Czech University of Life Sciences Prague

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Bachelor Thesis

Analysis of Unemployment in the Czech Republic

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Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

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Economics and Management

Thesis title

Analysis of unemployment in the Czech Republic

Objectives of thesis

The objective of this work is to analyze the current situation of unemployment problem in the Czech Republic. The practical part consists of an overview of unemployment based on age and gender groups, different regions and educational level of unemployed people. It also includes the forecasting of the future values of unemployment rate for the following year using different statistical methods. Another goal was to find the most effective model for forecasting unemployment rate in the Czech Republic.

Methodology

The theoretical part of this work is focused on the overview of basic information about unemployment, its definition and basic terms based on qualitative research of Czech and foreign literature as well as web portals of state and non-state institutions. The empirical part of the thesis uses descriptive statistic tools, such as percentage, mean and range, in order to analyze the quantitative data. Several statistical methods were used in order to obtain the forecast of the unemployment rate. MSD, MAPE and MAD statistics enabled to compare the fits of those forecasting methods.

The proposed extent of the thesis

30-40

Keywords

unemployment, labour force, labour market, Holt's double exponential smooting method, mean absolute percentage error

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Recommended information sources

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Expected date of thesis defence

2018/19 SS – FEM

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Declaration

I declare that I have worked on my bachelor thesis titled "Analysis of Unemployment in the Czech Republic" 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 14.3.2019 _____

Acknowledgement

I would like to thank my supervisor, Karel Malec, for his time, advice and patience during the whole process of writing this thesis. Special thanks goes to my family and friends for their support and belief in me.

Analysis of Unemployment in the Czech Republic

Abstract

This Bachelor thesis will be dealing with Unemployment problem in the Czech Republic. Theoretical part of this work is devoted to an introduction to the basic terms connected to unemployment, so the concepts such as labour market, types of unemployment and its measuring, employment policies and risky groups of unemployed will be defined in this part. Literature review creates a foundation of information, which is essential for the following practical part of this work.

The beginning of the empirical part will be focused on a descriptive analysis of the current situation of unemployment in the Czech Republic. It was done for the purposes of deeper understanding of the subject area and as a background for the future forecast. The main aim of this work was to find the best fit among smoothing methods for the forecasting of future values of unemployment rate in the Czech Republic, so the techniques named Double exponential smoothing, which is also known as the Holt's method, Holt-Winter's multiplicative and additive methods were employed. In the process of forecast accuracy evaluating, Mean Square Error (MSE), Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) indicators were employed. In the conclusion part, the answers to the main objectives of this work will be described.

Keywords: Unemployment, labour force, labour market, Holt's double exponential smooting method, mean absolute percentage error, labour market, risky groups of unemployed, types of unemployment

Analýza nezaměstnanosti v České republice

Abstrakt

Tato bakalářská práce se bude zabývat problematikou nezaměstnanosti v České republice. Teoretická část práce je věnována seznámení se základními pojmy souvisejícími s nezaměstnaností, takže v této části budou definovány pojmy jako trh práce, typy nezaměstnanosti a její měření, politiky zaměstnanosti a rizikové skupiny nezaměstnaných. Přehled literatury vytváří základ informací, který je nezbytný pro následující praktickou část této práce.

Začátek empirické části bude zaměřen na deskriptivní analýzu současné situace nezaměstnanosti v České republice. To bylo provedeno za účelem hlubšího porozumění oboru a jako podklad pro budoucí prognózu. Hlavním cílem této práce bylo najít nejvhodnější způsob vyhlazování pro předpovídání budoucích hodnot míry nezaměstnanosti v České republice, a to technikami nazvanými Dvojité exponenciální vyhlazování, které je také známo jako Holtova-Winterova multiplikativní metoda. a aditivní metody. V procesu hodnocení přesnosti prognózy byly použity indikátory střední střední chyby (Mean Square Error - MSE), průměrné odchylky absolutní odchylky (MAD) a průměrné absolutní odchylky (MAPE). V závěrečné části budou popsány odpovědi na hlavní cíle této práce.

Klíčová slova: Nezaměstnanost, pracovní síla, trh práce, Holtova dvojitá exponenciální metoda smootingu, průměrná absolutní procentuální chyba, trh práce, rizikové skupiny nezaměstnaných, typy nezaměstnanosti

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MAD-Mean Absolute Deviation

MSE-Mean Squared Error

MAPE-Mean Absolute Percentage Error

CZSO-Czech Statistical Office

CR-Czech Republic

GCE- General Certificate of Education

USA-The United States of America

1. Introduction

My bachelor thesis is dedicated to the problematic of unemployment in the Czech Republic. Unemployment is one of the most serious nowadays problems of majority of economies. It causes serious economic, social and internal political problems in every country and in the same time brings financial and emotional distractions for individuals. Recessions, introduction of new technologies, competition between companies in a particular industry and job outsourcing are the main reasons of people being unemployed. The economic crises in 2008 became a reason of deepening of unemployment in the Czech Republic and number of other countries. Governments use unemployment statistics in order to track the health of the economy.

The main aim of the thesis is to create the short-term forecast of unemployment rate in the Czech Republic. Determining the best fit among smoothing methods, which will provide the most accurate forecast is another goal. Sub objective was to get an overview on the current situation of unemployment in the Czech Republic from the perspective of age, gender groups, as well as the highest educational level of unemployed people.

This work consists of two parts and some additional subchapters. Theoretical part of this thesis deals with the basic concepts, related to unemployment problem. Literature review was done by using Czech and foreign literature and publications, as well as the data from the official websites of several state institutions, such as Czech Statistical Office and Ministry of Labour and Social Affairs. In the empirical part of this thesis, smoothing methods, such as Double exponential smoothing (Holt's method), triple exponential smoothing (Holt-Winter's), both multiplicative and additive, will be employed in order to obtain predictions of general unemployment rate for the year 2019. In the forecasting procedure quarterly data of general unemployment rate, which was taken from the CZSO website, is used. The time series consists of the data of period from the first quarter of 2010 up until the fourth quarter of 2018. Accuracy evaluating indicators, such as Mean Square Error (MSE), Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) will be used in order to find the best fit for the short-term forecasting of unmployment rate values in the Czech Republic.

2. Objectives and Methodology

Objectives

The main goal of this thesis is to create forecast of general unemployment rate in the Czech Republic for the year 2019. Determining the most effective smoothing method for the short-term predictions of values of unemployment rate in the Czech Republic is another goal. Sub objective of this work is to analyze the current situation of unemployment problem in the Czech Republic. The practical part consists of brief descriptive analysis of unemployment, based on different regions, age and gender groups as well as the educational level of unemployed people. It also includes the forecasting of the future values of unemployment rate for the following year using different smoothing methods.

Methodology

Descriptive statistics

Descriptive statistical tools are used in order to describe the main features of the data in a study and to present the quantitative descriptions in a compliant form by simplifying big amounts of information in a sensible way. The basic descriptive statistical tools are:

- **Mean** is an average of data set and can be found by adding up all values and dividing them by the number of values.

$$\bar{x} = \frac{\sum x}{n} \quad (1)$$

  Where x represents each observation and n represents the number of observations.

- **Variance** measures how far is each dataset value from the mean of the whole dataset. The variance of sample is calculated by the following expression:

$$s^2 = \frac{\sum (x_i - x)^2}{n-1} \quad (2)$$

  Where x = the sample mean, x_i represents the i^{th} element from the sample and n = the number of observations in the sample.

- **Standard deviation** is calculated as a square root of variance and it measures the scatter of the dataset relative to the mean, so the further data points situated the mean, the higher deviation within a dataset will be.

$$s = \sqrt{\sum \frac{(x_i - x)^2}{n-1}} \quad (3)$$

Where *x* represents the sample mean, x_i represents the i^{th} element from the sample and *n* = the number of observations in the sample.[1]

Exponential smoothing methods

In these methods of forecasting, all past observations do have weights, so the newer observations is, the more influence it has on the forecast. Older observations have less infuence on the forecast.

Double exponential smoothing (Holt's method)

Double exponential smoothing employs a level component and a trend component at each period. This method uses two weights, which are also called smoothing constants, to update the components at each period. This method involves a forecast equations, where (6) is used for one-period-ahead forecast and (7) is used for m-period-ahead-forecast, and two smoothing equations, where one is for determining the level component at each period(4) and one is for determining the trend component at each period (5).

$$l_t = \alpha y_t + (1 - \alpha)(l_{t-1} + b_{t-1}) \quad (4)$$

$$b_t = \gamma(l_t - l_{t-1}) + (1 - \gamma)b_{t-1} \quad (5)$$

$$f_{t+1} = l_t + b_t \quad (6)$$

$$f_{t+m} = l_t + mb_t \quad (7)$$

where l_t is a level at a time t

b_t is a trend at time t

[1] Ali, Z., & Bhaskar, S. B.*, Basic statistical tools in research and data analysis*, 2016

y_t is the data value at time t

f_{t+1} is the forecast value for one period ahead at time t

f_{t+m} is the forecast for m periods ahead at time t

α and γ are the *smoothing constants* $0 \leq \alpha \leq 1$ and $0 \leq \gamma \leq 1$.

Holt-Winter's exponential smoothing

In 1960, Peter R. Winters improved Holt's algorithm by adding a seasonal component in the basic equations. This method is used for calculations of a trend line for the data and also seasonal indices. This method is also known as a triple exponential smoothing and includes three smoothing equations and a forecast equation.

In the case of **multiplicative exponential smoothing**, this method is represented by the following equations:

$$l_t = \alpha \frac{y_t}{S_{t-s}} + (1-\alpha)(l_{t-1} + b_{t-1)} \quad (8)$$

$$b_t = \beta(l_t - l_{t-1}) + (1-\beta)b_{t-1} \quad (9)$$

$$s_t = \gamma \frac{y_t}{l_t} + (1-\gamma)s_{t-s} \quad (10)$$

$$f_{t+k} = (l_t + kb_{t)}s_{t+k-s} \quad (11)$$

Where *s* is a a number of seasons per year

l_t is a smoothed level at time t

b_t represents the change of the trend at time t

S_t represents the seasonal smooth at time t

α, β, γ are smoothing constants, where $0 \leq \alpha \leq 1$, $0 \leq \beta \leq 1$ *and* $0 \leq \gamma \leq 1$.

