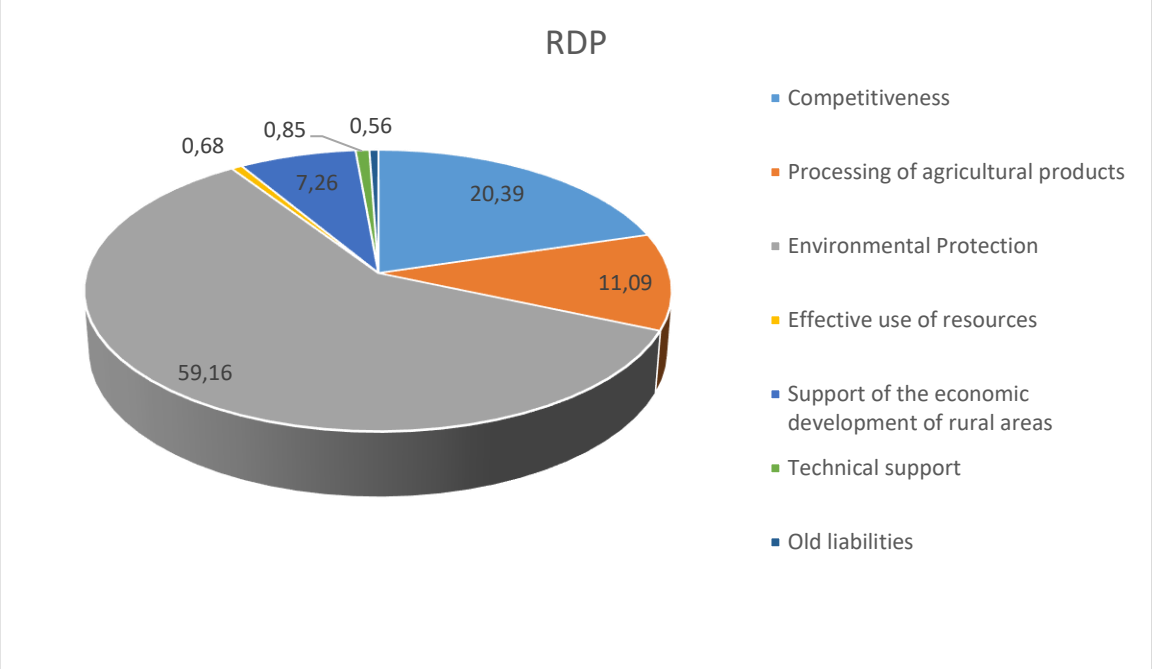
In 2016, there were no any application on payments received under the Rural Development Programme 2007-2013 since the concept was terminated in the end of 2015. However, NAIF continues to implement the control of former participants of the program and administrate reports about changes.

3.7.2. Rural Development Programme 2014-2020

Rural Development Programme 2014-2020 focuses on increasing the competitiveness of agricultural, forestry and food sectors. The European Commission has approved basic programming document of the Czech Republic in 26th of May 2015. During the 2014-2020 period, the Czech agriculture will receive almost 3.5 billion euros (which is more than 91 billion CZK), where 2.3 billion euros (about 60 billion CZK) of this amount will be granted from EU budget (including 135 million euro, which will be transferred from the envelope for CAP direct payments) and the rest 1.2 billion (more than 31 billion CZK) will be given by the Czech government. (Ministry of agriculture of the Czech Republic, 2015)

The main objective of the RDP 2014-2020 is to conserve, restore and improving farming conditions through agri-environmental measures, invest in agricultural holdings for increasing their competitiveness, develop innovative methods in production procedures and support young farmers to expand agriculture among population. (NAIF, 2016)

Figure 1: Expected percantage share of financial sources in RDP 2014-2020



Source: Ministry of Agriculture of the Czech Republic

In the framework of RDP 2014-2020, the European Commission also set the priorities of supported regions.

1. A transfer of knowledge and innovation in agrarian sector
2. Improving the survivability of farms and the competitiveness of agricultural production; promoting modern production methods in agriculture
3. Support of the food chain, including procession and realization of agricultural output
4. Restoration, conservation and development of ecosystems in agriculture
5. Supporting an efficient use of resources
6. Promoting economic development in rural areas

In the Czech Republic, the EU funds all six priorities, especially focusing on enhancing of ecosystems, which is described in Priority 4. (European Commission, 2016)

The most sponsored measures in Rural Development Programme 2014-2020 are: agri-environment and climate measures (€905 million), payments for LFA (€786 million), productive investments (€749 million), organic farming (€341 million) (EC, 2016)

Productive investments measure is aimed to increase the competitiveness of small and medium-sized farms, food and forestry as well as to contribute to the sustainable management of natural resources. Productive investments in the Czech Republic share 16% of total Rural Development Programme 2014-2020 expenditure.

3.7.2.1. Agri-environmental and climate measures

Agri-environmental and climate measures (AEC) are related to conservation and promotion of required changes in agrarian sector. Payments of AEC are provided for farmers, who take on a responsibility to ensure a positive influence on environmental protection and climate improvement on agricultural land. The measure promotes the conservation of hereditary areas of high natural value, natural resources, biodiversity and landscape maintenance. The period of the programme is counted for 5 to 7 years, where farmers receive annual payments. The Czech Republic has around 25% share of AEC spending within the framework of Rural Development Programme 2014-2020. Along with the Czech Republic, similar ratio of AEC payments has Ireland, the Netherlands, Austria and Luxemburg. (OECD, 2017)

The applicant for AEC don't need to be agricultural entrepreneur, however he must be registered in LPIS with a minimum area of agricultural land. In 2016 4036 applications were filled for inclusion in the AEC for a five-year commitment under the Government Order of the Czech Republic № 75/2015 Coll., as amended. An application for a grant goes under the AEC as a part of the Single Application. In 2016, 14158 grant applications were submitted. (NAIF, 2016)

3.7.2.2. Organic farming

Organic farming aids as payments per hectare of agricultural land for farmers, who apply organic methods described in the European Council Regulation №834/2007. Comparing with organic farming under the framework of Rural Development Programme 2007-2013, there are no significant differences in the following RDP. The share of organic farming in total RDP expenditure in the Czech Republic doesn't exceed 10% and accounts for around 341 million CZK. (OECD, 2017)

The applicant must be in condition of active farmer and be registered as organic entrepreneur according to §6-8 Act on Organic Farming with minimum agricultural land[4]. In 2016, 1518 applications for inclusion in the organic farming were submitted for a five-year commitment under the Government Order of the Czech Republic № 76/2015. An application for a grant of organic farming goes as a part of the Single Application. At the same year, 3862 grant applications have been submitted. (NAIF, 2016)

[4] 0,5 hectares

3.7.2.3. Payments for areas with natural constraints

The new programme of Rural Development supports farmers, taking their agricultural activity in the areas with natural constraints (ex. lack of water, climate, short crop season, tendencies of depopulation etc.). The main goal of Less-Favoured Area payments is to compensate additional costs, expenses and lost revenue of farmers related to some limitations in agricultural production. These subsidies are significant in the Czech Republic because more than 50% of agricultural land is considered to be the land with handicaps.

Payments to farmers in these areas should help to preserve rural landscapes, maintain and promote sustainable farming systems by encouraging stable use of agricultural land. Usually, farms in the Less-Favoured Areas are less productive than farms in sustainable region.

LFA are divided into 3 parts: mountain areas, other areas and specific. Mountain LFA have higher attitudes or higher attitudes with sloping land. Other LFA are characterized by lower yields in agricultural land, located in populated regions with high proportion of labour force in agriculture. Specific LFA are represents by lands with lower yields outside of other LFA. (NAIF, 2016)

Table 4: Basic rates for payments according to type of LFA

Area of LFA	Type of area	Basic rate (CZK/ha)
Mountain areas	H1	3702.15
	H2	3485.97
	H3	2459.09
	H4	2972.53
	H5	2242.91
Other areas	OA	2215.89
	OB	1540.31
Specific areas	S	2242.91

Source: Annual report for 2016 from SZIF

The applicant must be registered in LPIS and be in condition of active farmer who has minimum 1 hectare of agricultural land according to §2e and §2h of Act of agriculture. Also, he must regularly carry out cross-compliance requirements. Requests for payments for areas with natural or other specific constraints based on Government Decree No. 72/2015 Coll. In 2016, 14292 applications were made to provide payments for areas with natural or other special restrictions. (NAIF, 2016)

4. Analytical part

A benefit from agricultural holdings is considered to be a foundation of interpreting "farmer's income" since their welfare directly depends on farm's profitability. This is particularly relevant for small-size farms, which are experiencing a huge competition on the market by comparison of large agricultural holdings. There are two approaches for determine income from agricultural activities: a combined approach which uses a data from agrarian sector (Eurostat) and an approach which is represented by individual farm data (FADN). The first approach encompasses all agricultural activity in the country, while the second covers farms and holdings, which are considered to be commercial. Eurostat method is extensively used by European policymakers because of the speed of results that can be received. FADN method contains key details, which are significant for future concepts of CAP. (Hill, Bradley, 2015)

Analytical part of the thesis is divided into 2 parts. The first part is represented by evaluation of trend functions according to type of payments in non-LFA and in mountain regions. In the second part, there is a regression analysis of selected economic indicators: FNVA (FNVA/AWU) or FNVA, total subsidies excluding investments and total labour input for not in LFA and mountain areas. We use areas with various characteristics in order to compare values of selected economic indicators and their changes in different lands. The evaluation of economic indicators is based on FADN, which estimates indicators on the farm level and shows detailed information about agricultural holdings represented in the survey. Data is taken from year 2007 to 2015.

