

Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Statistics



Bachelor Thesis

Direct impacts of the Covid-19 pandemic on the Czech economy

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

Anastasia Kaliuzhna

Economics and Management

Thesis title

Direct impacts of the Covid-19 pandemic on the Czech economy

Objectives of thesis

The aim of this research is to analyse the influence of the covid 19 on Czech economy and fiscal measures to support the economy.

The objectives of this bachelor thesis are:

1. to analyse the selected economic indicators;
2. to analyse and offer the fiscal measures to support the economy ;
3. to evaluate the state of the economy;
4. to provide a future outlook of the Czech economy development.

Methodology

At the initial stage of the research the quantitative approach of data collection will be employed. Quantitative data sources will include literature and administrative documents of the selected public authorities.

The purpose of the literature review is to examine and discuss available sources to provide foundation for research to be carried out.

This bachelor thesis will predominantly exploit previous studies carried out by CEPR, University of Oxford, Google Scholar and Discover Database list will searched in great detail in order to source relevant literature.

The practical part aims to analyze main economic indicators in connection with the covid-19 pandemic in the Czech Republic using methods of exploratory data analysis, statistical methods for time series analysis and regression analysis.

The proposed extent of the thesis

30-40 pages

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Covid-19 pandemic, economy development of Czech republic, poverty rate, main economic indicators, statistical analysis, fiscal measures, future financial state

Recommended information sources

FERNANDES, N. Economic Effects of Coronavirus Outbreak (COVID-19) on the World Economy. IESE Business School Working Paper No. WP-1240-E.

FIELD, A. Discovering statistics using IBM SPSS Statistics. Thousand Oaks: SAGE Publications, 2013. ISBN 978-1-4462-4917-8.

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VITENU-SACKEY, P. A. THE IMPACT OF COVID-19 PANDEMIC ON THE GLOBAL ECONOMY. China: School of Finance and Economics, School of Management, Jiangsu University, Zhenjiang, Jiangsu Province, 2021. ISSN: 2312-430X

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Declaration

I declare that I have worked on my bachelor thesis titled "Direct impacts of the Covid-19 pandemic on the Czech 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 any copyrights.

In Prague on 30.03.2022

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Direct impacts of Covid-19 on the Czech economy

Abstract

This Bachelor thesis is focused on the analysis of the influence of Covid-19 on the Czech Republic's economy. The goal is to evaluate the state of the Czech economy and predicted the economic indicators during Covid-19. The first part of the thesis includes a theoretical background of GDP, labour market, unemployment, definitions of terms, and the methodology where the statistical analysis was explained. In the practical part, it was analysed the state of the Czech Republic's economy and commodity prices. Also, it was made a time series and correlation analysis. The output is the forecast that predicts economic indicators: GDP, Export, Salary, Consumption, Gross Capital from 2019 to 2021 year. The results of the forecast show that during the Covid, all the predicted values decreased as observed values taking from Eurostat data. statistical predictive analysis for future economic outlook by taking selected economic indicators: GDP, Prices, and Labour. The results of the correlation analysis shows that the Covid-19 cases influenced the consumer price index, so the variables are highly correlated.

Keywords: covid-19, correlation analysis, forecast, GDP, time series, unemployment, economic indicators

Přímé dopady Covid-19 na českou ekonomiku

Abstrakt

Tato bakalářská práce je zaměřena na analýzu vlivu Covid-19 na ekonomiku České republiky. Cílem je zhodnotit stav české ekonomiky a provést predikci ekonomických ukazatelů během Covid-19. První část práce obsahuje teoretická východiska HDP, trhu práce, nezaměstnanosti, definice pojmů a metodiku, kde byla statistická analýza vysvětlena. V praktické části byl analyzován stav ekonomiky České republiky a ceny komodit. Dále byla provedena časová řada a korelační analýza. Výstupem je prognóza, která předpovídá ekonomické ukazatele: HDP, export, plat, spotřeba, hrubý kapitál v letech 2019 až 2021. Výsledky prognózy ukazují, že během Covidu se všechny predikované hodnoty snížily jako pozorované hodnoty vycházející z dat Eurostatu. statistická prediktivní analýza pro budoucí ekonomický výhled pomocí vybraných ekonomických ukazatelů: HDP, cen a práce. Výsledky korelační analýzy ukazují, že případy Covid-19 ovlivnily index spotřebitelských cen, takže proměnné jsou vysoce korelované.

Klíčová slova: covid-19, korelační analýza, prognóza, HDP, časové řady, nezaměstnanost, ekonomické ukazatele

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1 Introduction

COVID-19 is not only a global pandemic and public health crisis, but it has also affected the global economy and financial markets. The rise in unemployment, significant decline in income, increase in prices are the consequences of the measures implemented by many countries. The crisis has completely unexpectedly damaged the economy. For almost a year the economy in the Czech Republic was frozen, money flow declined, and the businesses had to close. It was necessary to reduce the number of cases and it was effective. On the other hand, there was one more important point: the economic effects of the pandemic, which we faced today.

„The pandemic had an impact on many sectors and industries. Even the most conservative employers had to review their habits. Anybody who so far objected to new technologies, home office status, online functioning, virtual meetings, and contactless transactions, had to quickly reconsider. Shops, restaurants, and administrative services moved to online space. With the end of the emergency state and gradual loosening of the restrictions, people will slowly return to their good old habits, but some people will want to keep the comfort of remote access from home even in the so-called “new normal”, said Jaroslava Rezlerová, CEO of ManpowerGroup Czech Republic. (ManpowerGroup, 2020) COVID-19 epidemic negatively affected 57 % of Czech companies, 10 % of which had to close their operations completely. 35 % of companies did not experience any changes in business activities and 3 % have even improved.

In the Czech Republic, the small-size companies with up to 50 employees are the hardest hit. The sector Restaurants and Hotels is by far worst affected, where 53 % of companies had to close completely and 92 % had to reduce their operations to some extent. The most important employer sector – Manufacturing – very uniquely achieved a 100 % closure of operations. Still, some partial operations always remained, such as expedition of existing orders or maintenance, etc. However, 30 % of employers in this sector reduced their operations by more than 50 %. (ManpowerGroup, 2020)

In international comparison, the epidemic impact on the Czech business is similar to the one in for example Germany or Slovakia. It did not significantly differ from the global average, where 63 % of companies report the negative effect of the epidemic on their business.

Looking at the macroeconomic situation, according to the report on financial market developments in 2020 (Republic, 2021) published by the Ministry of Finance of the Czech

Republic, Gross domestic product declined by 5.6%. The consumer price index rose at its highest annual rate in five years, climbing by 3.2%. The unemployment rate nudged up only slightly to 2.6%, remaining the lowest in the EU and well below the EU average. For the first time in four years, the general government sector posted a deficit, which amounted to 6.2% of GDP. This, coupled with the economic downturn, was reflected in a 7.8 pp rise in the general government debt ratio to 38.1% of GDP.

2 Aims and Methodology

This research aims to analyse the direct impact of the covid 19 on the Czech economy by selected economic indicators such as GDP, Prices development, and Unemployment rate. The evaluation is based on the statistical analysis of time series. The bachelor thesis is divided into two parts: theoretical and practical. The theoretical part includes themes: Economic performance where the main economic indicator GDP was explained, its impact, and how it is measured. Also, the second topic is the Labour market which includes terms, unemployment rates, types of unemployment. The third topic is Prices Development where the analysis of increased prices was made.

2.1 Methodology

At the initial stage of the research, the quantitative approach to data collection will be employed. Quantitative data sources will include literature and administrative documents of the selected public authorities.

The purpose of the literature review is to examine and discuss available sources to provide a foundation for research to be carried out.

This bachelor thesis will predominantly exploit previous studies carried out by CEPR, the University of Oxford, Google Scholar, and Discover Database list will search in detail to source relevant literature.

The practical part aims to analyse main economic indicators in connection with the covid-19 pandemic in the Czech Republic using methods of descriptive analysis, trend analysis, index analysis, hypotheses testing, and Arima modelling.