The additive exponential smoothing is given by the following equations:

$$l_t = \alpha(y_t - s_{t-m}) + (1-\alpha)(l_{t-1} + b_{t-1}) \quad (12)$$

$$b_t = \beta(l_t - l_{t-1}) + (1-\beta)b_{t-1} \quad (13)$$

$$s_t = \gamma(y_t - l_{t-1} - b_{t-1}) + (1-\gamma)s_{t-m} \quad (14)$$

$$f_{t+h} = l_t + b_t h + s_{t+h-m} \quad (15)$$

Where *m* is a seasonal period (for example, m=12 when monthly data is being used)

f_{t+h} is a h-step forecast made using the data to time t

l_t is a smoothed level at time t

b_t represents the change of the trend at time t

s_t represents the seasonal smooth at time t

α, β, γ are smoothing constants, where $0 \leq \alpha \leq 1$, $0 \leq \beta \leq 1$ and $0 \leq \gamma \leq 1$.

Holt-Winters method of exponential smoothing requires the **initializing** of each component commonly using:

$$s_1 = \frac{Y_1}{a_p}\ , s_2 = \frac{Y_2}{a_p}\ ,\ \ldots,\ s_p = \frac{Y_p}{a_p} \tag{16}$$

$$s_1 = Y_1 - a_p, s_2 = Y_2 - a_p, \ \ldots, s_p = Y_p - a_p \tag{17}$$

$$a_p = \frac{1}{p}(Y_1 + Y_2 + \ldots Y_p) \tag{18}$$

$$b_p = \frac{1}{p}\left[\frac{Y_{p+1} - Y_1}{p} + \frac{Y_{p+2} - Y_2}{p} + \ldots + \frac{Y_{p+p} - Y_p}{p}\right] \tag{19}$$

Where *p* is the number of seasons per year (for example, p=4 for the quarterly data)

l_t is a smoothed level at time t

b_t represents the change of the trend at time t

s_t represents the seasonal smooth at time t.[2]

MSE, MAD and MAPE

In order to check the accuracy of the estimated forecastng models, MSE (Mean Square Error), MAD (Mean Absolute Deviation) and MAPE (Mean Absolute Percentage Error) accuracy measures are being used. In general, the lower the values of these indcators, the better the model.

MSE measures the variability in the forecast error and is being calculated using the expression:

[2] Hyndman, R.J., & Athanasopoulos, G., *Forecasting: principles and practice*, 2018

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(f_t - y_t)^2 \tag{20}$$

MAD is the average of absolute errors. Here, absolute error is the absolute value of the actual data minus forecasted data. MAD is calculutated by the following equation:

$$\mathrm{MAD} = \frac{\sum_{i=1}^{n}|y_t - f_t|}{n} \tag{21}$$

MAPE shows that on average, the chosen exponential smoothing model made a forecast that differs from the actual value by calculated percentage. The value of MAPE can be obtained using the expression:

$$\mathrm{MAPE} = \frac{\sum_{i=1}^{n}\frac{|y_t - f_t|}{y_t}}{n} * 100\% \tag{22}$$

In all those three equations (20, 21 and 22), n is the number of data points, y_t is the data value at time t and f_t is a predicted value at time t.[3]

3 Ridha Rizki Novanda et al., *A Comparison of Various Forecasting Techniques for Coffee Price,* 2018

3. Literature review

In the theoretical part of this work, the key concepts related to the unemployment will be studied and explained.

3.1 Unemployment and its characteristics

Unemployment is a topic, that is being frequently discussed in a modern society. It is a macroeconomic problem, negative and undesirable state, which brings an adverse impact and number of various problems. From the economic point of view, it can never disappear. It also can be described as a phenomenon that reduces the potential level of the economy.[4]

Besides the negative impact on the economy, unemployment is also partly responsible for some social and psychological consequences. It negatively affects the standard of living of unemployed and their families.[5]

3.1.1 Definition of Unemployment

We can define unemployment as a state when a person, who is able to be working and is looking for any kind of work, is unable to find one. That person should be an active member of labor force and actively be seeking financially rewarding work in order to be considered unemployed.

There are three basic groups in the society regarding their employment status:

1. Employed-group of people, who work and get benefits (mostly financial) for it. This group also includes people, who has job or business, but temporarily not working because of different reasons, such as illness or vacation for example.
2. Unemployed-group of people, who does not have job, but actively looking for one.
3. Others-this group includes people, such as students and parent on maternity leaves, withal disabled and those, who are homemakers or simply are not registered at the labor market (not economically active population).[6]

[4] NĚMEC, D., *Hystereze nezaměstnanosti v České republice*, p. 5
[5] JUREČKA, V., *Makroekonomie*, p. 135
[6] Ibid, p. 139-140

3.1.2 Types of Unemployment

There are three basic types of unemployment: frictional, structural and cyclical. They help us to understand the reasons, leading to unemployment and also their relations with economy. We could also define some additioanl types, such technological unemployment, long-term unemployment, unemployment which is devided based on voluntary and hidden unemployment.

3.1.1.1 Main types of Unemployment

Frictional Unemployment

Frictional Unemployment is a component of Natural Unemployment and is a part of a normal labour turnover. It occurs when workers just left or lost their job but already looking for a new one, so it's usually a short-term. This type of unemployment isn't bringing harm to economy. In fact it even benefits it, as the increase of the frictional unemployment rate means the increase in people's willingness to find a better place, where they could develop their skills more efficiently. Furthermore, frictional unemployment helps companies to bring on good workers.[7]

Structural Unemployment

It is a longer-lasting type of unemployment and it occurs when specific economic shifts make hard for some people to keep or find a job. It means that the level of employee's skills is not matching the demand of the job available. Technological development in manufacturing and different government policies can serve as examples of causes, which bring to an increase of structural unemployment rate. This increase, in turn, brings to a higher rate of natural unemployment.[8]

Cyclical Unemployment

Cyclical Unemployment is the main cause of high unemployment. Unemployment is considered to be high at 8 percent of labor force. This type of unemployment is dependent on a business cycle and occurs when this cycle is facing decline. By measuring Gross

[7] JUREČKA, V., *Makroekonomie*, p. 139-140
[8] Ibid, p. 139-140

Domestic Product (GDP), we can analyze the level of economy contract. In addition, this type of unemployment is temporary, so when the economy enters the recession phase again, previously laid off employees can get their jobs back. The main cause of cyclical unemployment is a large drop off of the demand, which is a result of decrease in personal consumption.[9]

Among the measures to reduce Cyclical Unemployment are:

- Lower interest rates
- Lower direct taxes
- Improved government spending
- Foreign investments
- Employment subsidies.[10]

3.1.1.2 Additional Types of Unemployment

Long-term Unemployment

This type of unemployment occurs when people are not able to find work for at least 12 months. Long-term unemployment causes mental and material stress for affected people and also questions the efficiency of functioning of the labour market, which brings concerns to policy-makers.[11]

Technological Unemployment

Technological unemployment is a part of structural unemployment. It occurs when development in technology, such as computers, robots and artificial intelligence for example, become a reason of people to lose their jobs.

Seasonal Unemployment

This type of unemployment is short term and occurs due to seasonal changes in the job offer. Seasonal unemployment therefore causes discontinuity of production in sectors, where production is dependent on weather. Such sectors as agriculture, construction,

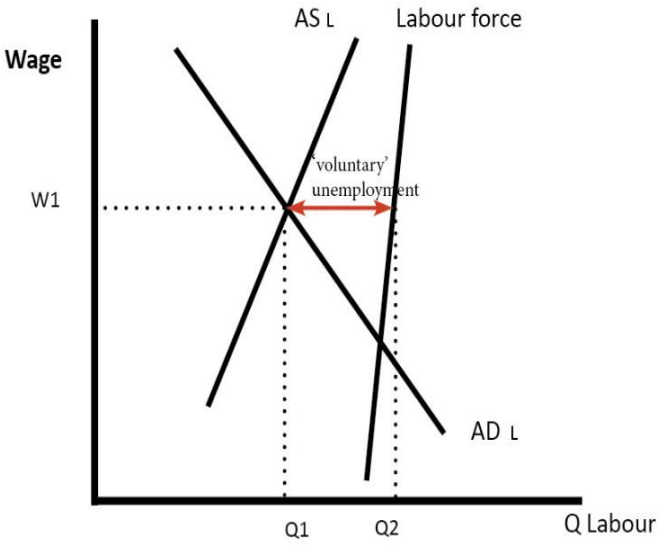
[9] JUREČKA V., *Makroekonomie*, p. 139-140
[10] MAITAH M., *Macroeconomics*, p. 150
[11] OECD.org, 2018

forestry, fishing could serve as examples of this case. Seasonal unemployment also has a major impact on tourism-related services.

Voluntary Unemployment

This type of unemployment occurs when people deliberately refuse to accept work because it offers lower wage rate, that they would like to be getting or when they are unable to find the work which would meet their personal preferences. Among the reasons, which make people to chose to be unemployed, is their satisfaction with the amount that is provided by the government in the form of unemployment benefits. [12]

Figure 1. Voluntary Unemployment



Source: economicshelp.org

The figure above shows that the concept of voluntary unemployment could be explained as a difference between Labour force and Aggregate supply of Labour (AS L). Aggregate supply of Labour indicates the number of people that are supplying their labour.