4.1. Farm's income

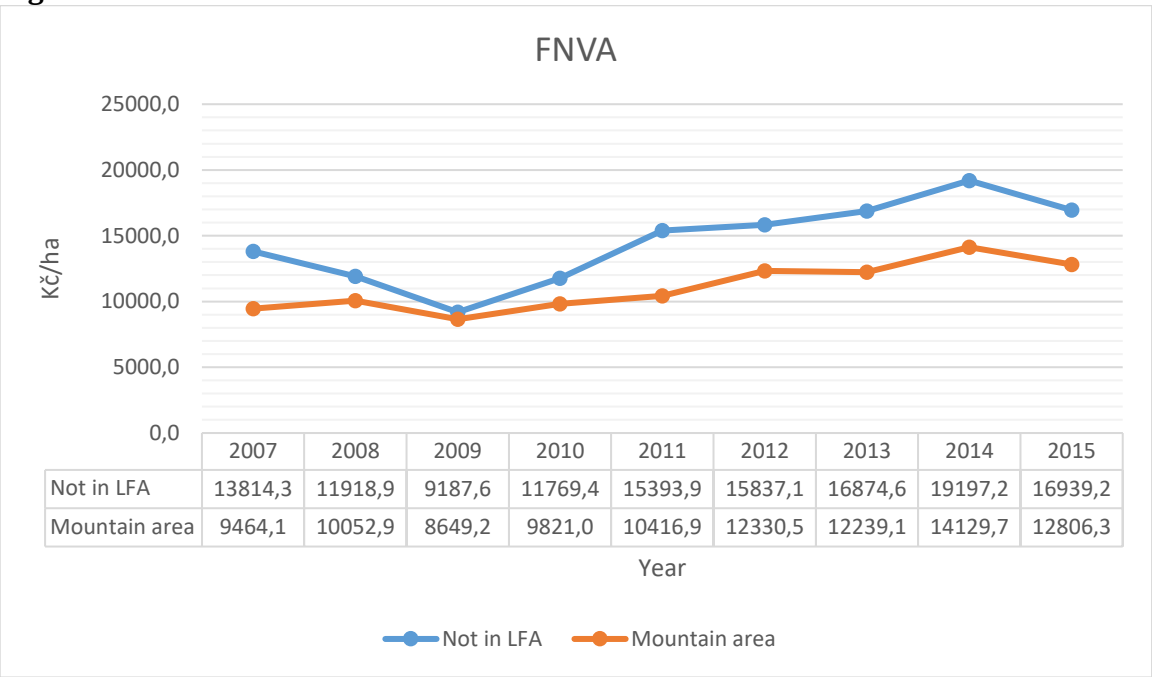
The evaluation of income from agricultural holdings is one of the main objectives of FADN. In this network, farm's income is measured in terms of calculating *Farm Net Value Added (FNVA)* or *Family farm income(FFI).* In our case, we use first economic indicator, which can be express per farm (FNVA) or per Annual Work Unit (FNVA/AWU). FNVA shows the remuneration of all production factors such as land, capital and labour.

Formula 5: Farm Net Value Added

FNVA = Total output + balance current subsidies and taxes – intermediate consumption - depreciation

In other words, FNVA indicates the economic performance of agricultural holdings from which external factors such as wages, rent and interest still must be paid. FNVA is represented by amount of money (CZK) per hectare. (Hill, Bradley, 2015)

Figure 2: Farm Net Value Added



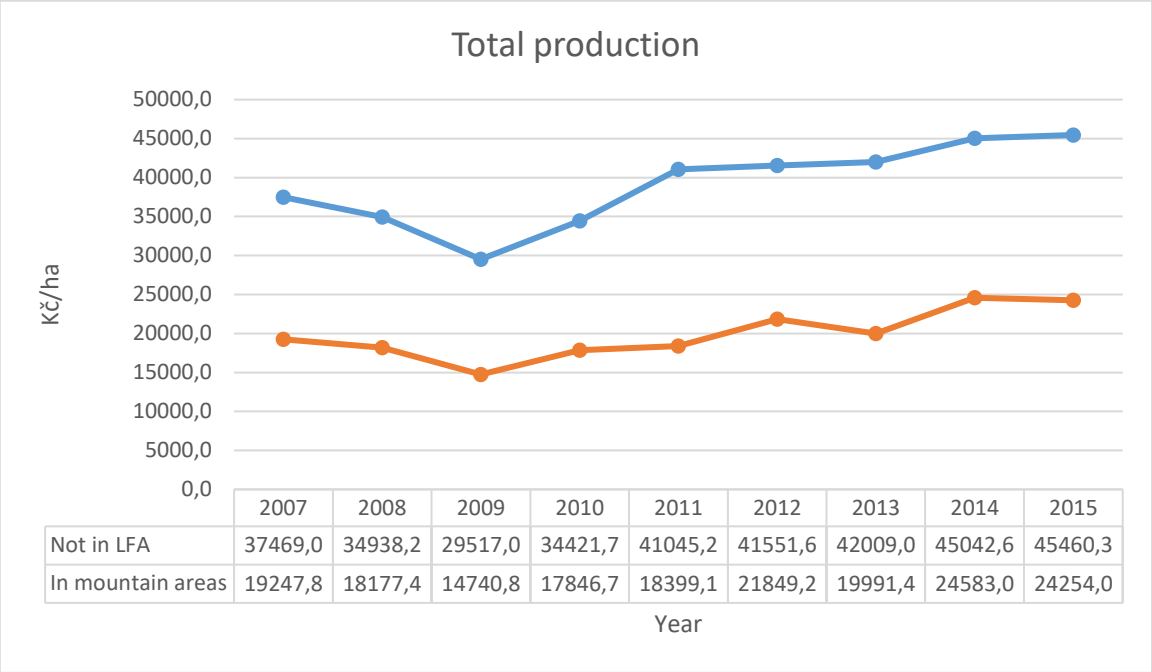
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Not in LFA	13814,3	11918,9	9187,6	11769,4	15393,9	15837,1	16874,6	19197,2	16939,2
Mountain area	9464,1	10052,9	8649,2	9821,0	10416,9	12330,5	12239,1	14129,7	12806,3

Source: FADN 2007-2015, own processing

As it was expected, the performance of agricultural holdings in mountain area was slightly lower comparing with other regions. This is explained by natural constraints of these areas, which requires more investments for cultivation. As it is shown on the graph, there was a drop of farm net value added indicator in outside of LFA during the period from 2007 to 2009, which accounted for about 34% of decrease, while FNVA for mountain areas was almost stable for these 2 years. A significant decline could be caused by world crisis started in 2007. Since 2009, farm's income in not LFA and in mountain areas has leveled off and rose gradually by 84% and 63%. In 2014, FNVA indicator reached a peak in both regions, representing 19197.2 CZK per hectare in non-LFA and 14129.7 CZK per hectare in mountain areas. Moreover, we can claim that farm's performance in mountain areas doesn't fluctuate greatly during the given period, showing stable results throughout the time. It is primarily determined by development programme of Common Agricultural Policy, paying exclusive attention on areas with natural and other handicaps. Overall, we could see that trends in the increase of farm's profitability since the accession of the Czech Republic to the EU remains and continuous to grow.