2.1.1 Time series

A time series is defined as a set of quantitative observations arranged in chronological order. We generally assume that time is a discrete variable. Time series have always been used in the field of econometrics. (Gebhard Kirchgässner, 2007)

Any time series can include some or all the following elements:

1. Trend (T)
2. Cyclical (C)
3. Seasonal (S)
4. Irregular (I)

These elements can be combined in a variety of ways. It is commonly assumed that they are multiplied or added.

$$Y_t = T \times C \times S \times I \quad (1)$$

$$Y_t = T + C + S + I \quad (2)$$

2.1.2 Trend component and trend analysis

A time series' trend is its long-term pattern. A trend can be either positive or negative depending on whether the time series shows an increasing or decreasing pattern. (Buteikis, 2019)

Cyclical component

A cyclical pattern is defined as any pattern that shows an up and down movement around a given trend. The length of a cycle is determined by the type of business or industry being studied.

Seasonal component

Seasonality occurs when a time series exhibits regular fluctuations in the same month (or months) or quarter year after year.

Irregular component

This component is erratic. Every time series contains some unpredictability, which makes it a random variable. The goal of prediction is to "model" all the components to the point where the only component left unexplained is the random component.

A trend is a progressive upward or downward shift in a series' level, or the propensity for series values to increase or decrease with time. Local or global trends exist, but a single series can reflect both. The stock market index has historically shown an upward global trend in series plots. Local negative trends have emerged during recessions, while local upward trends have emerged during prosperous periods. Trends can be linear or nonlinear. Linear trends are additive positive or negative increments in the level of the series, the effect of simple interest on the principal. Nonlinear trends are frequently additive, with increases proportional to the value of the previous series (s). (Ann Hessa, 2001)

2.1.3 Least squares method

This is one of the most often used approaches to mathematical trend fitting. The fitted trend is said to be the best because the sum of squares of deviations of data from it is the

smallest. This Least Squares approach can be used to fit either a linear or nonlinear trend (Parabolic and Exponential trend). (Miller, 2012)

2.1.4 Linear trend fitting

Given the data (Y_t, t) over n periods, where t signifies the period (year, month, day, etc.). We need to know the values of the linear trend equation's two constants, 'a' and 'b':

$$Y_t = a + b_t \quad (3)$$

The Y-intercept, or the height of the line above the origin, is the value of 'a.' In other words, when $X=0$, $Y=a$. The slope of the trend line is represented by the other constant 'b.' The slope is upwards when b is positive, and downwards when b is negative.

This line is known as the line of best fit because it is fitted to the point where the total gap between the given data and the line is the smallest. Squaring the difference between the trend value and the actual value of the variable yields the total number of deviations. As a result, this strategy is known as "Least Squares."

The normal equation for obtaining the values of a and b using the least square method is:

$$\sum Y_t = na + b \sum t \quad (4)$$

$$\sum tY_t = a \sum t + b \sum t^2 \quad (5)$$

Let

$$X = t - A \quad (6)$$

That $X = 0$, where A represents the year of origin.

The equations above can also be written as

$$\sum Y = na + b \sum X \quad (7)$$

$$\sum XY = a \sum X + b \sum x^2 \quad (8)$$

Because $x = 0$, i.e., the deviation from the actual mean is zero, we can write

$$a = \sum Y/n \quad (9)$$

$$b = \sum XY / \sum x^2 \quad (10)$$

2.1.5 Hypothesis Testing and Regression Analysis

A hypothesis is a statement about a population parameter developed for testing

Hypothesis testing is a procedure based on sample evidence and probability theory to determine whether the hypothesis is a reasonable statement

Regression Analysis is a statistical procedure to determine the relationship between a dependent variable and one or more explanatory variables. (Sykes, 1993)

Regression equation = an equation that expresses the relationship between variables

- To enable the value of the dependent variable to be predicted from the given values of the explanatory variables

- Useful tool if changes in one factor appear to be related in some way to movements in one or several other factors

Four types of regression analysis exist: Simple regression, Multiple regression, Linear regression, Non-linear regression

2.1.6 Correlation Analysis

Correlation Analysis is a group of techniques to measure the relationship between variables. (Patrick Schober, 2018)

Correlation is an inter-relationship or association

- Variables: – perfectly correlated – partly correlated – uncorrelated

- Correlation: – positive – negative

Coefficient Correlation is a measure of the strength of the linear relationship between variables and can be $\langle -1;1 \rangle$

- High value: – strong association – not necessarily causal relationship – spurious regression

- Low value: – no relationship among variables – might be a strong relationship, however, not expected form of the relationship (a form of the function)

Coefficient of determination = the proportion of the total variation in the dependent variable that is explained, or accounted for, by the variation in the independent variable

Correlation is used to measure how much two or more variables fluctuate in combination. A positive correlation indicates how much those variables increase or decrease in combination. A negative correlation denotes how much one variable rises as the other declines.

When the fluctuation of one parameter reliably correctly predicted the fluctuation of another, there is a tendency to assume that the transformation in one causes the change in

the other. Correlation, however, does not mean causation. There could be an unknown factor influencing both variables in the same way.

Correlation is a statistical technique used to determine whether and how strongly two variables are related. Although this correlation is fairly obvious, your data may contain unanticipated information.

Even though this correlation is obvious, your data may contain unanticipated correlations. You may also suspect that there are correlations but are unsure which ones are the strongest. In-depth correlation analysis can help you gain a better understanding of your data.

A correlation value is positive or direct when the values increase together, and it is Negative when one value decreases while the other increases, and this is known as inverse or contrary correlation. Correlation has a value: 1 indicates a perfect positive correlation, 0 denotes no correlation (the values do not appear to be linked at all), and -1 denotes a perfect negative correlation. The value indicates how strong the correlation is (rather than how steep the line is) and whether it is positive or negative.

2.1.7 The ARIMA model (Auto-Regressive Integrated Moving Average)

The ARIMA modeling is essentially an exploratory data-oriented approach that has the flexibility of fitting an appropriate model which is adapted from the structure of the data itself. With the aid of the autocorrelation function and partial autocorrelation function, the stochastic nature of the time series can be approximately modeled; from which information such as trends, random variations, periodic components, cyclic patterns, and serial correlation can be discovered. As a result, forecasts of the future values of the series, with some degree of accuracy, can be readily obtained. (S.L. Ho, 1998)

We predict the variable of interest in an autoregressive model (AR) by using a linear combination of the variable's past values. Rather than using past values of the forecast variable, we use past prediction error in a moving average model (MA). To cope with non-stationarity, ARIMA combines autoregressive and moving average models, as well as differences in the series (integrated into this context means the opposite of differencing). ARIMA models aim to explain the autocorrelations in the data, as opposed to exponential smoothing models, which are based on an explanation of the trend and seasonal factors in the data. Seasonal terms are included in a seasonal ARIMA model.

We will discuss an ARIMA (p, d, q) (P, D, Q) m model, in which:

p = the auto-regressive non-seasonal part's order

d = the non-seasonal part's extent of first differencing.

q = the order of the non-seasonal moving average part

P = denotes the order of the auto-regressive seasonal component.

D = denotes the degree of first differencing involved in the seasonal part.

Q = denotes the moving average seasonal part's order.

m = denotes the number of observations per year.

3 Theoretical part

3.1 GDP

GDP is defined clearly by the Bureau of Economic Analysis (BEA) (Analysis, 2022) : Gross domestic product (GDP) is the value of the goods and services produced by the nation's economy less the value of the goods and services used up in production. GDP is also equal to the sum of personal consumption expenditures, gross private domestic investment, net exports of goods and services, and government consumption expenditures and gross investment.

Gross domestic product (GDP) is a widely used economic indicator that is one of the most well-known in the world. The use of GDP as an indicator of social welfare and powerful economics has been criticized and warned about for a long time, almost since its inception. Nonetheless, GDP is now commonly used not only to evaluate economic performance but also to track a country's overall development progress. Numerous alternative indicators have been proposed and developed since the 1970s. However, none of these indicators can compete with the widely used GDP.