Involuntary Unemployment

Involuntary Unemployment occurs when people are ready to accept the job at the offered

[12] HOLMAN, R., *Makroekonomie*, p. 668

wage rate or even lower, but not able to find work due to reasons which are beyond their control.[13]

Hidden Unemployment

This type of unemployment includes all unemployed people who are not registered as unemployed, even if they do not have a job. The huge part of it is formed by teenaers and married women. It also includes people with low qualifications, elderly people, people with disabilities, etc. This is a form of unemployment when an unemployed person is not looking for a job or does it in informal ways, directly with employers for example, he also doesn't want to be registered in labour office.[14]

3.1.2 Measuring Unemployment

Unemployment is considered to be one of the most important macroeconomic indicators. The output of measuring unemployment is an unemployment rate. It serves as a tool to compare the economic level in different regions and is usually calculated by the simple equation:

$$u = \frac{U}{L+U} * 100(\%),$$

where u-is an unemployment rate (in %), U represents the number of unemployed and Lis the number of employed.[15]

Monitoring of Unemployment rate is considered to be one out of four basic economic policy objectives. Most countries use the methodology of International Labor Organization (ILO) in order to measure unemployment rate. Missing factors, which haven't been included in the official unemployment rate, fall into the underemployment category. Not taking those factors into account is a big shortcoming of the official unemployment rate, as underemployment also includes people who would like to work more hours, but not able to due to inadequate demand on the labour market. Underemployed people are those, who are unemployed but willing and able to work, in spite of their belonging to economically

[13] BROŽOVÁ, D., *Společenské souvislosti trhu práce*, s. 86
[14] MAREŠ, P., *Nezaměstnanost jako sociální problém*
[15] HOLMAN, R., *Makroekonomie*, s. 158

active population. The declining unemployment rate could serve as false proof of an improving labor market situation where the number of involuntary part-time workers is growing.

3.1.2.1 Okun's Law

This law is about a negative relationship between the change in unemployment rate and the growth of GDP and says, that if the actual unemployment rate deviates by 1% from the natural rate of unemployment, the product deviates by 2% from the potential product. The important thing is whether the real product will grow or fall.

$$c(u - u*) = \frac{Y* - Y}{Y*}$$

where c - coefficient of linear dependence, u - actual unemployment rate, u * - natural rate of unemployment, Y - the real product and Y * - potential product.[16]

3.1.2.2 Unemployment indicators in CR

By the year 2013, in Czech Republic, there were two indicators of unemployment rate.

The **registered unemployment rate** is the first one of them. In order to obtain it's value (the number of job applicants, who are out of work and registered in labour offices), the data provided by the Ministry of Labour and Social Affairs were used. "Unemployment rate is derived as the ratio of the number of job applicants out of work to the number of employment as obtained by the LFSS (annual moving average) plus the number of job applicants registered by the labour offices and out of work (annual moving average)."[17]

The second indicator is the **general unemployment rate**, which is provided by Czech Statistical Office. This rate expresses the share of total number of unemployed in the labour

[16] Brčák, J., Sekerka, B., *Macroekonomie*
[17] czso.cz, 2018

force, expressed in percentages. This rate is obtained from the results of Labour Force Sample Survey.[18]

From the beginning of January of 2013, based on agreement of Czech Statistical Office and Ministry of Labour and Social Affairs, the unemployment measurement system was unified, so since then the indicator "Share of Unemployed" (czech: „Podíl nezaměstnaných osob") is being used. "It is the ratio of available job seekers aged 15 to 64 years in the population of the same age."[19]

3.1.3 The risky groups of unemployed

This chapter is dedicated to so-called risky groups on the labor market, people from this groups have a higher risk of losing their job and can be characterized by certain internals. s of people from these categories are more likely to be employed in less paid jobs or may not even get one at all because most of them do not have needed qualifications. Among those people are, for example, women with small children, disabled, young, elderly people and so on. These groups of people are the focus of employment policy. So let's descry these categories in more details.[20]

Younger age groups up to thirty

This category includes high school and university graduates who are looking for the first job. These people do not have working experience and enough practice yet and that's why they are at a disadvantage compared to those people who have that experience. Nowadays, the unemployment rate among graduates is a major problem.[21]

Older people

The older people perceive unemployment the most difficult, as they more likely to have a poor orientation in the work environment. Despite of a huge working experience, employers usually find this group less attractive compared to younger age groups. [22]

[18] czso.cz, 2018
[19] mpsv.cz
[20] Srov. BUCHTOVÁ, B., *Nezaměstnanost,* p. 91-94
[21] Ibid, p. 82-84
[22] Ibid, p. 85-87

Women

Employers often prefer a male workforce to the female one, as usually women are more affected by household care. Women who have small children are committed to family and it is not easy for them combine maternity and work. The solution could be an improvement of the financial security of women.[23]

People with disabilities

People with limited ability have a small chance to find a work as they have economic, social and psychological problems. Their life situation is not easy and in most cases their family has to take care of them.[24]

People without qualifications

From the perspective of long-term unemployment, this group is considered to be the largest one and it includes people with social problems, such as, for example, alcoholics and recidivists. People from this group have only basic education and have almost no interest in learning. That's why they do have very low chances to find a work and are often dependent on state support. [25]

Roma Ethnicity

It is extremely hard for people from this group to find a job as they do not have the necessary education and appropriate social conditions. They are, asa group mentioned earlier, have only basic education and are not interested in further qualifications. They have their own ways for behaving, that's why they have very small chances to be employed. These people are mostly dependent on social support from the state.[26]

3.1.4 Employment Policy and its influence on Unemployment

Thanks to chosen economic policy, the state or the government, is able to reduce both the consequences of unemployment and time spent on finding a job in several ways.[27]

[23] BUCHTOVÁ, B., *Nezaměstnanost,* p. 88-89.
[24] Ibid, p. 89-90
[25] Ibid, p. 90
[26] Ibid, p. 91
[27] BROŽOVÁ, D., *Společenské souvislosti trhu práce*, p. 86

We could define employment policy as an activity which tries to strike the balance between supply and demand of the labour force in the labour market. It also aims to manage the productive use of labour resources and protect the citizens' right to work.[28] Employment policy has two forms: active employment policy and passive employment policy.[29]

3.1.4.1 Active Employment Policy

This form of government employment policy that supports the creation of new jobs through the contribution of employers to people who are seeking jobs. [30]
In Czech Republic it's run by the Ministry of Labor and Social Affairs through the Labour Offices. Active employment policy is an instrument that helps to reduce unemployment on a regular basis. [31] Another aim of this policy is to help the most vulnerable groups of unemployed and keep them from being socially excluded.
The basic forms of active employment policy include:

- Retraining
- investment incentives,
- public works,
- socially meaningful jobs,
- bridging allowance,
- contribution to the incorporation,
- contribution to the transition to a new business program.[32]

3.1.4.2 Passive Employment Policy

This type of policy deals with elimination of the negative impact of unemployment from the point of view of the job-seeker. The passive employment is firmly linked to the function of job searching and informing the unemployed about vacancies available. It also manages the payment of unemployment benefits.

[28] BUCHTOVÁ, B., *Nezaměstnanost,* p. 91
[29] JÍROVÁ, H., *Trh práce a politika zaměstnanosti*
[30] mpsv.cz, 2012
[31] JUREČKA V., *Makroekonomie*
[32] JÍROVÁ, H., *Trh práce a politika zaměstnanosti*

The term *passive employment policy* means, in particular, material security and direct job placement for jobseekers. These are tools, which are dealing with the consequences of unemployment.[33]

3.1.5 Natural rate of unemployment

Natural rate of unemployment means the equilibrium level of the labor market. It is achieved if the economy is in the long run and its resources are being fully used. The meaning of term "natural" is not about an appropriate rate of unemployment; it is called that because in the long term perspective, the natural rate of unemployment is not very different from actual unemployment. The formula of the natural rate of unemployment is as follows:

$$u* = \frac{\sigma}{\sigma+\varphi}$$

where *u* - the natural rate of unemployment, σ is the rate of job loss and φ is the rate of finding work.

This formula says that the natural rate of unemployment is in direct dependent on the rate of job loss and and inversely proportional to the level of finding work.These relationships depend on the people's awareness on the labor market. So the greater the awareness is, the greater the possibility of finding work and the lower natural rate unemployment are.[34]

3.1.5.1 Factors that influence the natural rate of unemployment

There are number of factors influencing the natural rate of unemployment. Among them are:

- **Motivation to find a new job** that people have. The higher motivation is, the sooner they will find and get a job, and the lower the natural rate of unemployment will be.
- **Ability of labor offices to provide information** on the current situation on the labor market. In order for the unemployment rate to be as low as possible, it is necessary to keep the potential workers well-informed.