4.2. Total production

Figure 3: Total production



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Not in LFA	37469,0	34938,2	29517,0	34421,7	41045,2	41551,6	42009,0	45042,6	45460,3
In mountain areas	19247,8	18177,4	14740,8	17846,7	18399,1	21849,2	19991,4	24583,0	24254,0

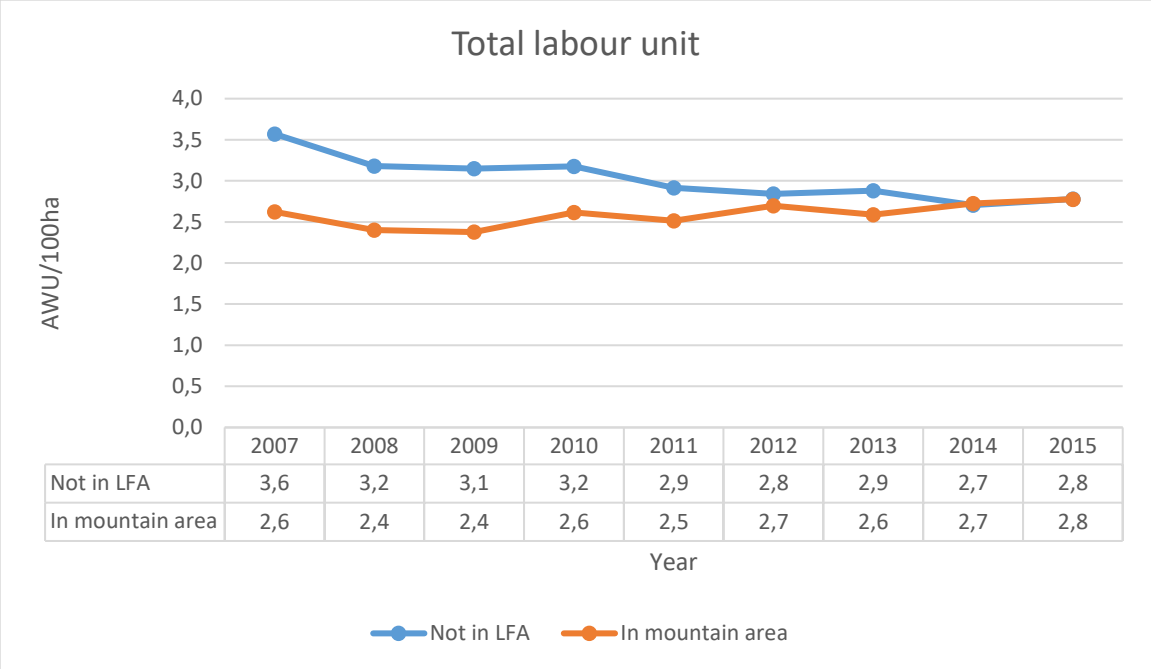
Source: FADN 2007-2015, own processing

Undoubtedly, total production of farms, which are represented in mountain areas, much lower than in not LFA. Farmers experience difficulties with limitations in agricultural resources, related to natural or other constraints. Comparing two lines of total production, we see that they are parallel, which explains almost similar changes every year in each area. In 2009, there was a significant drop in total production in both areas, accounted for 21% of decrease in non-LFA and 23% in mountain areas. It can be explained by deterioration of the economic situation in the world in 2009. However, in the following years, total output began to level off and increase. Since 2009, total production increased by 54% in non-LFA and 64% in mountain areas for 6-year period. Moreover, we see that number of agricultural products tend to in last years and mountain areas have bigger tendency. It can be explained by increasing of high rates of payments per hectare in LFA, since mountain area can be considered as a part of LFA.

4.3. Total labour input

Total labour input is an essential part of calculation income of farms. The calculation is performed in accordance of standardized FADN methodology and expressed as Average Work Unit per 100 hectares. AWU includes number of hours employee worked full-time on a farm, where 1 AWU is equals to 1800 hours. This number also doesn't include public holidays, paid leave, lunch breaks etc.

Figure 4: Total labour input



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Not in LFA	3,6	3,2	3,1	3,2	2,9	2,8	2,9	2,7	2,8
In mountain area	2,6	2,4	2,4	2,6	2,5	2,7	2,6	2,7	2,8

Source: FADN 2007-2015, own processing

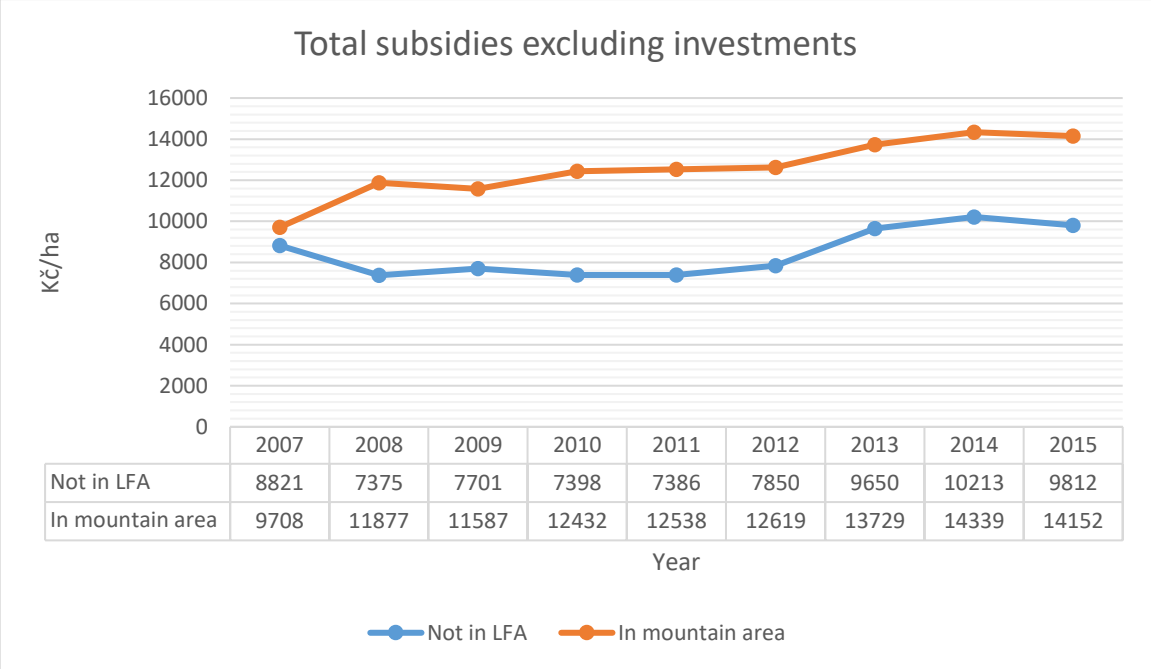
In 2008, non – LFA areas fell under the influence of the Great Recession, which affected economies of countries in the world. By some estimates, the world decline continued until 2015, what leaded to further fall in average work units per 100 ha. According to Figure 4, we see that total labour input in not LFA gradually decreases from 2007, with 22% of total drop, while the performance of the same indicator in mountain areas almost didn't change during this period. Minor fluctuations show that total labour input in mountain areas generally stands stable. This can be explained by sustainable financial support for these areas within the framework of Rural Development Programme, providing decent condition for workers in mountain regions. Moreover, despite the global crisis, support of regions with natural constraints were not reduced, which didn't affect the employment in mountain areas, since these regions are always limited in effective using of resources. Therefore, thanks to regular support of LFA, these areas are not subjected to impact of economic declines.

4.4. The evaluation of trend functions for subsidies

4.4.1. Total subsidies excluding investments

Since the aim of this thesis is to evaluate the impact of subsidies on farm economy, in analysis there will be used data about agricultural payments in LFA with comparison of trend functions. Subsidies will be represented by amount of money (in CZK) paid per hectare.