GDP measures the monetary value of final goods and services—that is, those purchased by the end-user—produced in a country over a given period (say a quarter or a year). It includes all of the output produced within a country's borders. GDP is made up of goods and services produced for market sale as well as some nonmarket production, such as government-provided defence or education services. A different concept, gross national product, or GNP, accounts for all of a country's output. So, if a Czech-owned company has a factory in Germany, the output of that factory is not included in Germany's GDP, but rather in the Czech GDP. (Callen, 2012)

GDP is commonly referred to in two different ways, depending on how it is calculated: nominal GDP and real GDP.

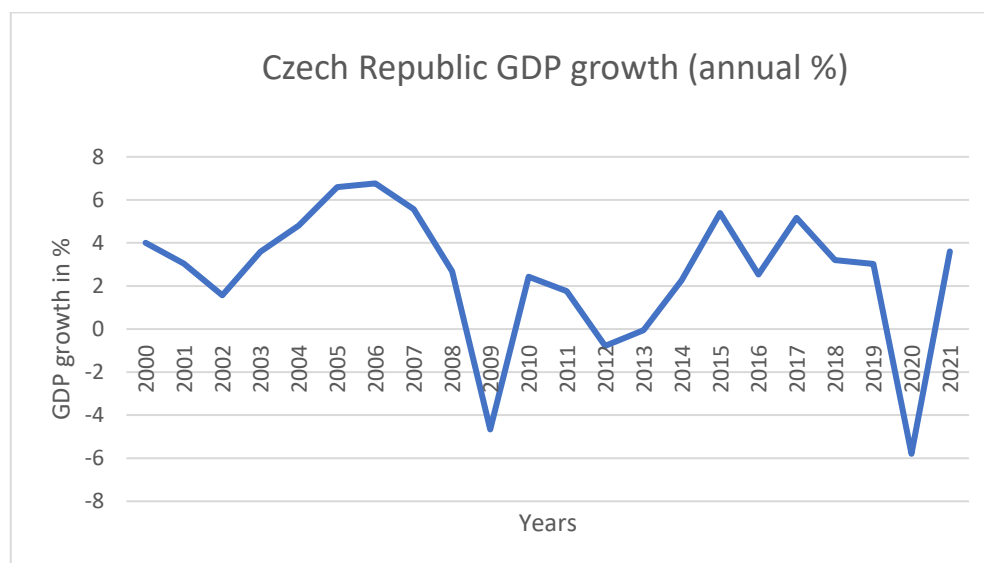
Nominal GDP accounts for today's prices without taking into account deflation or inflation, so it tracks overall changes in the value of an economy in the long term. Real GDP takes inflation into account and accounts for the overall rise in price levels, making it a more accurate measure of a country's economic health.

3.1.1 Calculation of GDP

GDP can be demonstrated as an equation that adds up all of its components: a country's consumption, investment, government expenditures on products and services, and the profit difference between exports and imports. (Mankiw's, 2017)

$$\text{GDP} = \text{Consumption} + \text{Investment} + \text{Government Spending on Goods and Services} + (\text{Exports} - \text{Imports}).$$

Figure 1: Czech Republic's annual GDP growth



Source: World Bank, OECD, own calculations

According to the Czech Republic GDP chart, it has declined dramatically from 3.02% in 2019 to -5.7% in 2020. The main reason was the epidemiological measures implemented by the Czech Government. Despite the low GDP, the economy of the Czech Republic is recovering, and GDP is growing as the economic situation becomes stable.

3.2 Labour Market

A labour market is a mechanism that connects potential employers of people (the demand for labor) with people who are looking for work (the labour supply). Labour markets operate at the local, regional, national, and, increasingly, international levels, reflecting how economies function. (MOF, 2019)

A variety of factors influence labor markets, including:

1. Changes in the external business environment, such as increased consumer demand for an industry's goods or services, or cheaper competition from abroad, result in job losses.
2. Internal business environment changes, such as changes in production processes, new technologies, or business structures that result in job losses, or changes in the level of occupations available (for example, more technical jobs, fewer unskilled jobs)
3. Interventions by the government, such as recovery programs that support education, training, and financing in specific skills or geographical areas.
4. New laws that affect jobs (for example, prohibiting hunting or limiting the number of people who can work)
5. In our case, the main factor was the pandemic situation that has influenced economies worldwide.

The labor market, like any other market, has a supply and a demand side. The population's labor supply, also known as the economically active population or labor force, is divided into two parts: employed people and unemployed people. Enterprise and other production units' labor demand can also be divided into two categories: jobs (filled positions) and job vacancies (unfilled posts) (Pietschman, 2016)

Statistics on the working-age population, employment, unemployment, and underemployment are useful for a wide range of purposes. They also provide measures of the supply of labour, actual labour input, employment structure, and the scope to which available workforce time and human resources are utilized or not. This type of data is critical for macroeconomic and human resource development planning and policy formulation. When collected at various points in time, the data serve as the foundation for monitoring current trends and changes in the labor economy, and financial situation, which can then be analyzed in conjunction with other economic and social phenomena to examine macroeconomic policies. The unemployment rate, in addition, is widely used as an overall indicator of a country's current economic performance.

The population that is currently active

As of now, the active population consists of all persons over a specified minimum age (e.g., 15 years) who fulfill the criteria for inclusion among the employed or unemployed for a specified brief period of one week or one day. Each country must specify the minimum age limit for defining the working-age population based on its national circumstances, such as

schooling age, the minimum age for admission to hiring, and the extent of child labour. Because these circumstances differ so greatly between countries, it is impossible to set a universally accepted minimum age limit on an international scale. (Comission, 2020)

3.3 Employment and Unemployment

The global definition of employment is expressed in terms of the labor force framework, i.e. in terms of a short reference period. The definition differentiates between paid work (workers, apprentices, or trainees) and self-employment (employers, own-account workers, including manufacturers of goods for their final use, members of production companies' co-operatives, and helping family workers). It establishes separate criteria for measuring these two types of employment. According to the definition, the "employed" are all persons over the age specifically mentioned for measuring the economically active population (e.g., 15 years) who were in the categories listed during such a defined short period either one week or one day (Hussmanns, 1998):

(a) paid employment:

1. at work: those who worked for a wage or salary in cash or in-kind for at least one hour during the reference period ;
2. with a job but not at work: individuals who had previously worked in their current job but were temporarily absent from it during the reference period despite having a formal attachment to it;

(b) self-employment:

1. at work: people who performed some work (at least one hour) for profit or family gain, in cash or in-kind, during the reference period;
2. Having a business but not working: people who own a company (which could be a business) enterprise, a farm, or a service undertaking) who was absent from work for whatever reason during the reference period.

Unemployment is defined by three conditions that must all be met at the same time. The unemployed, according to this definition, are all people over the age specified for assessing the economically active population during the reference period who were:

- (a) "unemployed," that is, not employed or self-employed following the international definition of employment (see section 5 above);

(b) "currently available for work," that is, during the reference period, they were available for paid employment or self-employment;

(c) "seeking a job," that is, taking explicit efforts in a recent time to look for paid work or self-employment.

The unemployment rate is the most often used metric for assessing labor market conditions. The rate of unemployment can also reveal information about the state of the economy, making it a crucial element to consider. (RBA, 2018)

The unemployment rate is the percentage of people who are unemployed in the labor force. As a result, determining the unemployment rate necessitates determining who is employed. People who are employed or jobless make up the labor force.

To determine the Labour Force= Unemployed + Employed

To determine the unemployment rate: Unemployment rate= Unemployed/Labor Force * 100

Changes in the number of unemployed persons (the numerator) affect the unemployment rate. These changes might be caused by cyclical variables, such as the number of people who become jobless as a result of an economic recession, or more structural causes in the economy. Changes in the labor force size have an impact on the unemployment rate (the denominator).