[33] BROŽOVÁ, D., *Společenské souvislosti trhu práce*
[34] HOLMAN, R., *Makroekonomie,* p. 160

- **The size and duration of the unemployment benefit provided**. The more people receive, the more they get used to the support and are not interested in finding a work in a short time.
- **Demographic composition of the workforce**. It includes people, whom it's hard to place on the labour market, such as people with no qualification and elderly people.[35]

3.2 Labour Market

This is a very complex company system. The labor market can be explained as an area where there is a demand for work on one hand and a supply of work on the other. There is competition on the labor market both on the supply side and on the demand side. Work is constantly being demanded by many companies and offered by households and individuals. It is very diverse, there are lots of different professions and different wages of workers. Working in different professions do vary for example by risk or qualification. The difference in work intensity cause the difference between wages across professions. Labour market is considered to be imperfect, as there is unclear and/or incomplete information about it. That's why unemployed do not know about all the vacancies available on the market and employers, in turn, do not know about all the people, who are seeking jobs. It's, in turn, results with natural unemployment. Another reason of increases in natural unemployment is the existence of unemployment insurance, because unemployed is not limited by the need to find a new source for income quickly, and could wait until the job he is interested becomes vacant.[36]

3.2.1 Labour Supply

In the labor market the labor supply is dependent on the wage rate and time. Taking a job offer is a consumer choice; he compares the benefits of leisure with the benefits of products and services. The higher wage rate becomes the more work consumer is willing to do. In addition, additional hour worked brings the consumer even higher income, which results in

[35] JUREČKA, V., *Makroekonomie,* p. 142
[36] HOLMAN, R., *Makroekonomie,* p. 157

greater benefit from products and services. That's why there is a substitution of free time for work.[37]

The wage rate can be viewed from two different sides: higher wage rate leads to the reduction of number of hours worked, which is, in turn, limiting the supply of labor. However, if the prices of products and services remains the same while wage rate is higher, then that would lead to the change of the consumers' choice for leisure time and increased real income. At the lower wage rate, the so-called substitution effect occurs. People substitute retirement with leisure. However, the wage rate increase leads to an increase of demand for vacancies. Labor supply starts rising as well. [38]

The main determinants of the market offer are:
- Property
- Real wages, their current and expected levels
- Non-labor revenue, including government transfers
- Demographic trends, in particular gender, population and age structure
- The rate of economic activity of the population
- Customs, culture and traditions.[39]

3.2.2 Labour demand

The job demand is dependent on consumer demand for final goods and is represented by enterprises, ie employers. The position of an enterprise on the market and its goals do play a big role, since, in general, when it comes to purchasing work, they push off from costs and revenues. All businesses are willing to maximize their profit. That is why they will be hiring more people as long as the an increase in labor exceeds the value of another unit of labor. Employer maximizes his profit from work as long as income from the marginal product equals to the marginal labor costs.

[37] HOLMAN, R., *Makroekonomie,* p. 267
[38] JÍROVÁ, H., *Trh práce a politika zaměstnanosti*
[39] DVOŘÁKOVÁ, Z., et al. *Management lidských zdrojů*, p. 67

Thus: P*MPL = MCL, where P*MPL represents the monetary marginal product of labor and MCL is marginal labor costs.[40]

The marginal product can be explained as an output that results from the employment of one unit of labor if all other inputs are constant. As well as the labour supply, the labour demand depends on the wage rate, but the difference is that the labour demand is determined by the income from a smaller labor product.[41]

The main determinants of the labour demand are:
- The labor price is characterized by the wage rate
- Demand for products, services and their price
- Work productivity
- Prices of other inputs
- Expected future revenue.[42]

[40] HOLMAN, R., *Makroekonomie, p.* 155-156
[41] JÍROVÁ, H., *Trh práce a politika zaměstnanosti*
[42] DVOŘÁKOVÁ, Z. et al. *Management lidských zdrojů*, p. 68

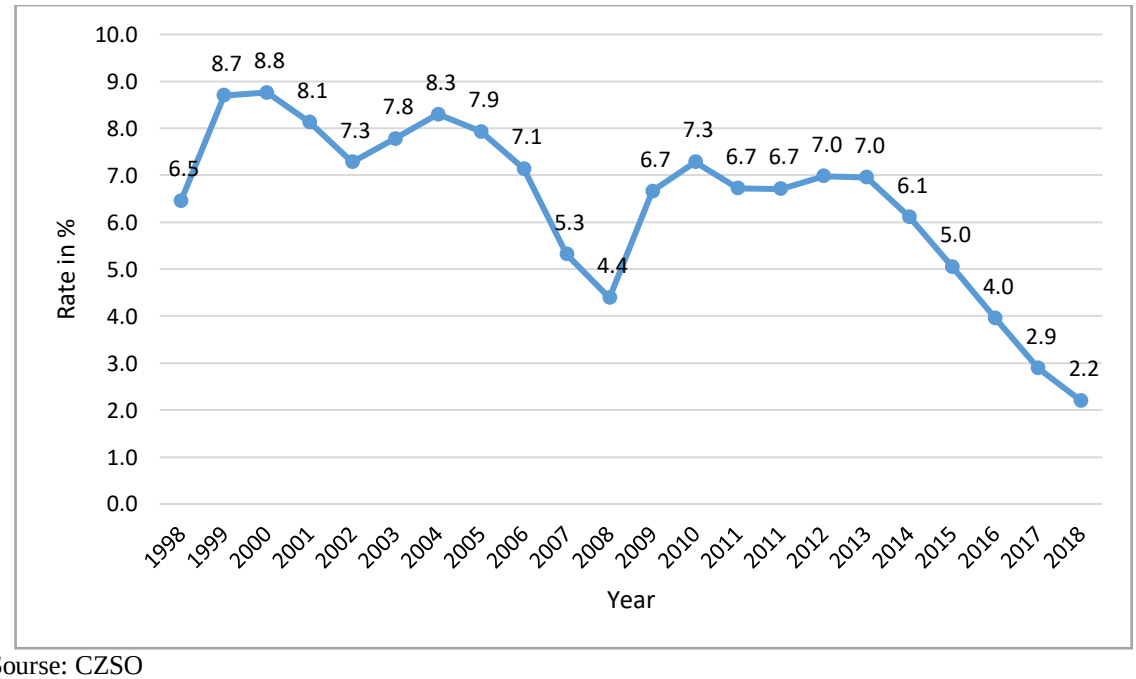
4. Empirical Part

The empirical part of this work consists of further two parts: first one will be focused on analysing the tendency of unemployment rate development as long as an analysis of current situation of unemployment in the Czech Republic from the perspective of regions, age and gender, and highest educational level of unemployed persons. The second part of this chapter will be dedicated to forecasting of the values of the general unemployment rate in the Czech Republic for the following year.

4.1 Unemployment in the Czech Republic

This chapter of an empirical part will be focused on an analysis of current situation of unemployment in the Czech Republic using descriptive statistics tools.

Graph 1. Development of Unemployment rate



Sourse: CZSO

Graph 1 illustrates the development of annual general unmeployment rate in the Czech republic in the last twenty years, so from the year 1998 up until 2018. The mean of the sample is 6,43. The overall graph is pretty fluttered, the highest rate was observed in 2000 at 8,8% and the lowest one in 2018 at 2,2%. We can see the decrease in values between

2004 and 2008 which was mainly caused by the accession of the Czech Republic in the European Union. This event enlivened the Czech economy because of the new investments, which in turn led to the creation of new jobs. The dynamic rise of an unemployment rate since 2008 was caused by the financial crisis in the USA, which henceforth spread to the European countries as well. This crisis mostly affected engineering and export business, which resulted in the huge surplus of staff and the decrease of cost of the labour. We can observe the constant decline tendency since the year 2013, which basically means that the situation with unemployment is getting better since then.

4.1.1 Unemployment in Czech republic by regions

The Czech Republic is devided into 13 self-governing units (regions) and a capital city. Let us compare the unemployment related indicators among those regions and the capital.

Table 1. Unemployment in Czech republic by regions by 31.12.2018

Region	Labour force (in thsnd)	Unemployed (in thsnd)	Rate (%)	No of jobs available (in thsnd)	Jobs available (%)
CR	5428,8	127,5	2,3	324,4	
Prague	721,4	9,2	1,3	67,3	20,8
Central Bohemia	693	15	2,2	48,1	14,8
South Bohemia	321,4	4,4	1,4	17,6	5,4
Plzen	297	4,7	1,6	34,9	10,7
Karlovy Vary	155,3	4,7	3	8,1	2,5
Usti	402,6	15,8	3,9	14,9	4,6
Liberec	213,5	3,4	1,6	11	3,4
Hradec Králové	276,4	6,4	2,3	12,8	4,0
Pardubice	263,1	3,8	1,4	35,6	11,0
Vysočina	263,3	4,2	1,6	9,99	3,1
South Moravia	598,5	18,2	3	24	7,4
Olomouc	319,5	9	2,8	10,9	3,4
Zlin	291,5	4,3	1,5	11,8	3,7
Moravia-Silesia	612,3	24,5	4	17,2	5,3

Source: CZSO

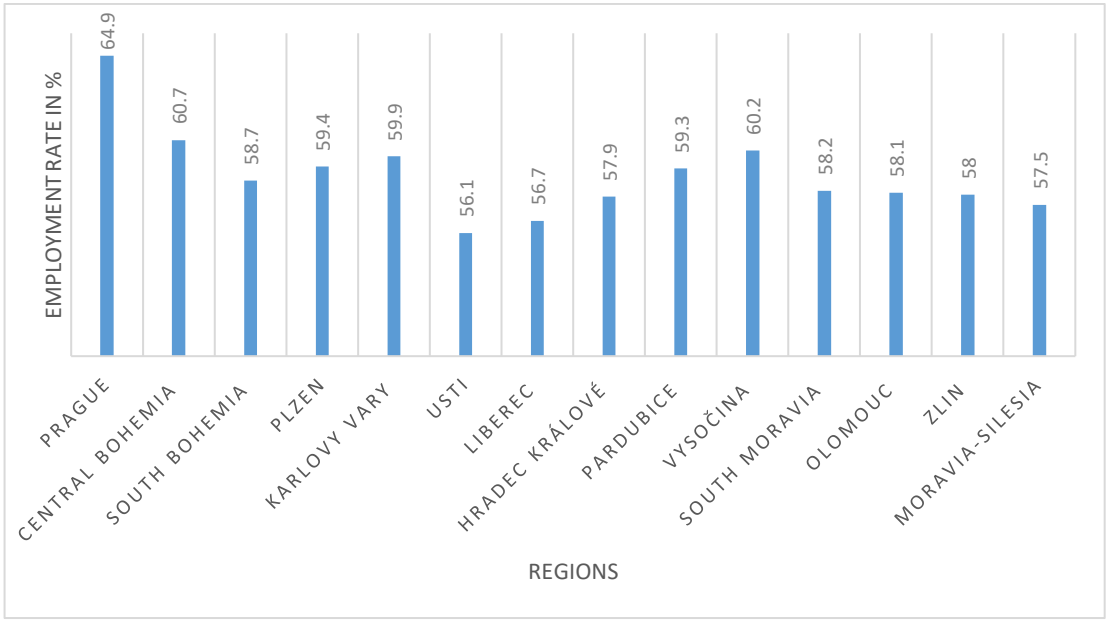
From the Table 1, we can see that the highest number of unemployed is in the South Moravia and Moravskoslezsky regions, which show the results of 18,2 and 24,5 thousand people respectively and in sum build more than the third part of the whole number of unemployed. Decrease in industry could be a result of a high unemployment rate in

Moravia-Silesia region, as historically most of people of that region have been working in that area. This table also shows us that one of the highest unemployment rate is in Usti region, but unlike in Moravia-Silesia, it is caused by high concentration of ethnic people, for whom it is more favorable to use social support than to be employed and receive a regular salary. Olomouc region at a 2,8%, which is higher than the average, represents one of the highest unemployment rates as well.