Figure 5: Total subsidies excluding investments



Source: FADN 2007-2015, own processing

Comparison of trend functions:

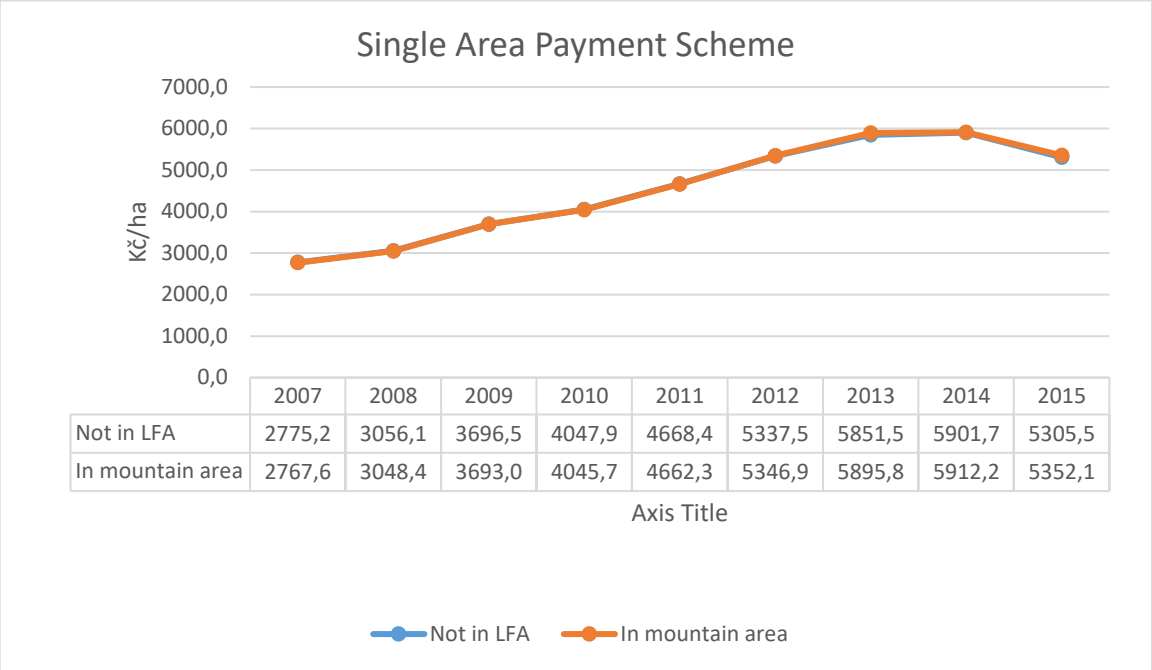
Not in LFA: $y_t = 280.48t + 7064.8$, where $R^2 = 0.4348$

In mountain area: $y_t = 493.89t + 10084$, where $R^2 = 0.8799$

Since the beginning of 2007, we have seen the growth of total subsidies excluding investments per hectare. Comparing these regions on Figure 5, mountain areas has held leading positions according to payments per hectare. It can be explained as the highest pay rates for mountain area, which is 3702 CZK/ha, while payments for other regions significantly less. The coefficient of trend function for mountain areas is 1,75 higher than in non-LFA, which shows greater tendency in increasing of payment per hectare in the future. Moreover, coefficient of determination for these areas is relatively high, which makes prediction possible. Concerning, non-LFA, due to strong fluctuation, variance of dataset is explained only by 43%, what decreases an accuracy of future predictions.

4.4.2. Single Area Payment Scheme

Figure 6: Single Area Payment Scheme



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Not in LFA	2775,2	3056,1	3696,5	4047,9	4668,4	5337,5	5851,5	5901,7	5305,5
In mountain area	2767,6	3048,4	3693,0	4045,7	4662,3	5346,9	5895,8	5912,2	5352,1

Source: FADN 2007-2015, own processing

Comparison of trend functions:

Not in LFA: $y_t = 404{,}3t + 2494.1$, where $R^2 = 0.8853$

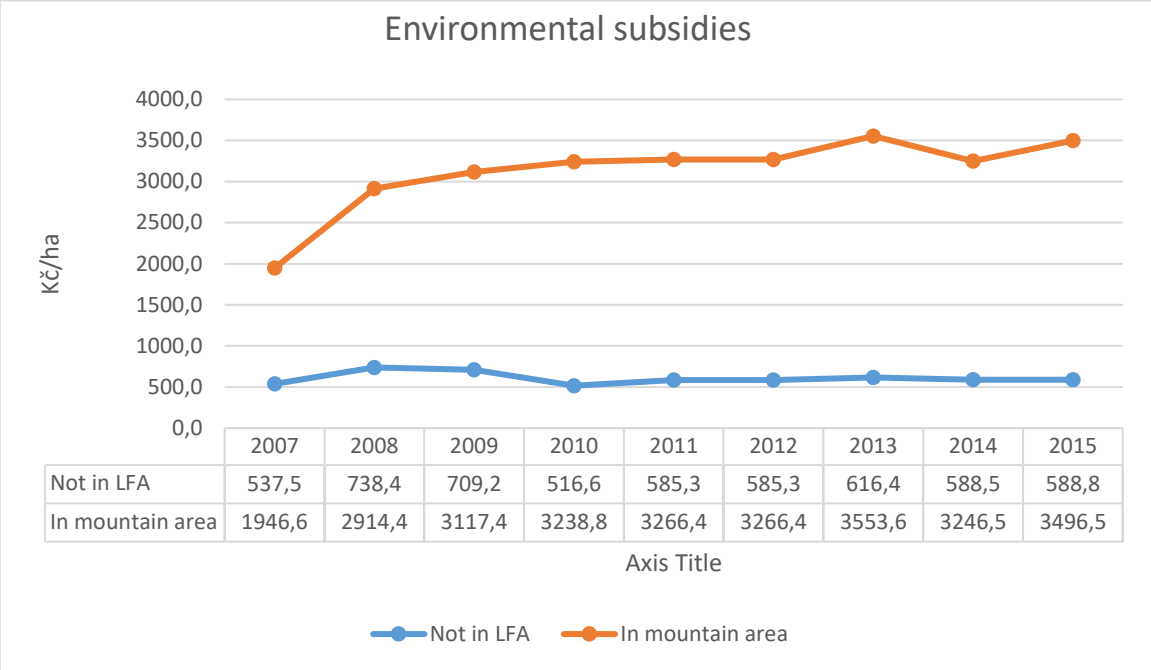
In mountain area: $y_t = 410{,}6t + 2471.9$, where $R^2 = 0.8895$

Annual increase of single area payment scheme is shown on Figure 1. Moreover, we find that both lines correspond among each other. It explains that SAPS are granted according to the principle of size of cultivated land and it doesn't depend on type of area where agricultural land is located. In other words, payments per hectare are the same for each region. Subsidies in not LFA per hectare increased by 112% during 8-year period, while payments in mountain areas by 93%.

Coefficients of trend functions for SAPS payments are almost identical, as well as time series. However, payments per hectare in mountain areas tend to increase more than payments in not LFA. We also observe that the variance of data in each area is highly explained, which makes sufficient conditions for future predictions.

4.4.3. Environmental subsidies

Figure 7: Environmental subsidies



Source: FADN 2007-2015, own processing

Comparison of trend functions:

Not in LFA: $y_t = -6.02t + 637.45$, where $R^2 = 0.0513$

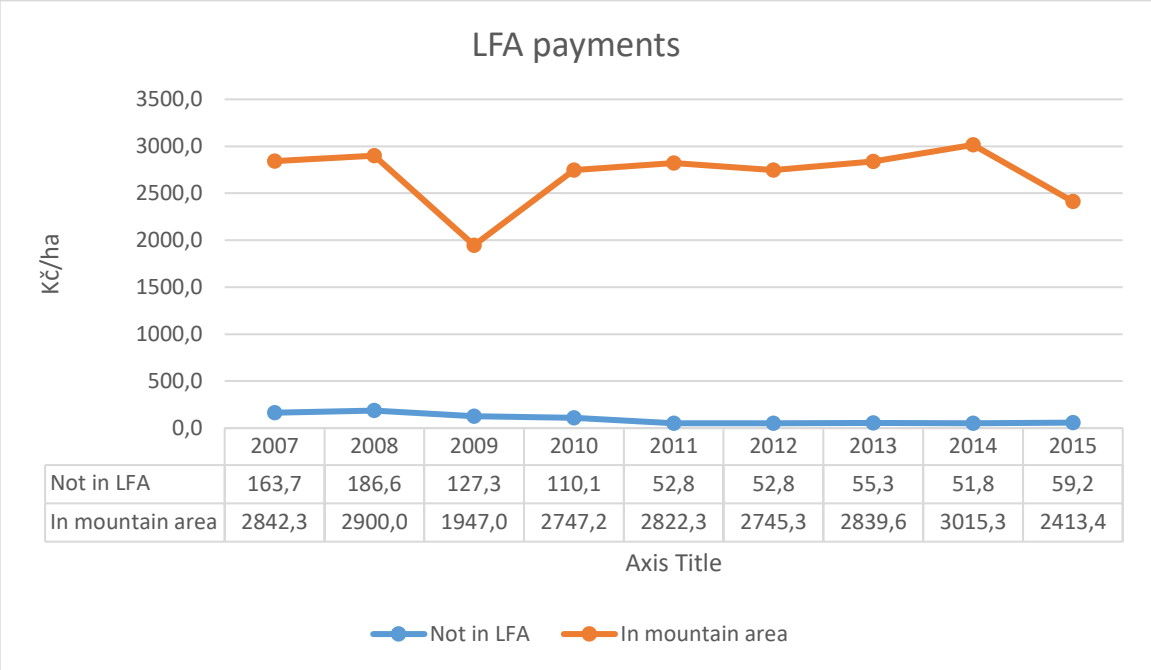
In mountain area: $y_t = 134.93t + 2441.6$, where $R^2 = 0.5996$

Figure 8 shows payments of environmental subsidies per hectare in non-LFA and mountain areas from 2007 to 2015. Subsidies in non-LFA don't have any significant fluctuations during the period, where the average payments are accounting for 607 CZK per hectare. Mountain areas show positive changes of environmental payments since 2007, reaching 55% of growth during this period. It can be explained that agri-environmental and climate measures, in which environmental subsidies are paid, stand under the Rural Development Programme jointly with LFA to which mountain areas refer. It also constitutes the biggest share of RDP measures in budgetary terms with 905 million euro of total funding. Subsidies in mountain areas, related to environmental measures, have a positive trend with coefficient 134.93. However, upward tendency in mountain areas is lower in comparison of SAPS. An explained variance is higher than in non-LFA and represents 59%.