In addition, unemployment can be classified into three categories: cyclical, structural, and frictional. Changes in economic activity across the business cycle cause cyclical unemployment. During a downturn in the economy, there are fewer jobs available for those who wish to work due to a lack of demand for goods and services. Businesses that are facing lower demand may downsize their workforce by laying off existing employees or employing fewer new employees. As a result, persons looking for a job will have a harder time finding work. When demand rises, the situation is the total opposite. (Sengenberger, 2011)

When there is a mismatch between available jobs and persons looking for work, structural unemployment emerges. This mismatch could be caused by the fact that job seekers lack the skills necessary to do the available tasks, or by the fact that the available positions are located far away from the job seekers. Workers may lose their jobs if they work in shrinking industries or have abilities that could be automated because of large-scale technology advancements. They may find it difficult to obtain work in another industry, and they may need to learn new skills or relocate to a place with more chances.

Frictional unemployment happens when people transition into and out of the labor force, as well as when they shift between jobs in the labor market. Worker mobility is required for a

flexible labor market and aids in the efficient allocation of labor across the economy. People may not be able to find work straight away and will have to put in the time and effort to find the perfect job. Businesses also devote time to finding qualified applicants to fill employment openings. As a result, job seekers are not instantly matched with openings and may face a period of temporary unemployment.

3.4 Price theory

Price theory is concerned with explaining the economic activity in terms of the creation and transfer of value, which includes the exchange of goods and services among various economic agents. It is a concept that assumes that market factors such as supply, and demand define the price of goods and services. The relationship between supply and demand, by this theory, influences whether the prices of goods and services rise or fall. (Friedman, 1986)

The price theory is an economic principle that states that demand and supply define the prices for which goods and services are traded. The optimal market price is realized when the payments made for products and services by consumers equal the marginal cost of producing the products. The optimal market price is also known as the point of equilibrium between supply and demand.

The followings points of price theory:

1. The study of how economic dynamics such as demand and supply impact the prices of products and services in the market is known as price theory.
2. According to this theory, the optimal market price for goods and services is determined when the amount of commodities supply meets consumer needs and the price offered by customers meets the marginal costs of producing the goods and services.
3. The best price of goods and services is determined by market conditions and forces, which means that this price reacts to the market.
4. Demand and supply are not constant; they change based on a variety of circumstances, which has an impact on the cost of goods and services.

The main components of price in the price theory are supply and demand. The theory of price is a microeconomic principle that states that when supply and demand are considered, the appropriate price of goods and services is determined. The goal of most price theories is to arrive at a market optimal price, which is the point where supply and demand are in

balance. When a market reaches equilibrium, the number of items available meets consumer demand. Because market conditions affect the prices of products and services, equilibrium is an effective price adjuster. (McCloskey, 1985)

3.5 Factors Affecting Pricing Decisions in the Market

Internal factors: Advertisers should keep a variety of considerations in mind when determining rates, which are the result of company decisions and behaviour. These considerations are primarily governed by the organization and can be altered if necessary. Nonetheless, while the company may have control over these variables, making rapid improvements is frequently unrealistic. (Jain, 2021)

Rate of Return: A company may set a marketing goal as a condition for achieving a certain percentage of return on the commodity's advertising budget. This amount of returns, along with an estimate of revenue, would aid in determining the necessary price levels to meet the ROI goal.

Cash Flows: Organizations can begin by setting prices at a level that ensures sales revenues cover the cost of production and marketing of goods. This is more likely to happen with innovative goods where the corporate goals allow the new product to cover the expenses as attempts are made to bring the products to market.

Market Shares: A cost decision may be required if the company wishes to gain control of a market segment or maintain a part of the market.

Increase Profit: Mature commodities that cater to a no longer growing market can have a business goal that requires the price to be fixed at a point that maximizes income.

Variable Cost: These prices are primarily related to the production and sale of goods and can change as the amount for output and revenue increases. So, when prices are particularly dependent on individual products, variable costs are usually calculated on a per-unit basis.

External Factors: There have seemed to be several factors that are not regulated by organizations but can influence price decisions. Identifying such factors enables a salesperson to analyse data to monitor what is developing for each market that the business defines, as the effects of such factors vary by market.

3.6 Core Inflation: Concept

Inflation measures how much more expensive a set of goods and services has become over a certain period, usually a year (ONER, 2018)

Inflation is the rate of increase in prices over a given period. Inflation is typically a broad measure, such as the overall increase in prices or the increase in the cost of living in a country. But it can also be more narrowly calculated—for certain goods, such as food, or services, such as a haircut, for example. Whatever the context, inflation represents how much more expensive the relevant set of goods and/or services has become over a certain period, most commonly a year. (ONER, 2018)

The cost of living for consumers is determined by the prices of various goods and services, as well as the proportion of each in household expenditure. Government agencies conduct household surveys to identify a basket of commonly purchased items and track the cost of purchasing this basket over time to determine the average consumer's cost of living. The consumer price index (CPI), the most generally used measure of inflation, is the cost of this basket at a particular moment stated relative to a base year. Consumer price inflation is the percentage change in the CPI over a specific period. (For instance, if the base year CPI is 100 and the current CPI is 106, inflation during the period equals 6%.)

Core consumer inflation concentrates on fundamental and enduring trends in inflation by excluding government-set prices and high volatility prices of goods such as food and energy, which are most affected by seasonal factors or temporary supply conditions. Policymakers are also keeping a close eye on core inflation. Calculating an overall inflation rate—say, for a country rather than just for consumers—requires a broader index, such as the GDP deflator.

3.7 The development of prices in the Czech Republic

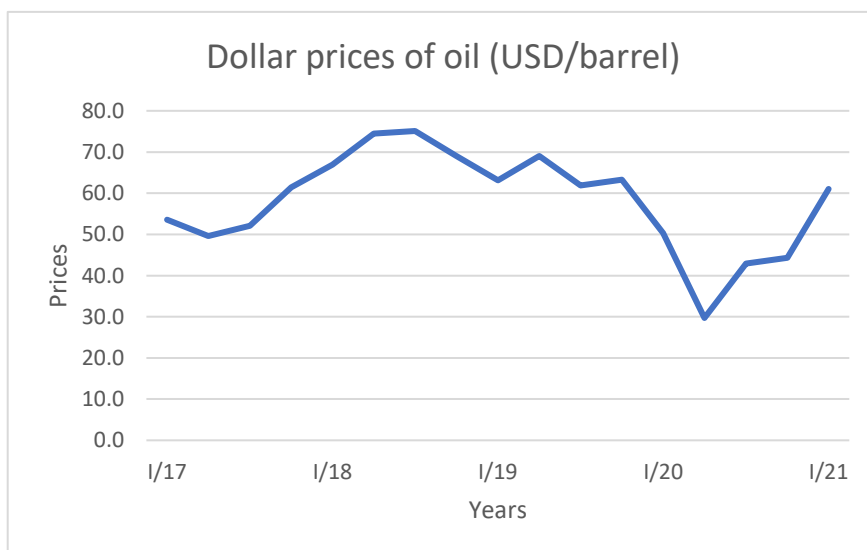
A significant increase in demand associated with the global economy's recovery following the Covid-19 pandemic, driven particularly by high energy prices, has raised industrial producer prices in the EU, and more expensive imports have begun to change domestic prices. Domestic industrial producer prices began to rise sharply in the third quarter of 2021, owing primarily to the high cost of oil and other commodities, but also disrupted supply chains. Consumer inflation has been delayed because of rising producer prices. This is

currently becoming a significant macroeconomic issue, as high housing costs push it significantly above the upper limit of the CNB's band for inflation.

The global economy's recovery following the Covid-19 pandemic has caused turbulence in the world commodity markets, driving commodity prices to new highs. Brent crude oil, a major component index, reached an average price of 71 USD per barrel in 2021. Due to its low levels last year, the price increased by more than 70% compared to the 2020 year and by 11% compared to 2019 (see Figure 2). In the second quarter of 2021, the Organization of Petroleum Exporting Countries and its affiliate states continued to gradually relax production limits. Their July agreement reaffirmed this path and resulted in a further gradual increase of 0.4 million barrels of daily oil production, each month. Oil consumption has increased in tandem with rising global oil production as the global economy has improved

Aside from the price of oil, Natural gas prices also rose dramatically. In 2019 the price has decreased by 37.5%, but in 2021 it increased by 20%. (see Table 1). Neither of these commodities is an exception to the trend that has been visible in commodity markets since the end of last year. This trend has affected metals and food commodities, in addition to energy (including electricity market prices), and is gradually being reflected in consumer prices.