No surprise, that the best situation with unemployment is in the capital city- Prague, which has 1,3% of general unemployment rate by the end of the year 2018. South Bohemian and Pardubice regions, which showed the rate at 1,4% are almost not falling behind.

A bit more than the fifth part of the whole amount of jobs available in the country, are offered in Prague at a 20,8%, or 67,3 thousand positions. It can be explained by the highest concentration of firms, which is leading to the higher number of positions available. Almost 15% of overall job positions are concentrated in Central Bohemian region, which is followed by Pardubice and Plzen regions at an 11% and 10,7% relatively.

Diagram 1. Employment among regions



Source: CZSO, 2018

Graph 3. shows the difference between employment rate values among regions and, here again, we can see that the best indicator is performed in Prague at the rate of 64,9 per cent, followed by Central Bohemia region at a 60,7%, Vysocina region at a 60,2% and Karlovy Vary region, showing 59,9% of employment rate by the end of the year 2018.

4.1.2 Unemployment in the Czech Republic by age and gender

According to the International Labour Office (ILO) methodology and CZSO data, by the end of the fourth quarter of 2018, there was 111,0 thousand of unemployed people, which is 17,7 thousand less than in the previous year. The number of unemployed women was 63,0 thousand persons, which is 6,4 thousands less comparing to the previous year. The number of unemployed men faced positive changes too, reaching 48,0 thousand persons, which is 11,3 thousand less than in the year of 2017.

Table 2. Unemployment in the CR by age and gender

Age	in thousands			in %		
	Total	Women	Men	Total	Women	Men
15-19	6,51	2,93	3,58	4,19	3,42	5,13
20-24	18,64	8,40	10,23	11,98	9,81	14,65
25-29	19,22	10,09	9,13	12,36	11,78	13,06
30-34	17,45	11,04	6,41	11,22	12,88	9,18
35-39	22,26	13,86	8,40	14,31	16,17	12,03
40-44	18,72	11,08	7,64	12,04	12,93	10,94
45-49	14,26	8,01	6,25	9,17	9,35	8,94
50-54	16,99	8,96	8,04	10,93	10,45	11,50
55-59	14,67	8,73	5,94	9,43	10,19	8,50
60-64	5,63	1,92	3,71	3,62	2,25	5,31
65+	1,18	0,66	0,53	0,76	0,77	0,75
Total	155,54	85,68	69,86	-	-	-

Source: author, based on CZSO data, 2017

In the Table 2, the data on unemployed people divided by age groups and genders is presented. The total number of unemployed by the end of 2017 was 155,54 thousand people. The unemployment number of female population, which is 85,68 is higher, than

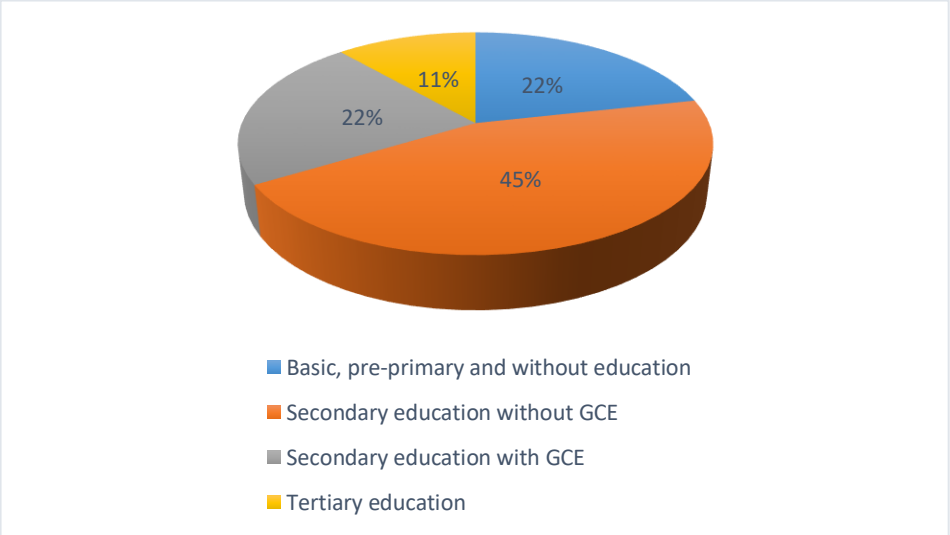
the share of unemployed men, and represents around 55% from total number. There was 69,86 unemployed men by the end of the year 2017.

Therefore, we actually see that the biggest part of unemployed is represented by the group of people between 35-39 years old at a 22,26 thousands people or around 14% out of the whole number of unemployed people. Next group,which shows high share in total number of unemployed people, is people aged 25-29. This group is represented by students and graduates and in the end of 2017 there were estimated 12,36 thousand of unemployed from this category, which is 12,4% from the whole unemployment people.

4.1.3 Unemployment by highest educational attainment

The Diagram 2. illustrates the unemployment in the Czech Republic from the perspective of the highest educational level that unemployed persons have. This diagram was created using data, taken from CZSO website, and represent the situation of the end of the year 2017. As it may be seen, the biggest part of unemployed in the Czech Republic has a secondary education without General Certificate of Education (GCE), 22% of unemployed is created be the people who has basic, pre-primary education or don't have any at all and also by the people with secondary education with GCE. The smallest share of 11% comes people with tertiary education.

Diagram 2. Unemployment in the CR by the highest educational level attained



Source: author based on CZSO data, 2017

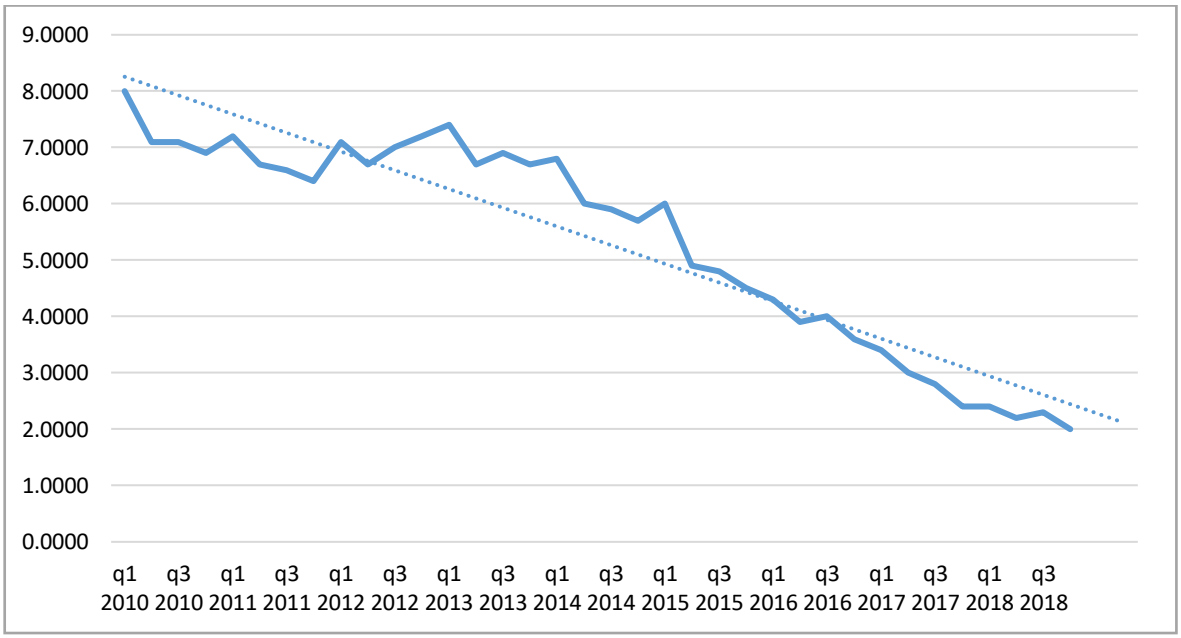
4.2 Forecast

In this chapter, I am willing to provide forecast of the future values of general unemployment rate for the future year using three different methods: Double exponential smoothing (or Holt's method), Holt-Winter's multiplicative and additive methods.

4.2.1 Double exponential smoothing (Holt's method)

In order to use this method, the quarterly data on unemployment rates in the period from first quarter in 2010 to fourth quarter of 2018 were used. The data were taken from the Czech statistical office website. At the beginning there was a need to decide whether there is nature of trend and seasonality, so the time plot was created and, as it may be seen from the Graph 2, there is a a declining trend in unemployment rate.