Environmental subsidies in not LFA tend to decrease, since the coefficient of trend function is negative and represented by -6.02. Coefficient of determination R^2 is also very low 0.0513, what tells us that prediction in these areas will be inaccurate.

4.4.4. Subsidies for Less Favoured Areas

Figure 8: LFA payments



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Not in LFA	163,7	186,6	127,3	110,1	52,8	52,8	55,3	51,8	59,2
In mountain area	2842,3	2900,0	1947,0	2747,2	2822,3	2745,3	2839,6	3015,3	2413,4

Source: FADN 2007-2015, own processing

Comparison of trend functions:

Not in LFA: $y_t = -17{,}056t + 180{,}8$, where $R^2 = 0{,}7706$

In mountain area: $y_t = 6{,}9t + 2662{,}5$, where $R^2 = 0{,}0034$

LFA payments per hectare are significantly higher in mountain areas than payments in non-LFA, since mountain areas are areas with natural constraints areas. In 2009, subsidies in mountain area plummeted by 32% and were lower than 2000 CZK per hectare. The following years, this amount bottomed out and remained stable until 2014, when again dropped by 20% in 2015. As we have already observed, FNVA in mountain areas also decreased in 2009. We can suppose that this decline has been also affected by the world crisis, which is called the Great recession.

The trend function shows that LFA subsidies only in mountain areas have positive tendency. By contrast, the coefficient of trend slope is 6,9, which is much lower than coefficients of SAPS and environmental subsidies. Also, we see that R^2 is very low (0,0034) due to high fluctuations in time series, so we can't predict precisely in the future. The coefficient of trend function in not LFA is negative, so we expect a decrease in LFA payments in this region. R^2 is also observed in not LFA with 77% of explained variance in the dataset. This can be explained that, LFA measures dominate in mountain areas rather than in not LFA.

4.5. Regression analysis

4.5.1. Not LFA

This chapter of the thesis aims to explain the relationship between farm's income and total subsidies (excluding investments) with total labour unit in not LFA and mountain areas. In other words, we would like to know how farm's income will change, when other economic indicators such as total subsidies and total labour input vary in these regions. The data, as it has been already said, is collected from FADN and converted into the table with necessary economic indicators. The dataset is represented by the period from 2007 to 2015.
Economic model for non-LFA:

FNVA/AWU = f (total subsidies, total labour input)

Regression equation:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon \quad ,$$

where y is represented by *Farm Net Value Added/Average Work Unit (FNVA/AWU),*

x_1 is regressor (explanatory variable) represented by *total subsidies excluding investments,*

x_2 is regressor (explanatory variable) represented by *total labour input,*

β_0 is *constant,* β_1, β_2 are *regression coefficients,*

ε is a random value or *error*

Table 5: Time series for non-LFA

Year	Y	X_1	X_2
2007	386895.1	8821.1	3.6
2008	374847.1	7374.6	3.2
2009	284576.5	7701.0	3.1
2010	370422.6	7397.7	3.2
2011	527889.2	7385.7	2.9
2012	557684.1	7849.6	2.8
2013	585683.6	9650.1	2.9
2014	709729.9	10212.9	2.7
2015	609109.3	9812.1	2,8

Source: FADN, own elaboration

1) Correlation of regressors and multicollinearity

When the independent variables are actual variables, some of them could be highly correlated between each other thus making the regression analysis of data represented more complicated. To prove that explanatory variables are not highly correlated between each other (pairwise correlation), we use a table from SAS correlation analysis.

Figure 9: Correlation analysis for non-LFA

Pearson Correlation Coefficients, N = 9 Prob > |r| under H0: Rho=0		
	Total payments excluding investm	**Total labour input**
Total payments excluding investm	1.00000	-0.41893
Total payments excluding investments		0.2617
Total labour input	-0.41893	1.00000
	0.2617	

Own calculations by SAS

As it is shown above, the correlation between total subsidies excluding investments and total labour input is represented by number -0.41893, which explains us that the correlation between regressors is represented by negative medium dependency ($r_{x_{1,}x_2}$ = -0.41893). We can assume that medium correlation of independent variables won't prevent further estimation of regression model, since it's not high.

Another tool is detecting multicollinearity among variables by using variance inflation factor (VIF) to confirm accuracy of our previous calculations. In multiple regression, we need to make sure that there is no multicollinearity is present between our regressors. VIF shows a meticulous check for collinearity than correlation coefficient. Collinearity exist if VIF > 5:

Formula 6: Variance Inflation Factor

$$\boldsymbol{VIF_i = \frac{1}{(1 - R_i^2)}}$$

Where R_i^2 is obtained from regressing X_1 and X_2

Running a regression for one explanatory variable (it does not make sense to run regression for both variables, since the results will be the same):

$x_1 = \alpha_0 + a_1 x_2 + \varepsilon$, so, we determine that R_1^2 = 0.175. Calculation of VIF_1:

$VIF_1 = \frac{1}{1-0.175} = 1{,}21$

Therefore, VIF < 5, it means that there is no multicollinearity is present between explanatory variables.

2) Autocorrelation

The next step of our regression analysis is to recognize whether there is autocorrelation or not. It occurs when the residuals are not independent between each other, i.e. they are correlated. The most common used test for determine autocorrelation is Durbin Watson criteria, which used only in time series. It has a range of 0 to 4 and non-autocorrelation is defined when it's equal to 2. The closer number D to 2, the stronger evidence that there is no autocorrelation is present among residuals. If number is not equal to 2, but it's close, we compare D statistic with values d_L, d_U (for 9 observations and 2 regressors) from Durbin and Watson table because it doesn't have p-value. (Chatterjee, Hadi, 2006) Null hypothesis:

H_0: there is no autocorrelation

H_a: there is autocorrelation

Figure 10: Durbin-Watson statistic for non-LFA

Durbin-Watson D	1.696
Number of Observations	9
1st Order Autocorrelation	0.076

Own calculations using SAS

Then if:

$D < d_L$, we reject null hypothesis

$D > d_U$ we accept null hypothesis

$D = 1.696$, $d_L = 0.408$, $d_U = 1.389$, then $D > d_U$, we **accept** null hypothesis, which means that there is no autocollinearity exists between residuals. In other words, autocorrelation won't prevent us to estimate our regression model in the future.

3) Homoskedasticity

Homoskedasticity shows whether the variance of error terms is similar throughout the values of explanatory variables, while heteroskedasticity states that error variance is not constant over all observations. If heteroscedasticity is present, this will affect estimated coefficients with lack of accuracy in theoretical sense. (Chatterjee, Hadi, 2006) In other word, we would like to have a regression model with homoskedasticity in variance of error. Stating the null hypothesis:

H_0: Homoskedasticity is present

H_a: Heteroskedasticity is present

Level of significance alpha = 0,05

Figure 11: Heteroskedasticity test for non-LFA

Test of First and Second Moment Specification		
DF	Chi-Square	Pr > ChiSq
5	3.62	0.6047

Own calculations using SAS

Chi-square test statistic 3.62, p-value 0.60, p-value > 0.05. Therefore, we **accept** null hypothesis. It means that the variance of error is equally distributed across the values of predictors, which explains that homoskedasticity is present.