Figure 2: Dollar prices of oil in Czechia



Source: MoF, my calculation

Table 1: Prices of selected commodities in Czechia

Prices of Selected		2013	2014	2015	2016	2017	2018	2019	2020	2021
Crude oil Brent	USD/barrel	109	99	52.4	43.6	54.2	71.4	64.3	41.8	71
	growth in %	-2.6	-8.8	-47.1	-16.9	24.3	31.7	-9.9	-35	0.7
Natural gas (Europe)	USD/MMBtu	11.8	10.1	6.8	4.6	5.7	7.7	4.8	3.2	3.9
	growth in %	2.7	-14.7	-32.1	-33.1	25.3	34.4	-38	-32.5	0.2

Source: MoF

3.8 Consumer Prices

Consumer prices rose at a faster rate, reaching up to 4.6 percent year-on-year growth in 2021, according to the most recent data, and thus rose at the fastest rate in the previous thirteen years. The cause was both external and domestic inflationary pressures, specifically an increase in core prices. The prices increased significantly on fuel, housing costs, and energy. The scarcity of raw materials and materials on global markets is reflected in the prices of goods and services; problems also exist in disrupted supply chains. Domestic inflation is under pressure.

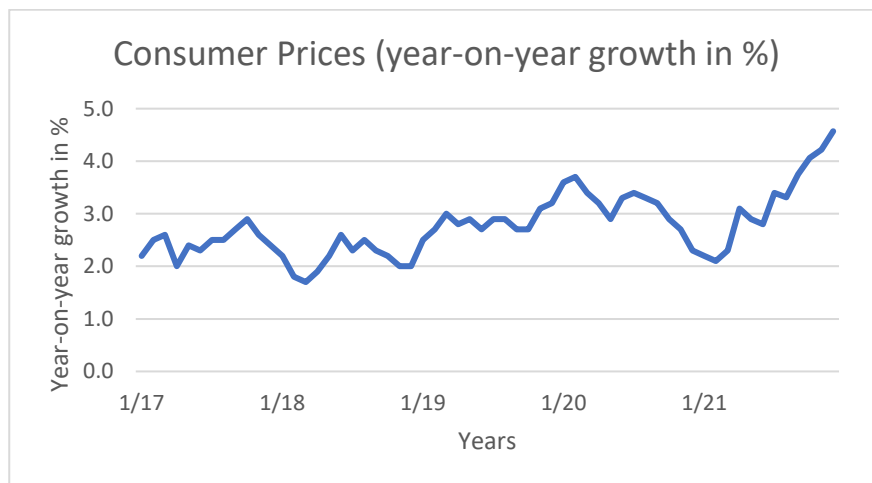
Consumer price inflation was 3.4 percent year on year in July 2021. The observed price trend deviated entirely from the forecast due to market factors, particularly the core component of inflation. In terms of consumer basket divisions, transportation (8.4 inflation rate) contributed the most to annual inflation in July, as fuel and car prices rose rapidly. Housing (2.8 inflation rate) and alcoholic beverages, tobacco (8.4 inflation rate) also made significant contributions; the rise in the price of tobacco products was supported by an increase in excise duty. Year-on-year inflation was almost entirely driven by market forces.

Table 2. Consumer price index according to ECOICOP - inflation rate

Code	Classification ECOICOP	2018	2019	2020	2021
0	Total	2.1	2.8	3.2	3.8
01	Food and non-alcoholic beverages	1.3	2.8	4.5	0.8
02	Alcoholic beverages, tobacco	3.0	2.2	7.6	8.4
03	Clothing and footwear	-1.1	-1.2	3.7	6.5
04	Housing, water, energy, fuel	3.0	5.3	2.9	2.8
05	Furnishings, households' equipment and maintenance	1.5	1.5	2.9	3.5
06	Health	3.7	3.2	2.3	3.6
07	Transport	2.8	0.4	-0.4	8.4
08	Post and telecommunication	-1.6	-1.9	-3.6	-0.6
09	Recreation and culture	1.0	1.6	2.2	3.0
10	Education	1.7	2.7	3.7	2.3
11	Restaurants and hotels	3.6	4.2	4.9	4.3
12	Miscellaneous goods and services	2.9	3.8	3.5	3.5

Source: CZSO

Figure 3: Consumer Prices in the Czech Republic



Source: MOF, own calculations

3.9 The analysis of government actions to control the Covid-19 pandemic

COVID-19 affected nearly all countries and more than 50 million people worldwide by 2020. It places governments in a state of extreme uncertainty, forcing them to make difficult trade-offs considering the health, economic, and social challenges it raises. By the spring of 2020, more than half of the world's population would have been subjected to a lockdown with strict containment measures. Aside from the coronavirus's health and human tragedy, it is now widely acknowledged that the pandemic precipitated the worst economic crisis since World War II. The nature of the crisis is unprecedented: the long-term effects on human capital, productivity, and behaviour may be long-lasting, in addition to the short-term repeated health and economic shocks. The COVID crisis has accelerated some pre-existing trends, most notably digitalization. It has shaken the world, causing waves of change with a wide range of possible outcomes. (OECD, 2020)

On March 1, 2020, the first case of COVID-19 was reported. To stop the spread of the virus, the government declared an emergency and imposed a nationwide quarantine, restricting free movement and international travel. It also put in place several measures to help the population, businesses, and jobs.

Main measures that were implemented by the Czech government (Government, 2021):

1. Closing the borders and decreasing the number of flights.
2. All persons need to wear a face mask.
3. A restriction on the free movement of people in the Czech Republic apart from travel to and from work.
4. Closing of schools and universities (online education).
5. Closing of shopping centers, entertainments, services, restaurants.
6. All sporting, cultural and other activities involving more than 30 people were forbidden.
7. The Czech government strongly advises businesses and workplaces to allow their employees to work from home if possible.
8. Quarantine for people who are infected with Covid-19.
9. Implementing the Covid-19 tests in the workplaces and while traveling.

These are the main important measures that have made an impact on Covid-19 in the first wave.

Because of the strong emergence of new infections during the pandemic's second wave, restrictions had to be reinstated in late summer/early autumn 2020. The previously declared state of emergency will be lifted on April 11, 2021. There are still some government containment measures in place. Obligatory testing applies to schools and workplaces and wearing FFP2 or equivalent masks in public transportation and at retailers is required. Depending on how the pandemic situation improves, the government is gradually reopening measures.

Vaccinations against the virus are being administered; so far, approximately 3,100,000 people, or 29.0 percent of the population, have been immunized (with two doses). Initially, certain groups were prioritized, beginning with doctors and people over the age of 80, then education professionals, people over the age of 70 and 60, and chronic disease patients. (Ashraf, 2022)

Fiscal

- The government implemented a fiscal package (expressed in ESA2010 methodology) of CZK 228.6bn (€8.6bn, 4% of GDP) in 2020 and another fiscal package of CZK 332.1bn. in 2021
- Until the end of May, the government also contributed 100% of wages (including SSC) to employers whose businesses were closed or reduced as a result of the government's crisis management or emergency measures.
- Between February and the end of May 2021, the government approved a new compensation incentive of CZK 1000 per day for self-employed people and small businesses (and CZK 500 per day for contractors). The government also approved two new comprehensive assistance programs for 2021 (the "COVID 2021" program and the "COVID-uncovered costs" program) based on a 50% reduction in firm turnover. These programs, along with the antivirus program and the new compensatory incentive, are critical help for businesses and self-employed people this year. In the same year as 2020, the government approved a CZK 18.3 billion incentive for personnel in social services and the healthcare sector.
- The government adopted steps to selectively support affected industries due to the renewed lockdown in response to the second wave of COVID-19 infections. Self-employed people, contractors, and small enterprises (Ltd) could apply for a lump amount of CZK 500 each day between October 5 and February 15, 2021.