Graph 2. Trend of unemployment rate



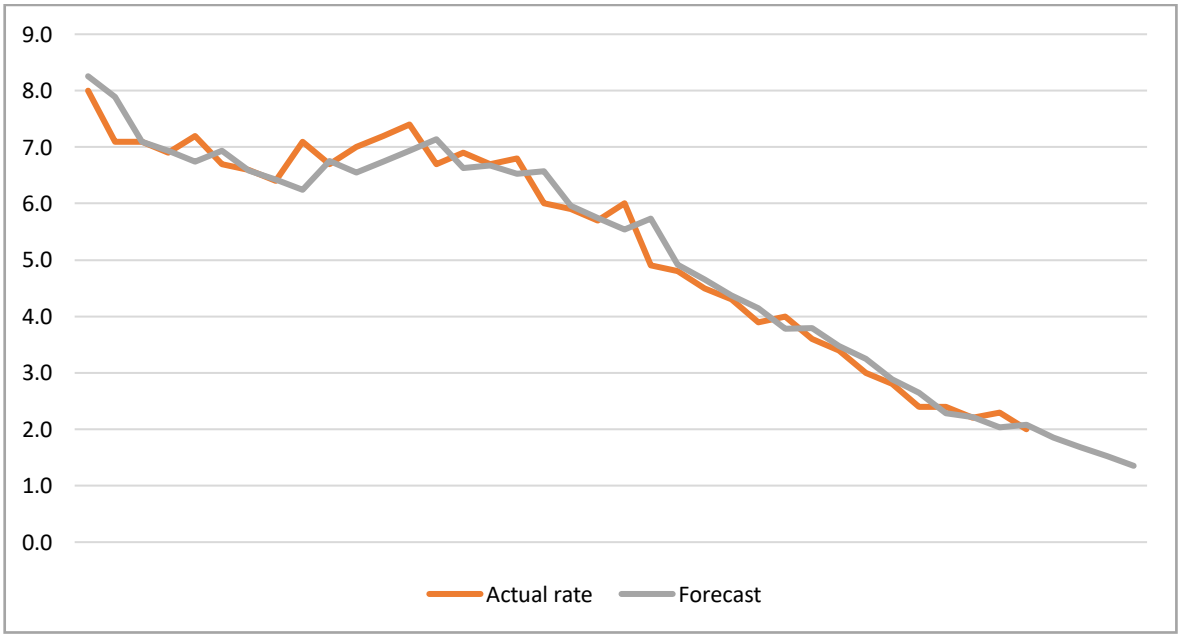
Source: CZSO, 2018

In the Tables 4, 5 and 6, which are in the Appendix section, only models with optimal smoothing constants, selected by the optimization algorithm or with the smallest values of MAPE are shown and interpreted.

Table 4 shows the calculating process, which were done while using double exponential smooting method. The values of coefficients of regression model were needed in order to obtain the initial Level and Trend values. The model was constructed thanks to Regression function in Microsoft Offce Excel, so the iniatial values of Level and Trend got the values of coefficients, which were obtained in that model: 8,4219 and -0,166 accordingly.
The future calculations took place in MS Excel as well. Furthermore, other values of Level, Trend and the Forecast columns were calculated, using formulas (4), (5) and (6), mentioned earlier in Methodology section of this work.

The smoothing constants α and γ at the beginning were set randomly, but after optimization, using MS Excel Solver, where as an objective the minimization of MAPE was set, the best result, at an α=0,79 and β=0 was obtained. «Error», «Error^2», «Absolute Error, At» and «At/yt» columns were calculated in order to obtain MSE, MAD and MAPE values, which will be described more detailed in the "Results and Discussions" section of this work.

Graph 3. Forecast using double exponential smoothing method



Source: author, based on CZSO data

Graph 3 visually illustrates the overall results of using double exponential smoothing method.

So the forecast of unemployment rate in the Czech Republic for the following year is as follows: the rate in the first quarter of 2019 is predicted to be at 1,85, in the second quarter at 1,68, third quarther at 1,52 and the fourth quarter at 1,35.

4.2.2 Holt-Winter's multiplicative method

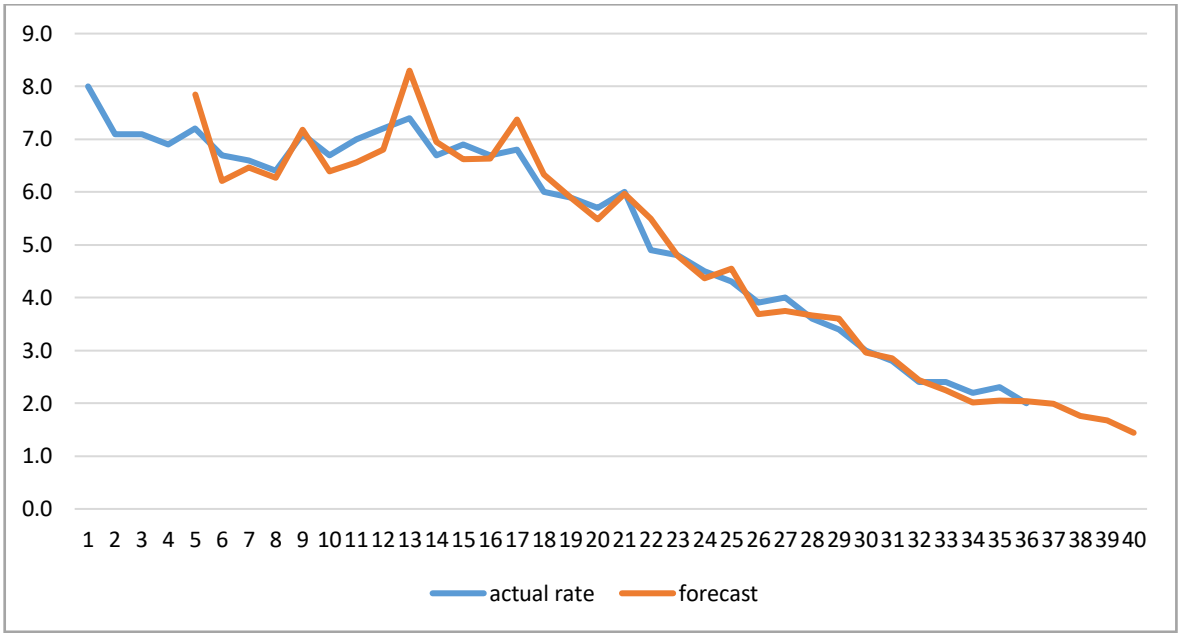
In the Table 5, y_t represents the general unemployment rate, l_t is a smoothed level at time t, b_t represents the change of the trend at time t, s_t represents the seasonal smooth at time t, f_t column stands for the forecast at time t, E is an error, E^2 is a squared error and AE/y_t are the values representing the fraction of absolute error and the actual rate. Last three columns will be used for obtaining the values of MSE, MAD and MAPE.

Smoothing parameters α, β and γ as in the previous method were set randomly at the beginning. But after the optimization part, where the minimization of MAPE value was set as an obective, α was set at 0,82, β equaled 0,3 and γ equaled 1.

During initialization, the seasonal component s_t was calculated according to the formula (16). In this method, the initial values of both level and trend columns are set at l_p and b_p (formulas (18) and (19)), where *p* is a number of seasons per year and in our case p=4, as the quarterly data are being used. That is why the caculations of level and trend columns has been started at the 4th quarter of 2010 only. In the case of calculating the forecast column, the absence of data in the first four rows is due to the presence of l_{t-1} and b_{t-1} values in the formula (11). Error column represents the subtraction of the forecasted values from the actual values.

As it also may be seen from the Table 5, that the forecasted values obtained by using Holt-Winters multiplicative method for the following year are as follows: it predicted unemployment rate to be at 1,99% in the first quarter, 1,76% in the second, 1,68% in the third quarter and 1,44%t by the end of the year 2019.

Graph 4. Forecast using Holt-Winter's multiplicative exponential smoothing method



Source: author, based on CZSO data

Graph 4 visually illustrates the overall results of using Holt-Winter's multiplicative exponential smoothing method.

4.2.3 Holt-Winter's additive method

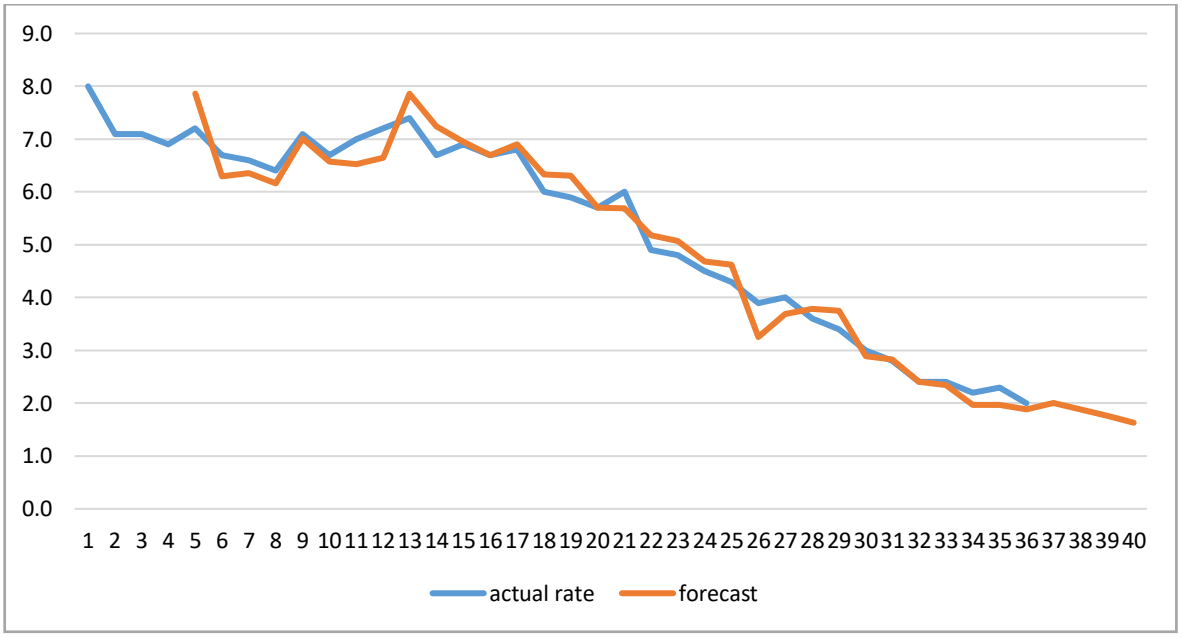
As in the previous model, in the Table 6, y_t represents the general unemployment rate, l_t is a smoothed level at time t, b_t represents the change of the trend at time t, s_t represents the seasonal smooth at time t, f_t column stands for the forecast at time t, E is an error, E^2 is a squared error and AE/y_t are the values representing the fraction of absolute error and the actual rate.