4) Estimation of parameters

In this section, we estimate the parameters β_0, β_1, β_2 based on available data. To identify the value of constant and coefficient of regression, we use OLS method. Using the estimated regression coefficients $\widehat{\beta_o}$, $\widehat{\beta_1}$,$\widehat{\beta_2}$, we write estimated regression equation as:

$$\hat{y} = \widehat{\beta_o} + \widehat{\beta_1} x_1 + \widehat{\beta_2} x_2$$

For calculating constant and regression coefficients, we use calculations from regression data analysis in SAS:

Figure 12: Estimation of parameters for non-LFA

Parameter Estimates								
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Variance Inflation
Intercept	Intercept	1	978969	398039	2.46	0.0492	0	0
Total payments excluding investm	Total payments excluding investments	1	56.22242	21.81110	2.58	0.0419	0.46599	1.21287
Total labour input		1	-319420	93628	-3.41	0.0143	-0.61675	1.21287

Own calculations using SAS

By taking data received from SAS calculations, we can obtain estimated parameters, where: $\widehat{\beta_o}$ = 978969, $\widehat{\beta_1}$ = 56, $\widehat{\beta_2}$ = -319420, i.e.

$$\hat{y} = 978969 + 56x_1 - 319420x_2$$

Interpretation of the intercept B_0: If all explanatory variables are equal to 0, Farm Net Value Added per Average Work Unit (FNVA/AWU) is 978969 CZK/AWU.

Interpretation of the intercept B_1: If total subsidies excluding investments increases by 1 CZK/ha, Farm Net Value Added per Average Work Unit (FNVA/AWU) will increase by 56 CZK/AWU.

Interpretation of the intercept B_2: If total labour input increases by 1 AWU/100ha, Farm Net Value Added per Average Work Unit (FNVA/AWU) will decrease by 319420 CZK/AWU.

5) Coefficient of determination (R^2)

Coefficient of determination measures goodness of fit of our regression model and tells us how much of variance did we explain by the explanatory variables in the model.

Formula 7: Coefficient of determination

$$R^2 = 1 - \frac{RSS}{TSS} = 1 - \frac{\sum_{i=1}^{N}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{N}(y_i - \overline{y})^2}$$

Where $\hat{y}_i$ – theoretical value of dependent variable obtained from estimated equation, $\overline{y}$ – average of dependent variable, N – number of observations

Figure 13: Coefficient of determination for non-LFA

Root MSE	65254	R-Square	0.8383
Dependent Mean	489649	Adj R-Sq	0.7844
Coeff Var	13.32674		

Own calculations using SAS

According to the table, we observe that coefficient determination (R^2) is high and equals to 0.83. In other words, 83% of variance was explained in the model.

6) Normality test

In this part, we are going to check whether residuals are normally distributed or not. It is significant to test for normality of residuals distribution, otherwise we can't trust our results in the future. Residuals in regression can be defined as differences between actual data and predicted values. To test the normality of residual distribution, we use Shapiro - Wilk test. For level of significance, we use alpha = 0.05. We state null and alternative hypotheses as:

H_0: There is no significant difference between normal distribution and residual distribution

H_1: There is a significant difference between normal distribution and residual distribution

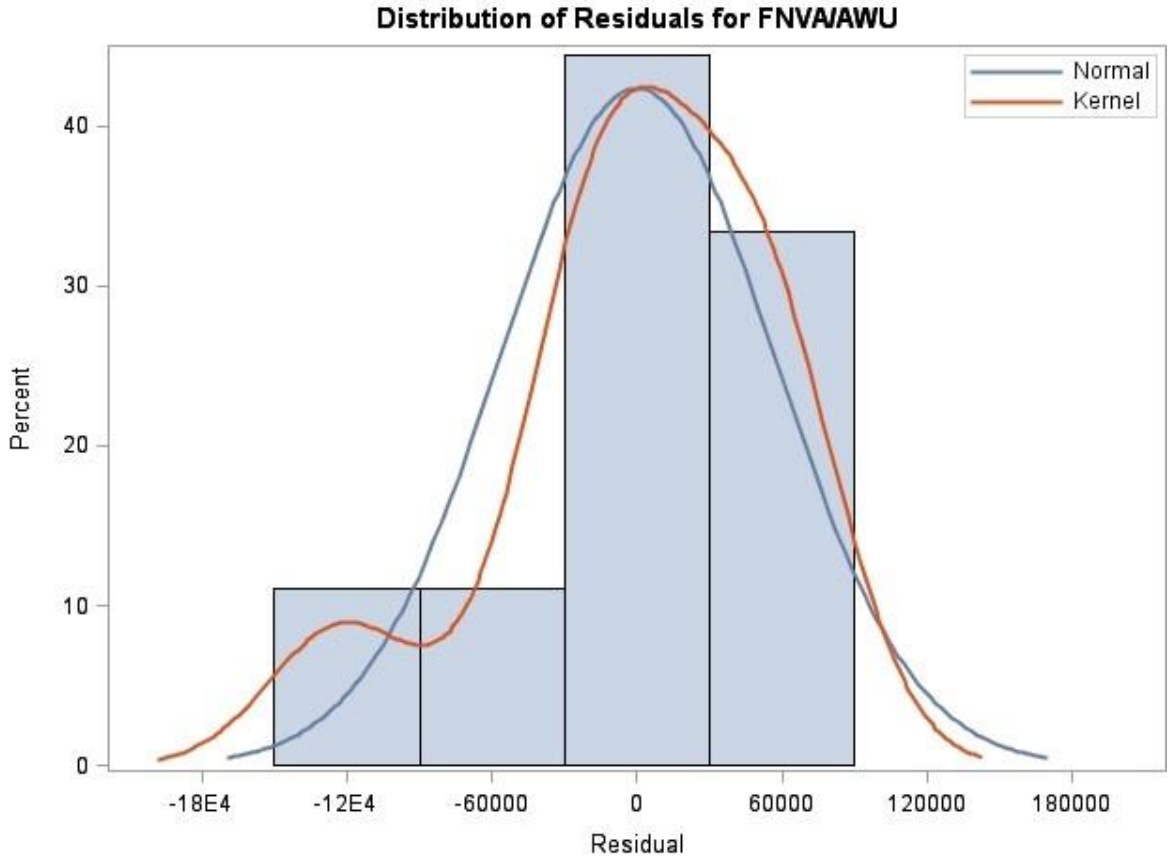
Figure 14: Normality test for not-LFA

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.907624	Pr < W	0.2996
Kolmogorov-Smirnov	D	0.169495	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.048342	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.359663	Pr > A-Sq	>0.2500

Own calculations using SAS

According to SAS calculations, we see that the test statistic of Shapiro -Wilk test is 0.90 with p-value = 0.29, p-value > 0.05. Therefore, we **accept** the null hypothesis, which means that residuals in our model are normally distributed. For validation of our results, we look at residual distribution, showed on the graph below.

Figure 15: Residual distribution for non-LFA



Own elaboration using SAS

As we can see, the line of residual distribution almost replicates normal distribution line, so we can claim that normal distribution of residuals is present.

7) ANOVA F-test

F-test is testing the equality of variances of two populations, which have normal distributions, based on the ratio of variance of a sample of observations taken from each. In common, it goes in the context of analysis of variances (ANOVA), which testing if variances are the same in addition to test for the equality of a set of means. (Everitt, 2006)

Level of significance, as usual alpha = 0.05.

Null and alternative hypotheses of F-test are:

H_0: *The whole model is not statistically significant* ($\beta_1 = \beta_2 = 0$)

H_a: *The whole model is statistically significant* ($\beta_1 \neq 0$ *or* $\beta_2 \neq 0$)

Figure 16: Analysis of Variance for non-LFA

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1.32479E11	66239482184	15.56	0.0042
Error	6	25548665012	4258110835		
Corrected Total	8	1.580276E11			

Own calculations using SAS

For accepting or rejecting null hypothesis (H_o), we need to look at "Pr>F" section, which we will compare with level of significance (alpha = 0.05) and then make a decision. F statistic is 15.56 with p-value = 0.0042, p-value < 0.05. Consequently, p-value is lower than alpha thus we **reject** null hypothesis and accept alternative. By this result, we can claim that the whole model is statistically significant.

8) t-Test

t-Test identifies the individual statistical significance of parameters. Firstly, we need to state the null and alternative hypotheses for both explanatory variables. Level of significance for both t-Tests is 0.05. Null hypothesis for *total subsidies excluding investments:*

H_0: β_1 *is not statistically significant* ($\beta_1 = 0$)

H_a: β_1 *is statistically significant* ($\beta_1 \neq 0$)

Null hypothesis for *total labour input*:

H_0: β_2 *is not statistically significant* ($\beta_2 = 0$)

H_a: β_2 *is statistically significant* ($\beta_2 \neq 0$)

We use values from Figure 10, where t statistic and p-value for each parameter are shown.