According to these key policy responses, the measures were implemented to help and support people in the Czech Republic. Therefore, the Czech Republic's policy was thoughtful and careful in advance.

4 Practical part

4.1 Economic performance

The Czech Republic's economy is measured by the gross domestic product. The gross domestic product represents the value of all goods and services produced over a specific time

Table 3. Annual GDP growth

Countries	2015	2016	2017	2018	2019	2020	Year-on-year change(pp)
United States	3.1	1.7	2.3	3	2.2	-3.5	-5.7
China	6.9	6.7	7	6.8	6	1.8	-4.2
European Union(27)	2.2	2	2.9	2.1	1.6	-6.3	-7.9
Eurozone(19)	1.9	1.8	2.7	1.9	1.3	-6.8	-8.1
Germany	1.2	2.1	2.9	1.3	0.6	-5.3	-5.9
Austria	0.9	2	2.5	2.5	1.4	-6.7	-8.1
United Kingdom	2.4	1.7	1.7	1.3	1.4	-9.8	-11.2
Poland	4.2	3.2	4.9	5.4	4.6	-2.7	-7.3
Czech Republic	5.5	2.4	5.4	3.2	2.2	-5.6	-7.8
Hungary	3.8	2.1	4.5	5.4	4.6	-5.1	-9.7
Slovakia	4.8	2.1	3	3.8	2.3	-5.2	-7.5

Source: MoF

within a country's borders. So, we can determine whether an economy is growing or experiencing a recession.

On the table 3, we can see that in 2020 the GDP of the Czech Republic has declined by 5.6 % due to the Covid-19 impact. In comparison with other European countries, the Czech Republic goes in line with Hungary and Slovakia. On the contrary, in the US and Poland, there was a less decline (3 %), while the significant decrease in GDP was in the United Kingdom (9.8%). China was the only economy where the GDP has grown by 1.8%.

Looking through the domestic GDP expenditure in table 4. The decline (5.8% in GDP was especially due to the factors consumption of households (6.8 decrease) and gross fixed capital formation (7.2% decrease). By contrast, government consumption was the only factor that influence GDP positively.

Table 4. Basic macroeconomic and fiscal indicators of the Czech economy

		2016	2017	2018	2019	2020
Nominal GDP	<i>bill. CZK</i>	4,797	5,111	5,410	5,790	5,695
	<i>nominal growth in %</i>	3.7	6.5	5.8	7.0	-1.7
Gross domestic product	<i>real growth in %</i>	2.5	5.2	3.2	3.0	-5.8
Consumption of households	<i>real growth in %</i>	3.8	4.0	3.5	2.7	-6.8
Consumption of government	<i>real growth in %</i>	2.5	1.8	3.8	2.5	3.4
Gross fixed capital formatior	<i>real growth in %</i>	-3.0	4.9	10.0	5.9	-7.2
Contribution of net exports	<i>pp</i>	1.4	1.2	-1.2	0.0	-0.5
Contrib. of change in inventc	<i>pp</i>	-0.3	0.5	-0.5	-0.3	-0.9
GDP deflator	<i>growth in %</i>	1.1	1.3	2.6	3.9	4.4
Average inflation rate	<i>%</i>	0.7	2.5	2.1	2.8	3.2
Employment (LFS)	<i>growth in %</i>	1.9	1.6	1.4	0.2	-1.3
Unemployment rate (LFS)	<i>average in %</i>	4.0	2.9	2.2	2.0	2.6
Wage bill (domestic concept)	<i>growth in %</i>	5.7	9.2	9.6	7.8	0.2
Current account balance	<i>% of GDP</i>	1.8	1.5	0.4	0.3	3.6
General government balance	<i>% of GDP</i>	0.7	1.5	0.9	0.3	-6.1

Source: MoF

The unemployment rate, which was decreasing steadily from 2016-to 2019 years, 2020 has increased by 0.6 pp. due to the closing of businesses and measures implemented by the government. However, the unemployment rate is still the lowest in the comparison with the EU average of 7.5%.

The general government balance has decreased to 6.1 % for the first time in four years. However, the current account balance has increased by 3.6% in the year 2020.

Talking about the Consumer Price Index (CPI) is a measure of inflation. It shows how much customers paid for various goods and services. In the Czech Republic, it rose again year on year by 3.2%. In 2020, global consumer price developments were largely influenced by the effects of the COVID-19 pandemic as well as the potential inflationary impacts of supply-side constraints and demand-side policies. The rate of price growth in most of the other economies slowed, but in Poland and Hungary, it has increased.

Table 5. Consumer price indices in selected economies

Average in given year (%)	2015	2016	2017	2018	2019	2020
United States	0.1	1.3	2.1	2.4	1.8	1.2
China	1.4	2	1.6	2.1	2.9	----
Japan	0.8	-0.1	0.5	1	0.5	0
Russian	15.5	7	3.7	2.9	4.5	3.4
European Union (27)	0.1	0.2	1.6	1.8	1.4	0.7
Eurozone(19)	0.4	1	2.6	2.3	1.7	1
Germany	0.2	0.2	1.5	1.8	1.2	0.3
Austria	0.5	0.5	1.5	1.7	1.4	0.5
United Kingdom	0.9	0.9	2.1	2	1.5	1.4
Poland	0.9	-0.6	2	1.7	2.3	3.4
Czech Republic	0.3	0.7	2.5	2.1	2.8	3.2
Hungary	0.1	0.4	2.3	2.9	3.3	3.3
Slovakia	0.3	-0.5	1.3	2.5	2.7	1.9

Source: CZSO, OECD, MoF

4.2 The current Czech Republic labour market

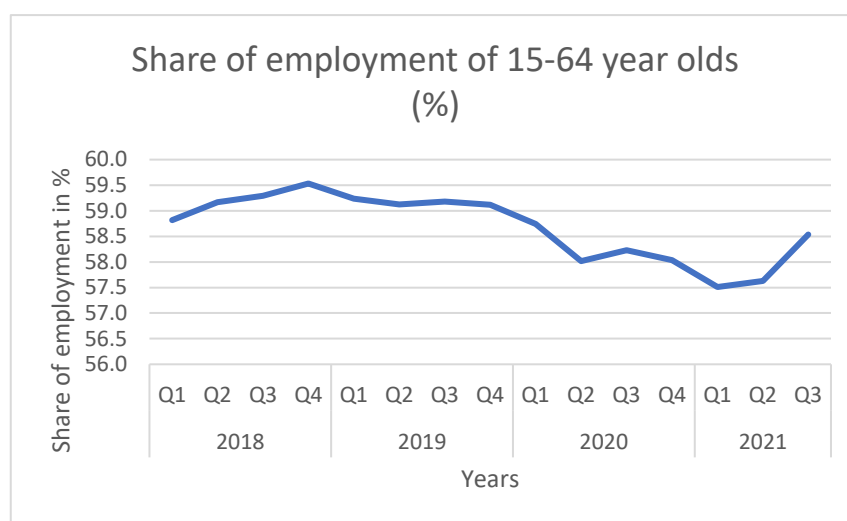
The job market remained in a state of change because of Covid-19. The economy's recession was only marginally reflected in the first quarter of 2020 results thus far. Total employment reached a high point, and unemployment remained low. The number of job openings still far outnumbers the number of unemployed. The coronavirus pandemic began progressively increasing unemployment rates at the beginning of the second quarter. Despite the increased number of unemployed people, The Czech Republic has the lowest unemployment rate among EU countries, which helps to overcome the crisis. (finance, 2020)

The total employment fell by about 1% in the first quarter of 2021 compared to the comparable period in 2019. In terms of employment structure, the number of entrepreneurs declined in the third quarter of 2021, while the number of employees increased significantly. Long-term employees have also noticed changes in the age structure. Employment fell for

employees in their prime productive years, while it increased significantly for those aged 45 to 49. These patterns were also prevalent before the pandemic.