The calculations of the initial values of level and trend were exactly the same as in the Holt-Winter's multiplicative method, so the formulas (18) and (19) were applyed, but before it was necessary to complete the calculations of the whole cycle (m=4) of seasonal component first. The formula (17) was used in order to calculate s_1, s_2, s_3 and s_4. The first value of the forecast column was received in the 1st quarter of 2011, since it required the l_{t-1}, b_{t-1} to be computed first.

The final values of the smoothing parameters α, β and γ were obtained after the optimization part. Again, the goal was to minimize MAPE value, so the best possible result was received at α=0,60, β=0,31 and γ=0,46.

The forecast of the unemployment rate in the Czech Republic using Holt-Winter's additive method had the following results: by the end of the 1st quarter it is predicted to be at a 2 per cent, 1,88 per cent be the end of the second quarter, 1,76 by the end of the third and 1,63 by the end of 2019.

Graph 5. Forecast using Holt-Winter's multiplicative exponential smoothing method



Source: author, based on CZSO data

Graph 3 visually illustrates the overall results of using double exponential smoothing method.

5. Results and discussions

Using the Error column in the Table 4, Table 5 and Table 6, the additional columns of Error squared, Absolute Error and the column, representing the fraction of Absolute Error and Rate columns, named «AE/y_t» were created in order to calculte MSE, MAD and MAPE values. After applying formulas (20),(21) and (22), where MSE was calculated as an average of Error squared column, MAD is an average of Absolute Error and MAPE is an average of AE/yt column, multiplied by 100%, the results interpreted in Table 3 were obtained. In the Table 3, Method 1 is a Holt's double exponential smoothing method, Method 2 is a Holt-Winter's mutiplicative model and Method 3 is a Holt-Winter's additive model.

Table 3. MSE, MAD and MAPE results

	α	β	γ	MSE	MAD	MAPE (%)
Method 1	0,79	0	-	0,12	0,25	4,92
Method 2	0,82	0,3	1	0,09	0,23	4,55
Method 3	0,6	0,32	0,46	0,1	0,26	5,45

Source: author

The Holt-Winter's additive method showed the worst results at MSE=0,1, MAD=0,26 and MAPE=5,45. So as the aim was to minimize the MSE, MAD and MAPE values, we can conclude that the most accurate forecast was provided by Holt-Winter's multiplicative method.

It should be also stressed, that this forecast is for the general unemployment rate of the whole Czech Republic and not for its separate regions. Even if the results showed the continuation of decreasing tendency of the unemployment rate in 2019, it is clear that the rate cannot continue decreasing in such tempo in a long run, so the accuracy of the predicted values could easily get affected by some external events, as it was in the years 2004 and 2008.

Conclusion

The main objective of this bachelor thesis was to make a forecast of general unemployment rate for the year 2019. Determining the best forecasting method for the short-term predictions of general unemployment rate in the Czech Republic was another goal. Several forecasting methods that are adequate for forecasting time series with the trend component, named double exponential smoothing (Holt's method) and triple exponential smoothing (Holt-Winter's method), both multiplicative and additive models, have been selected and employed. Quarterly data of general unemployment rate values in the period of the first quarter of 2010 up to the fourth quarter of 2018 were used. The data was taken from the Czech Statistical Office website. The results of accuracy evaluating, using Mean Standard Error, Mean Absolute Deviation and Mean Absolute Percentage Error accuracy indicators, showed that the best forecasting method for predicting general unemployment rate in the Czech Republic is The Holt-Winter's multiplicative exponential smoothing method. The forecasted values, at a smoothed constants α=0,82, β=0,3 and γ=1, are as follows: by the end of the first quarter of 2019 the general unemployment rate is predicted to be at 1,99%, the second quarter at 1,76%, third quarter at 1,68% and the fourth quarter at 1,44%. These predicted values show the extension of downward trend of unemployment rate in the Czech Republic in the following year.

Sub objective of this work was a brief analysis of the current situation of unemployment in the Czech Republic, which has been provided in the first part of the empirical part of the thesis. Descriptive analysis was done for the purposes of deeper understanding of the subject area and as a background for the future forecast. Descriptive statistical tools were used in the analysing procedure.

Czech Republic is the country with the lowest unemployment rate in Europe. According to the International Labour Office (ILO) methodology and Czech Statistical Office data, by the end of the fourth quarter of 2018, there was 111,0 thousand of unemployed people, which is 17,7 thousand less than in the previous year. The number of unemployed women was 63,0 thousand persons, which is 6,4 thousands less comparing to the previous year. The number of unemployed which was 48,0 thousand persons is 11,3 thousand less than in the year of 2017. The highest share of unemployed is represented by the group of people

between 35-39 years old at a 22,26 thousands people or around 14% out of the whole number of unemployed people.

The highest number of unemployed were recorded in the South Moravia and Moravia-Silesia regions at 18,2 and 24,5 thousands respectively. The highest general unemployment rate was recorded in Usti region, where by the end of 2018 it reached 3,9%, followed by Olomouc region, where the unemployment rate was a 2,8%. The lowest unemployment rate at a 1,3% was recorded in capital city, Prague. The highest number of jobs is also concentrated in there. One of the lowest general unemployment rates at 1,4% were in the South Bohemian and Pardubice regions.

The biggest part, 45%, of unemployed in the Czech Republic is created by the people with a secondary education without GCE, 22% of unemployed is created be the people who has basic, pre-primary education or don't have any at all and also by the people with secondary education with GCE. The smallest share of 11% comes people with tertiary education.

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Appendix

Table 4. Results of forecasting with double exponential smoothing

n	Quarter	Rate, yt	Level, St	Trend, bt	Forecast, Ft	Error	Error^2	Absolute Error, At	At/yt
			8,4219	-0,1660					
1	q1 2010	8,0	8,0539	-0,1660	8,26	0,2559	0,0655	0,2559	0,0320
2	q2 2010	7,1	7,2660	-0,1660	7,89	0,7879	0,6207	0,7879	0,1110
3	q3 2010	7,1	7,1000	-0,1660	7,10	0,0000	0,0000	0,0000	0,0000
4	q4 2010	6,9	6,9072	-0,1660	6,93	0,0340	0,0012	0,0340	0,0049
5	q1 2011	7,2	7,1033	-0,1660	6,74	-0,4589	0,2106	0,4589	0,0637
6	q2 2011	6,7	6,7500	-0,1660	6,94	0,2372	0,0563	0,2372	0,0354
7	q3 2011	6,6	6,5966	-0,1660	6,58	-0,0161	0,0003	0,0161	0,0024
8	q4 2011	6,4	6,4064	-0,1660	6,43	0,0306	0,0009	0,0306	0,0048
9	q1 2012	7,1	6,9188	-0,1660	6,24	-0,8596	0,7389	0,8596	0,1211
10	q2 2012	6,7	6,7111	-0,1660	6,75	0,0528	0,0028	0,0528	0,0079
11	q3 2012	7,0	6,9041	-0,1660	6,55	-0,4549	0,2070	0,4549	0,0650
12	q4 2012	7,2	7,1026	-0,1660	6,74	-0,4619	0,2134	0,4619	0,0642
13	q1 2013	7,4	7,3023	-0,1660	6,94	-0,4634	0,2147	0,4634	0,0626
14	q2 2013	6,7	6,7920	-0,1660	7,14	0,4363	0,1903	0,4363	0,0651
15	q3 2013	6,9	6,8422	-0,1660	6,63	-0,2741	0,0751	0,2741	0,0397
16	q4 2013	6,7	6,6950	-0,1660	6,68	-0,0238	0,0006	0,0238	0,0036
17	q1 2014	6,8	6,7429	-0,1660	6,53	-0,2711	0,0735	0,2711	0,0399
18	q2 2014	6,0	6,1216	-0,1660	6,58	0,5768	0,3327	0,5768	0,0961
19	q3 2014	5,9	5,9117	-0,1660	5,96	0,0555	0,0031	0,0555	0,0094
20	q4 2014	5,7	5,7096	-0,1660	5,75	0,0457	0,0021	0,0457	0,0080
21	q1 2015	6,0	5,9038	-0,1660	5,54	-0,4564	0,2083	0,4564	0,0761
22	q2 2015	4,9	5,0766	-0,1660	5,74	0,8378	0,7018	0,8378	0,1710
23	q3 2015	4,8	4,8233	-0,1660	4,91	0,1105	0,0122	0,1105	0,0230
24	q4 2015	4,5	4,5331	-0,1660	4,66	0,1572	0,0247	0,1572	0,0349
25	q1 2016	4,3	4,3141	-0,1660	4,37	0,0671	0,0045	0,0671	0,0156
26	q2 2016	3,9	3,9523	-0,1660	4,15	0,2481	0,0615	0,2481	0,0636
27	q3 2016	4,0	3,9549	-0,1660	3,79	-0,2138	0,0457	0,2138	0,0534
28	q4 2016	3,6	3,6398	-0,1660	3,79	0,1889	0,0357	0,1889	0,0525
29	q1 2017	3,4	3,4155	-0,1660	3,47	0,0738	0,0054	0,0738	0,0217
30	q2 2017	3,0	3,0526	-0,1660	3,25	0,2495	0,0622	0,2495	0,0832
31	q3 2017	2,8	2,8182	-0,1660	2,89	0,0865	0,0075	0,0865	0,0309
32	q4 2017	2,4	2,4532	-0,1660	2,65	0,2522	0,0636	0,2522	0,1051
33	q1 2018	2,4	2,3762	-0,1660	2,29	-0,1129	0,0127	0,1129	0,0470
34	q2 2018	2,2	2,2021	-0,1660	2,21	0,0102	0,0001	0,0102	0,0046
35	q3 2018	2,3	2,2444	-0,1660	2,04	-0,2639	0,0696	0,2639	0,1147
36	q4 2018	2,0	2,0165	-0,1660	2,08	0,0783	0,0061	0,0783	0,0392
37	q1 2019				1,85				
38	q2 2019				1,68				
39	q3 2019				1,52				
40	q4 2019				1,35				