For first explanatory variable, which is total payments excluding investments, we need to take p-value from second row in "Pr > |t" column, which is 0.0226 and compare it with level of significance; p-value = 0.0026, alpha = 0.05, p-value < 0.05. Consequently, we **reject** the null hypothesis (H_o) and accept alternative. This means that total payment excluding investments variable is statistically significant.

For second independent variable, which is total labour input, p-value equals to 0.0035 (number form third row). Comparing with level of significance; p-value = 0.0035, alpha 0.05, p-value < 0.05. We **reject** the null hypothesis (H_o) and accept alternative. This means that total labour input variable is statistically significant.

Therefore, we can claim that both explanatory variable (total subsides excluding investments and total labour input) are statistically significant.

4.5.2. Mountain areas

The following regression model will be for mountain areas. As in previous area, we would like to know the relationship between farm's income and total subsidies excluding investments with total labour input in mountain areas. However, farm's income in this model will be represented by Farm Net Value Added (in previous model it was FNVA/AWU). The main reason for this is that in model with FNVA/AWU as a dependent variable for mountain areas, p-value of t-Test for total labour input variable is more than alpha (0.41 > 0,05), so we accept the null hypothesis, which means that total labour input is not statistically significant in this model thus it won't help us to evaluate relationship.

As it has been already mentioned, farm's income can be represented by two economic indicators FNVA or FNVA/AWU, so we built a model with FNVA as dependent variable to see how it is going to work. All steps done with first regression model will be the same for second regression model.

Economic model for mountain areas:

FNVA = f (total subsidies, total labour input)

Regression equation:

$$\boldsymbol{y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon}$$

Where y is represented by *Farm Net Value Added*,

x_1 is regressor (explanatory variable) represented by *total subsidies excluding investments*,

x_2 is regressor (explanatory variable) represented by *total labour input*,

β_0 is *constant*, β_1, β_2 are *regression coefficients*,

ε is a random value or *error*

Table 6: Time series for mountain areas

Year	Y	X_1	X_2
2007	9464.1	9707.9	2.6
2008	10052.9	11877.0	2.4
2009	8649.2	11586.9	2.4
2010	9821.0	12431.6	2.6
2011	10416.9	12537.9	2.5
2012	12330.5	12619.2	2.7
2013	12239.1	13729.3	2.6
2014	14129.7	14338.7	2.7
2015	12806.3	14151.8	2.8

Source: FADN, own elaboration

1) Correlation of regressors and multicollinearity

In correlation analysis, as well as for non - LFA, we need to figure out whether there is high correlation between explanatory variables. For identifying this, we use output from SAS:

Figure 17: Correlation analysis for mountain areas

Pearson Correlation Coefficients, N = 9 Prob > |r| under H0: Rho=0		
	Total subsidies excluding invest	Total labour unit
Total subsidies excluding invest	1.00000	0.49009
Total subsidies excluding investments		0.1805
Total labour unit	0.49009	1.00000
	0.1805	

Own calculation using SAS

According to the table, the correlation between total subsidies excluding investments and total labour input in mountain areas is r_{x_1,x_2} = 0.49. This explains that the correlation between these explanatory variables is represented by medium dependency.

Since the correlation is not high, we can move to the next step of our estimation of regression.

The second step is identifying multicollinearity using VIF. From previous model, we know that multicollinearity exists if VIF > 5. Running regression for one explanatory variable: $x_1 = \alpha_0 + a_1 x_2 + \varepsilon$, so, we determine that R_1^2 = 0,24. Calculation of VIF_1:

$VIF_1 = \frac{1}{1-0,24} = 1,31$

Therefore, VIF < 5, there is no multicollinearity is present between explanatory variables.

2) Autocorrelation

After we proved that there is no multicollinearity is present, we need to establish that residuals are not correlated between each other. We use Durbin – Watson value for detecting autocorrelation as well as in previous calculations. Stating of hypothesis for autocorrelation:

H_0: There is no autocorrelation

H_a: There is autocorrelation

Figure 18: Durbin – Watson statistic for mountain areas

Durbin-Watson D	1.641
Number of Observations	9
1st Order Autocorrelation	0.111

Own calculations using SAS

Comparing with values d_L, d_U form Durbin and Watson table: D = 1.641, d_L = 0.408, d_U = 1.389, then D > d_U, we accept null hypothesis. This means that there is no autocollinearity is present among residuals, which makes our regression model suitable for estimations.

3) Homoskedasticity

As for previous model, we need to check whether homoskedasticity or heteroscedasticity is present by using SAS. Level of significance = 0.05. Stating the null hypothesis:

H_0: Homoskedasticity is present

H_a: Heteroskedasticity is present

Figure 19: Heteroskedasticity test for mountain areas

Test of First and Second Moment Specification		
DF	Chi-Square	Pr > ChiSq
5	5.74	0.3319

Own calculations using SAS

Running the test, we obtained that Chi-square statistic is 5,8 with p-value 0,33, p-value > 0,05. We **accept** null hypothesis, which means that the variance of error is equally distributed across the values of regressors. Therefore, homoscedasticity is present.

4) Estimation of parameters

By estimating parameters β_0, β_1, β_2 of our regression model, we also use OLS method, as for previous model. We use estimated regression equation with coefficients $\widehat{\beta_o}$, $\widehat{\beta_1}$,$\widehat{\beta_2}$:

$$\hat{y} = \widehat{\beta_o} + \widehat{\beta_1} x_1 + \widehat{\beta_2} x_2$$

Figure 20: Estimation of parameters for mountain areas

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Variance Inflation
Intercept	Intercept	1	-14492	5390.76532	-2.69	0.0361	0	0
Total subsidies excluding invest	Total subsidies excluding investments	1	0.75714	0.22885	3.31	0.0162	0.59667	1.31611
Total labour unit		1	6211.46458	2383.63932	2.61	0.0403	0.46996	1.31611

Own calculations using SAS

where $\widehat{\beta_o}$ = -14492, $\widehat{\beta_1}$ = 0.76, $\widehat{\beta_2}$ = - 6211, i.e.

$$\hat{y} = -14492 + 0,76x_1 - 6211x_2$$

Interpretation of the intercept B_0: If all explanatory variables are equal to 0, Farm Net Value Added (FNVA) is -14492 CZK/ha.
Interpretation of the intercept B_1: If total subsidies excluding investments increases by 1 CZK/ha, Farm Net Value Added (FNVA) will increase by 0,76 CZK/AWU.
Interpretation of the intercept B_2: If total labour input increases by 1 AWU/100ha, Farm Net Value Added (FNVA) will decrease by 6211 CZK/AWU

5) Coefficient of determination (R^2)

According to the table from SAS calculations, we see that coefficient determination (R^2) is also high and equals to 0,85. In other words, 85% of variance was explained in the model.

Figure 21: Coefficient of determination for mountain areas

Root MSE	813.56602	R-Square	0.8517
Dependent Mean	11101	Adj R-Sq	0.8023
Coeff Var	7.32872		

Own calculations using SAS

6) Normality test

By testing whether normal distribution of residuals is present, we appeal to ANOVA test by SAS calculations. For level of significance, we use alpha = 0,05. Stating null hypothesis as:

H_0: There is no significant difference between normal distribution and residual distribution

H_1: There is a significant difference between normal distribution and residual distribution