According to figure 4 the measure of employment (share of employed persons in the 15-64-year-old age group), was the highest in 2018 (59.5%) and the lowest in the first quarter of 2021 about 57.5%. However, in Q3 2021 the share of employment increased and is growing steadily.

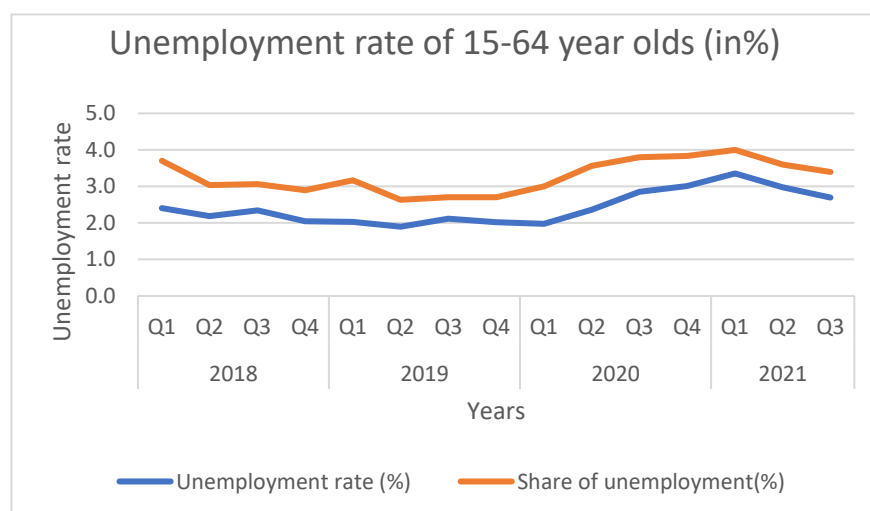
Figure 4: Share of employment in the Czech Republic



Source: CZSO, own calculations

In Q3 (figure 5) 2021 year, the general unemployment rate (as defined by the ILO) for those aged 15 to 64 (share of unemployed in labor force, ie the sum of employed and unemployed) declined by 1 percentage point year on year to 2.5 percent, while it was just 2.1 percent

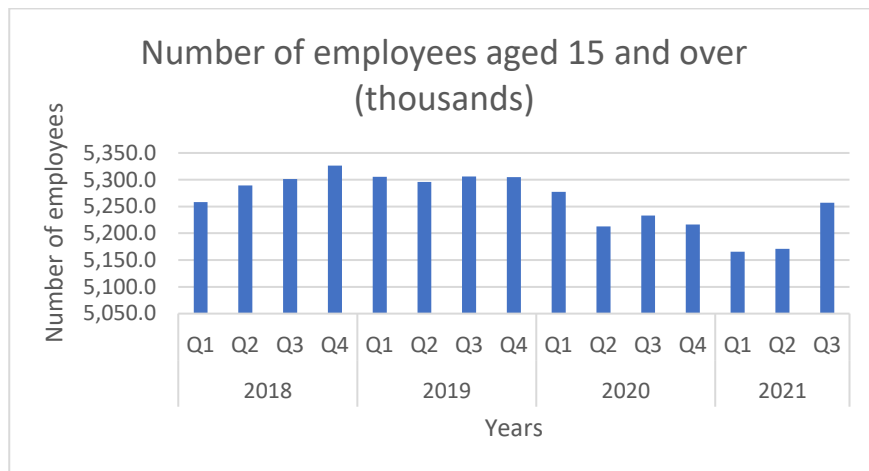
Figure 5: Unemployment rate in Czech Republic



Source: CZSO, MPSV, own calculations

in the same quarter of 2019. The increase was significant in 2020, with the jobless rate reaching its highest level in the prior four years in the first quarter of 2021.

Figure 6: Number of employees in the Czech Republic



Source: CZSO, own calculations

Considering figure 6 of the number of employees, during the pandemic situation the number decreased, and the highest decrease was in the first quarter of 2021 about 5 171 thousand people were employed, but in Q3 the number grow up to 5 250 thousand people.

According to the report of the MOF, 24 regions in the Czech Republic had unemployment rates equal to or higher than the national average, the lowest unemployment rate is in the Pardubický region (2,2%) and the highest in Ústecký and Moravskoslezský regions. The trend of the highest and lowest unemployment in specific districts has been relatively constant across the observed period. Until now, unemployment has risen at a reasonably moderate rate, aided in part by government actions (antivirus), and in part by employers waiting for workers due to a labour shortage. Nowadays, in the Czech labour market, the number of vacancies continues to outnumber the number of unemployed. As a result, businesses need more workers. In the Czech Republic, workers are in short supply in almost every field, particularly in technical and labour professions, as well as in services and low-skilled workers.

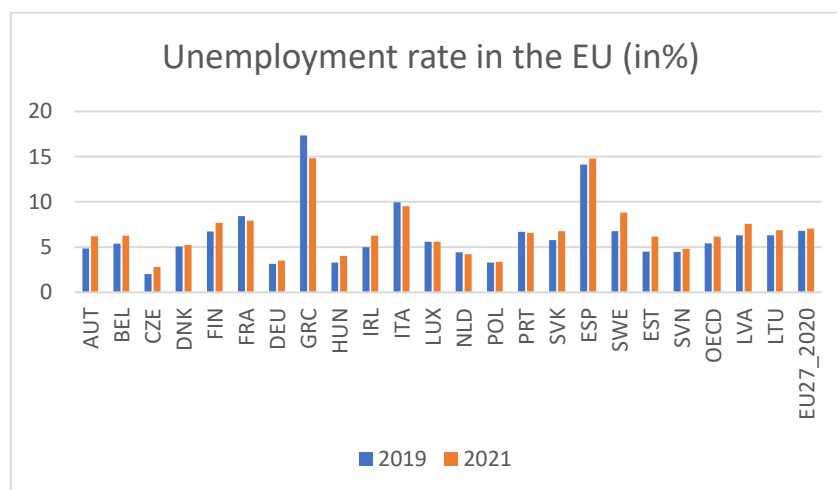
Lack of employees, caused by restrictions on foreign workers' stay, has become one of the key problems impeding economic growth and putting downward pressure on pay increases.

Despite the Covid-19 outbreak, there was pressure to increase salaries due to a lack of staff. The average gross nominal wage in the third quarter of 2021 is the highest in Prague (45 523 czk per month) and the lowest in the Karlovarský region (33 249 czk per month).

In the monitored period, the impact of anti-pandemic efforts was significantly uneven, as was the flexibility of individual labor market segments, resulting in differential wage patterns. Wage increase occurred in all sectors of the national economy in the third quarter of 2021 (compared to the same time in 2019). The highest change in monthly salary was Královéhradecký region (13.5% compared to 2019) and the lowest change was in Prague (9.5%).

The Czech Republic has the lowest rate of EU average unemployment rate, which was 2.7 percent on average in the third quarter of 2021. (From 2 percent in the same period 2019). The unemployment rate in the European Union has reached 6.8%. In Greece and Spain, they are already dealing with exceptionally high unemployment rates. Unemployment remains a persistent issue for Union young people (under 25), which is more than twice as prevalent as unemployment among working-age individuals (16.1 percent). However, for this age group, it is vital to consider that a significant portion of the young generation is enrolled in school and hence not economically active.

Figure 7: The unemployment rate in the EU



Source: Eurostat data

4.3 Time series analysis of Covid cases in the Czech Republic

To begin evaluating economic indicators, the necessary data must be gathered, as shown in Table 6. I have collected data from the Czech statistical office, Eurostat, and Ourworldindata, where the basic price index, GDP, Unemployment rate are calculated. The data is very important for forecasting and analysing economic indicators (salary, consumption, gross capital, and others). It helps to understand the economic situation in the country and make an international comparison.

Firstly, I decided to make a statistical analysis of how the number of covid cases per month has influenced the basic price index. The analysis is based on the time series analysis of covid cases in the Czech Republic in the period 03/2020-01/2021.