Source: author, based on CZSO data

Table 5. Multiplicative triple exponential smoothing results

no	Quarter	y_t	l_t	b_t	s_t	f_t	E	E^2	AE	AE/y_t
1	q1 2010	8,0			1,0997					
2	q2 2010	7,1			0,9759					
3	q3 2010	7,1			0,9759					
4	q4 2010	6,9	7,2750	-0,1375	0,9485					
5	q1 2011	7,2	6,6509	-0,2858	1,0826	7,8488	-0,6	0,4209	0,649	0,058
6	q2 2011	6,7	6,7775	-0,1601	0,9886	6,2119	0,5	0,2382	0,4881	0,0728
7	q3 2011	6,6	6,7372	-0,1236	0,9796	6,4582	0,1	0,0201	0,1418	0,0215
8	q4 2011	6,4	6,7243	-0,0899	0,9518	6,2727	0,1	0,0162	0,1273	0,0199
9	q1 2012	7,1	6,5718	-0,1090	1,0804	7,1823	-0,1	0,0068	0,0823	0,0116
10	q2 2012	6,7	6,7224	-0,0298	0,9967	6,3889	0,3	0,0968	0,3111	0,0464
11	q3 2012	7,0	7,0662	0,0840	0,9906	6,5562	0,4	0,1969	0,4438	0,0634
12	q4 2012	7,2	7,4922	0,1883	0,9610	6,8054	0,4	0,1557	0,3946	0,0548
13	q1 2013	7,4	6,9951	-0,0206	1,0579	8,2978	-0,9	0,8061	0,8978	0,1213
14	q2 2013	6,7	6,7666	-0,0840	0,9902	6,9512	-0,3	0,0631	0,2512	0,0375
15	q3 2013	6,9	6,9157	-0,0129	0,9977	6,6200	0,3	0,0784	0,2800	0,0406
16	q4 2013	6,7	6,9598	0,0045	0,9627	6,6336	0,1	0,0044	0,0664	0,0099
17	q1 2014	6,8	6,5219	-0,1304	1,0426	7,3674	-0,6	0,3220	0,5674	0,0834
18	q2 2014	6,0	6,1177	-0,2138	0,9808	6,3286	-0,3	0,1080	0,3286	0,0548
19	q3 2014	5,9	5,9118	-0,2114	0,9980	5,8905	0,0	0,0001	0,0095	0,0016
20	q4 2014	5,7	5,8824	-0,1559	0,9690	5,4875	0,2	0,0451	0,2125	0,0373
21	q1 2015	6,0	5,7497	-0,1489	1,0435	5,9706	0,0	0,0009	0,0294	0,0049
22	q2 2015	4,9	5,1021	-0,3009	0,9604	5,4930	-0,6	0,3516	0,5930	0,1210
23	q3 2015	4,8	4,8081	-0,2988	0,9983	4,7916	0,0	0,0001	0,0084	0,0017
24	q4 2015	4,5	4,6204	-0,2649	0,9739	4,3695	0,1	0,0170	0,1305	0,0290
25	q1 2016	4,3	4,1617	-0,3240	1,0332	4,5451	-0,2	0,0601	0,2451	0,0570
26	q2 2016	3,9	4,0218	-0,2679	0,9697	3,6858	0,2	0,0459	0,2142	0,0549
27	q3 2016	4,0	3,9625	-0,2043	1,0095	3,7475	0,3	0,0637	0,2525	0,0631
28	q4 2016	3,6	3,7071	-0,2199	0,9711	3,6602	-0,1	0,0036	0,0602	0,0167
29	q1 2017	3,4	3,3251	-0,2693	1,0225	3,6031	-0,2	0,0413	0,2031	0,0597
30	q2 2017	3,0	3,0870	-0,2598	0,9718	2,9633	0,0	0,0013	0,0367	0,0122
31	q3 2017	2,8	2,7831	-0,2732	1,0061	2,8540	-0,1	0,0029	0,0540	0,0193
32	q4 2017	2,4	2,4782	-0,2829	0,9685	2,4373	0,0	0,0014	0,0373	0,0156
33	q1 2018	2,4	2,3205	-0,2447	1,0342	2,2447	0,2	0,0241	0,1553	0,0647
34	q2 2018	2,2	2,2309	-0,1975	0,9862	2,0173	0,2	0,0334	0,1827	0,0830
35	q3 2018	2,3	2,2418	-0,1339	1,0259	2,0458	0,3	0,0646	0,2542	0,1105
36	q4 2018	2,0	2,0726	-0,1447	0,9650	2,0414	0,0	0,0017	0,0414	0,0207
37	q1 2019					1,9940				
38	q2 2019					1,7586				
39	q3 2019					1,6811				
40	q4 2019					1,4415				

Source: author, based on CZSO data

Table 6. Additive triple exponential smoothing results

Y	Quarter	yt	lt	bt	st	ft	E	E^2	AE	AE/yt
1	q1 2010	8,0			0,7250					
2	q2 2010	7,1			-0,1750					
3	q3 2010	7,1			-0,1750					
4	q4 2010	6,9	7,2750	-0,1375	-0,3750					
5	q1 2011	7,2	6,7366	-0,2657	0,4193	7,8625	-0,6625	0,4389	0,6625	0,0920
6	q2 2011	6,7	6,7154	-0,1875	0,0115	6,2959	0,4041	0,1633	0,4041	0,0603
7	q3 2011	6,6	6,6774	-0,1397	-0,0610	6,3529	0,2471	0,0610	0,2471	0,0374
8	q4 2011	6,4	6,6813	-0,0938	-0,2655	6,1627	0,2373	0,0563	0,2373	0,0371
9	q1 2012	7,1	6,6439	-0,0757	0,4623	7,0068	0,0932	0,0087	0,0932	0,0131
10	q2 2012	6,7	6,6410	-0,0525	0,0670	6,5796	0,1204	0,0145	0,1204	0,0180
11	q3 2012	7,0	6,8744	0,0390	0,1570	6,5276	0,4724	0,2232	0,4724	0,0675
12	q4 2012	7,2	7,2475	0,1458	-0,0107	6,6479	0,5521	0,3048	0,5521	0,0767
13	q1 2013	7,4	7,1176	0,0577	0,2521	7,8556	-0,4556	0,2076	0,4556	0,0616
14	q2 2013	6,7	6,8471	-0,0473	-0,1832	7,2423	-0,5423	0,2941	0,5423	0,0809
15	q3 2013	6,9	6,7654	-0,0583	0,1308	6,9569	-0,0569	0,0032	0,0569	0,0082
16	q4 2013	6,7	6,7093	-0,0576	-0,0091	6,6964	0,0036	0,0000	0,0036	0,0005
17	q1 2014	6,8	6,5889	-0,0777	0,2042	6,9038	-0,1038	0,0108	0,1038	0,0153
18	q2 2014	6,0	6,3128	-0,1412	-0,3346	6,3280	-0,3280	0,1076	0,3280	0,0547
19	q3 2014	5,9	5,9281	-0,2190	-0,0549	6,3024	-0,4024	0,1619	0,4024	0,0682
20	q4 2014	5,7	5,7091	-0,2190	-0,0091	5,7000	0,0000	0,0000	0,0000	0,0000
21	q1 2015	6,0	5,6751	-0,1599	0,3453	5,6942	0,3058	0,0935	0,3058	0,0510
22	q2 2015	4,9	5,3454	-0,2142	-0,4641	5,1806	-0,2806	0,0788	0,2806	0,0573
23	q3 2015	4,8	4,9640	-0,2676	-0,1824	5,0763	-0,2763	0,0764	0,2763	0,0576
24	q4 2015	4,5	4,5831	-0,3039	-0,0955	4,6873	-0,1873	0,0351	0,1873	0,0416
25	q1 2016	4,3	4,0829	-0,3667	0,1956	4,6244	-0,3244	0,1053	0,3244	0,0754
26	q2 2016	3,9	4,1082	-0,2413	-0,1651	3,2521	0,6479	0,4198	0,6479	0,1661
27	q3 2016	4,0	4,0578	-0,1802	-0,0368	3,6845	0,3155	0,0995	0,3155	0,0789
28	q4 2016	3,6	3,7674	-0,2155	-0,1795	3,7821	-0,1821	0,0331	0,1821	0,0506
29	q1 2017	3,4	3,3417	-0,2827	0,0352	3,7475	-0,3475	0,1208	0,3475	0,1022
30	q2 2017	3,0	3,1232	-0,2622	-0,1161	2,8938	0,1062	0,0113	0,1062	0,0354
31	q3 2017	2,8	2,8464	-0,2669	-0,0480	2,8242	-0,0242	0,0006	0,0242	0,0086
32	q4 2017	2,4	2,5795	-0,2669	-0,1795	2,4000	0,0000	0,0000	0,0000	0,0000
33	q1 2018	2,4	2,3442	-0,2568	0,0593	2,3479	0,0521	0,0027	0,0521	0,0217
34	q2 2018	2,2	2,2258	-0,2125	-0,0106	1,9713	0,2287	0,0523	0,2287	0,1039
35	q3 2018	2,3	2,2158	-0,1477	0,1064	1,9653	0,3347	0,1120	0,3347	0,1455
36	q4 2018	2,0	2,1355	-0,1262	-0,1281	1,8885	0,1115	0,0124	0,1115	0,0557
37	q1 2019					2,0093				
38	q2 2019					1,8832				
39	q3 2019					1,7570				
40	q4 2019					1,6308				

Source: author, based on CZSO data