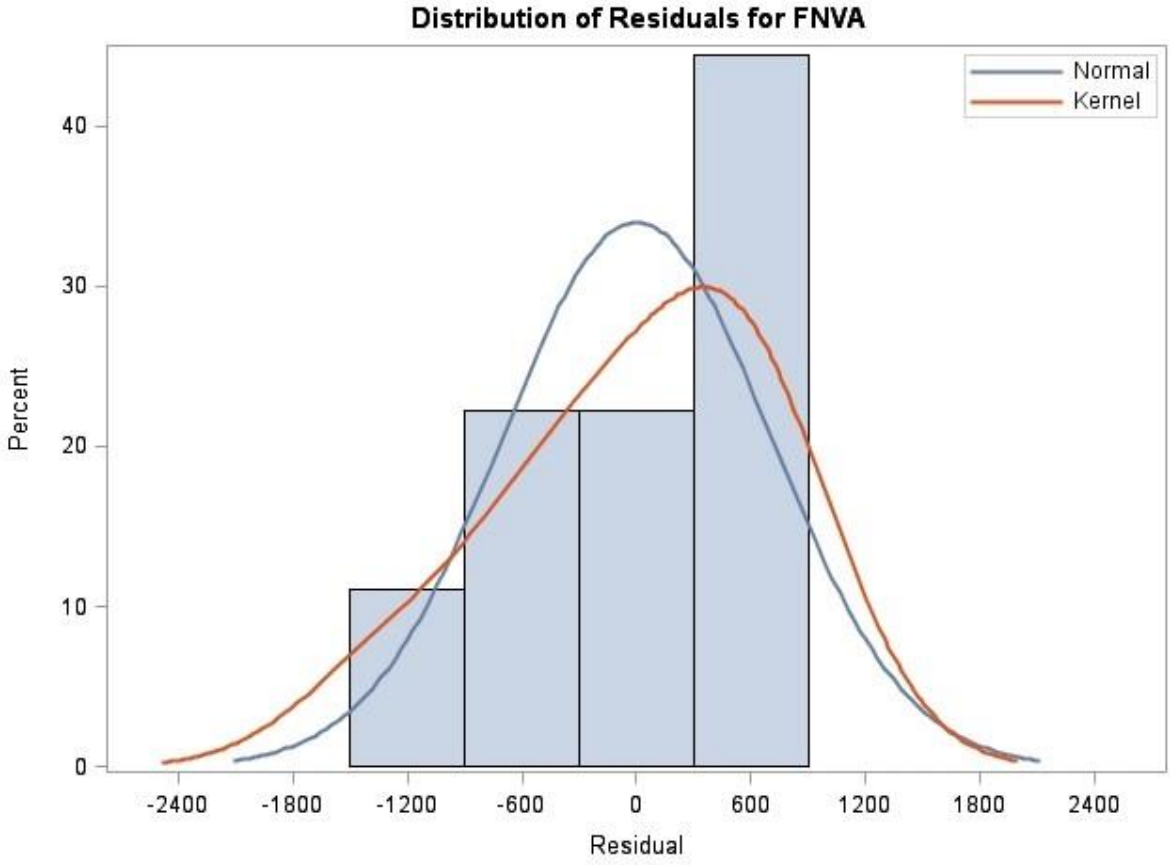
Figure 22: Normality test for mountain areas

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.941379	Pr < W	0.5965
Kolmogorov-Smirnov	D	0.204401	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.042014	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.268121	Pr > A-Sq	>0.2500

Own calculations using SAS

Test statistic of Shapiro - Wilk test is 0.94 with p-value = 0,6, p-value > 0,05. Therefore, we **accept** the null hypothesis, which means that residuals in our model are normally distributed.

Figure 23: Resiudal distribution for mountain areas



Own calculations using SAS

According to the graph, which is shown above, we can confirm that residuals in our model are normally distributed because the shape of both lines is similar.

7) ANOVA F-test

Now, we need to know the significance of our regression model for mountain areas. For processing, we also use F – test calculated from SAS and level of significance is equal to 0,05. Null and alternative hypothesizes of F-test are the same, as for previous model:

H_0: The whole model is not statistically significant ($\beta_1 = \beta_2 = 0$)

H_a: The whole model is statistically significant ($\beta_1 \neq 0$ or $\beta_2 \neq 0$)

Figure 24: Analysis of Variance for mountain areas

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	22812044	11406022	17.23	0.0033
Error	6	3971338	661890		
Corrected Total	8	26783382			

Own calculations using SAS

According to results, we see that F value is 17.23, p-value = 0.0024, p-value < 0.05. P-value is lower than alpha thus we **reject** null hypothesis and accept alternative. Therefore, we can say that the whole model is statistically significant.

8) t-Test

In t-Test, we identify a significance of each independent variables for regression model. Level of significance is 0,05. Null and alternative hypotheses for first variable:

H_0: β_1 is not statistically significant ($\beta_1 = 0$)

H_a: β_1 is statistically significant ($\beta_1 \neq 0$)

Null and alternative hypotheses for second explanatory variable:

H_0: β_2 is not statistically significant ($\beta_2 = 0$)

H_a: β_2 is statistically significant ($\beta_2 \neq 0$)

We also use Figure 16 for finding t statistics and p-values for each explanatory variable. For total payments excluding investments, t statistic is 3.31 p-value is 0.162 p-value < 0.05. Consequently, we **reject** the null hypothesis (H_o) and accept alternative, which means that total payment excluding investments variable in this model is statistically significant.

T statistic for total labour input is 2.61, p-value equals to 0.0403 p-value < 0.05 thus we **reject** the null hypothesis (H_o) and accept alternative. This means that total labour input is statistically significant in this model.

Therefore, we can say that both explanatory variables are statistically significant.

5. Conclusion

The main goal of this thesis was to identify the influence of agricultural payments represented in the Czech Republic on farm's income. For comparison, we took two different areas with distinctive characteristics of agricultural lands. The first lands were non-LFA, which predominantly includes farmed lands outside of LFA, while the second were represented by mountain areas with higher attitudes.

In the first part of the thesis we evaluated trend functions for subsidies according to their type. In broad terms, payments per hectare are much higher in mountain areas rather than in not LFA. Thanks to Rural Development Programme, which supports measures such as LFA, farmers can compensate their costs receiving these payments. Moreover, a decline in the economic performance of farms in these areas might cause a marginalization of LFA, which might negatively affect the Czech agrarian sector in the future. Overall, we see positive trends in both regions, however mountain areas will more likely to receive higher payments per hectare in the future. As for Single area payment scheme, there is no difference in payments at all, because only one factor influences on the amount of subsidies paid is number of hectare in agricultural land. These payments have also tendency to growth, showing almost identical results in trends. Environmental subsidies are much higher in mountain areas. Farmers in these areas tend to use agri-environmental practices on agricultural lands, which makes payments relevant. It can be explained that for agri-environmental measures, farm's income and total production is not a priority, which is suitable for the framework of LFA (Less Favored Areas are less productive, consequently farm's income is lower). LFA payments, significantly dominate in mountain areas, since most of mountain areas are in LFA. As well as for environmental payments, LFA subsidies tend to increase, while in non-LFA, they have a tendency to decrease.

In regression analysis we built two models to know a relationship between farm's income and total subsidies excluding investments with total labour input for each area. For non-LFA, the dependent variable was FNVA/AWU. In case of mountain area, farm's income was

represented by FNVA indicator, since model with FNVA/AWU accepts t-Test for total labour input, making this parameter statistically insignificant thus we decided to improve our model. Both models have good percentage of variances explained (more than 80%), with significance of a whole model and individual for parameters. Coefficients of total labour input in both models is negative, what tells us that this negatively effect on farm's income, while subsidies excluding investments are more likely to increase the profit of farms. There is a logical explanation for this, that agricultural holdings must provide additional expenses for workers such as wages, arrangement of workplaces, rent, insurance and other cost, while payments granted to farmers reduce this loss. Moreover, the constant of regression equation in both areas is different. Agricultural sector of non-LFA is more suitable for intensive production, since the constant is positive this tells us that in case if there will be no influence from subsidies paid and total labour input, farms are more likely to be profitable. The constant of model for mountain areas is negative, which explains if there is no influence of given factors, we expect loss in these areas. This can be explained that mountain areas are areas with natural limitation and this is the reason why, farm's income in these areas can't be reached without external additional support in the form of subsidies.

Referring again to subsidies, we defined that all types of payment tend to increase in mountain areas, which can be explained that the EU within the framework of the CAP actively supports these regions. Concerning non-LFA areas, environmental subsidies and payments for LFA tend to decrease, while SAPS payments have a tendency to growth. The reason of these differences is conditioned by various purposes of agricultural support. The role of payments in non-LFA is defined as support directed to the main objective of agriculture such as intensive production. It is essential to support productive areas in order to receive national agricultural products for population. Another role of subsidies was shown in mountains areas. In case of these payments, we can't claim that they primarily focus on achievement of ambitious goals such as increasing of total production. Conversely, payments in these areas are directed to sustaining rural development. As proof, environmental payments are significantly dominating in mountain areas rather than in non-LFA. It is also very important to support LFA areas, since they are representing more than 50% of agricultural land in the Czech Republic. Failure to do, we might expect a significant economic decline in agrarian sector. Overall, payments in these areas act as compensating

economic limitation related to specific natural conditions and supporting rural areas at farm level.

Therefore, by comparing selected agricultural payments in two different areas, the general hypothesis was confirmed, and we can claim that subsidies in the Czech Republic are important, performing different functions in farm economy.

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