Table 6. Time series analysis of covid cases in the Czech Republic

Data	Total covid cases	Basic price index
03/2020	25984	111.2
04/2020	184001	111
05/2020	262979	111.4
06/2020	307889	112.1
07/2020	430742	112.6
08/2020	628547	112.6
09/2020	1304611	111.9
10/2020	5443207	112.1
11/2020	13617115	112.1
12/2020	18743896	111.9
01/2021	26959120	113.4
02/2021	30777715	113.6
03/2021	43611257	113.8
04/2021	47718289	114.4
05/2021	51169649	114.6
06/2021	49954479	115.2
07/2021	51784975	116.4
08/2021	51968562	117.2

09/2021	50545691	117.4
10/2021	53159199	118.6
11/2021	57899447	118.8
12/2021	72970861	119.3
01/2022	82401574	124.6

Source: Eurostat, Ourworldindata, own calculations

Thanks to analysed data we have defined:

Dependent variable: Consumer price index

Independent variable: Covid cases

Assumption: Covid cases increase, Basic price index increases

The consumer price index has increased from 2020 to 2022

The main reasons for this growth might be seen in:

- Coronavirus pandemic
- Covid-19 measures implemented by the Czech government
- High inflation rate
- Strict measures on borders

The model describing the increase in the Consumer price index in the Czech Republic is based on the time series analysis. The time series contains the data for the period 2020-2022. The data set was provided by Ourworldindata and the Czech statistical office.

The next table shows us a descriptive analysis of the previous data. By describing it, we can find out the maximum, minimum value, mean, median. The mean of the covid case is 30950860.39, the median is 30777715, these values both measure central tendency. There is no data for mode in some columns, it means that the data occurs once. Also, considering the coefficient of variation, significant variability occurred. The standard deviation is 3.39. The variable with the highest variation is Covid cases.

Table 7. Descriptive analysis of covid cases and basic price index

Column1	Covid cases	Basic price index
Mean	30950860.39	114.62
Median	30777715	113.6
Mode	#N/A	112.1
Standard Deviation	26742035.86	3.39
Sample Variance	7.15	11.51
Minimum	25984	111
Maximum	82401574	124.6
Sum	711869789	2636.2
Variation coefficient	0.86	0.03

Source: own calculations

Also, the main features were detected using index analysis. So, according to the basic index (comparing each period with the first, the base is the first year- 2020), we can see that the basic price has increased between 03.2020 and 01.2022 because the minimum value was in 2020 and the maximum in 2022 (12%). According to the chain index that describes annual changes, the basic price index decreased in September 2020 by 6% and the biggest increase was in January 2022 year on 4 %.

Table 8. Index analysis of basic price index

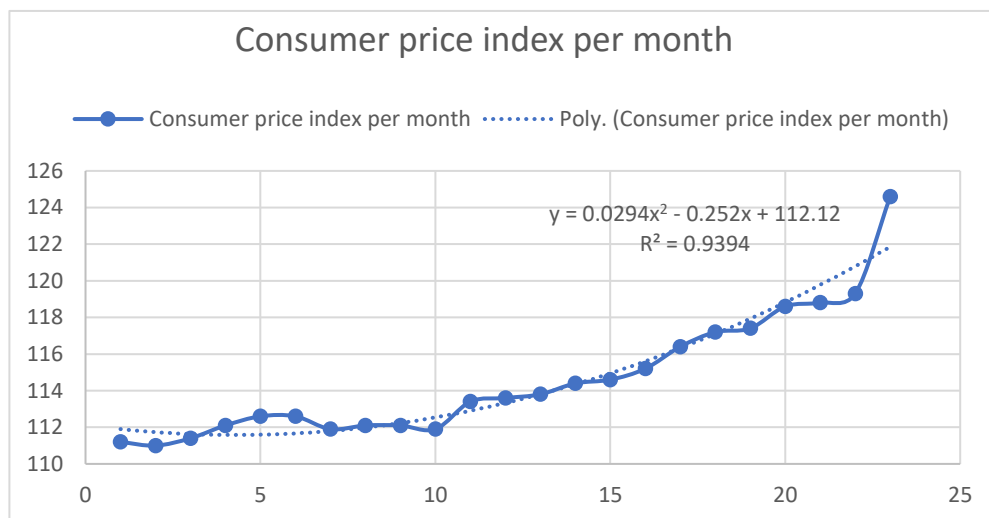
Data	Basic price index	Basic index	Chain index
03/2020	111.2	1.000	----
04/2020	111	0.998	0.998
05/2020	111.4	1.002	1.004
06/2020	112.1	1.008	1.006
07/2020	112.6	1.013	1.004
08/2020	112.6	1.013	1.000
09/2020	111.9	1.006	0.994
10/2020	112.1	1.008	1.002
11/2020	112.1	1.008	1.000
12/2020	111.9	1.006	0.998
01/2021	113.4	1.020	1.013
02/2021	113.6	1.022	1.002

03/2021	113.8	1.023	1.002
04/2021	114.4	1.029	1.005
05/2021	114.6	1.031	1.002
06/2021	115.2	1.036	1.005
07/2021	116.4	1.047	1.010
08/2021	117.2	1.054	1.007
09/2021	117.4	1.056	1.002
10/2021	118.6	1.067	1.010
11/2021	118.8	1.068	1.002
12/2021	119.3	1.073	1.004
01/2022	124.6	1.121	1.044

Source: Own Calculations

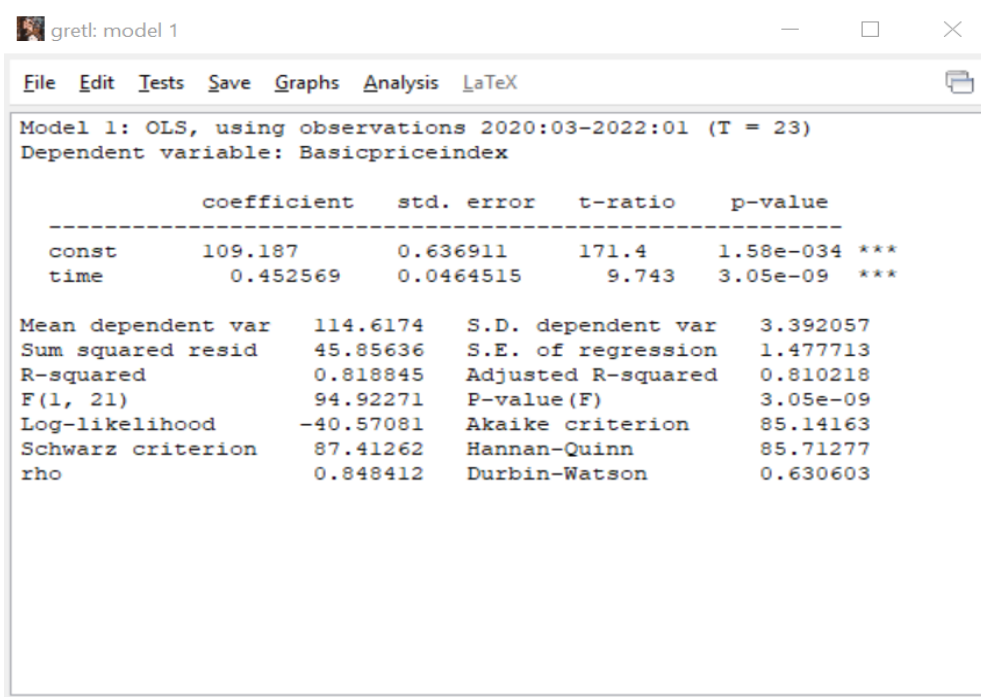
Using the trend function, I made a graph of the consumer price index per month in the Czech Republic in Excel (Figure 10) and Gretl (Figure 11). Considering that the estimating parameters are the same. The graph shows us that the consumer index per month is always increasing. Due to the coefficient of determination, we can say that 93 percent of the variation in the time series consumer price index is explained by the trend quadratic function. In addition, the quality of the trend function is high, and the parameters are statistically significant. The table provides the coefficients of a linear trend function, where 82 percent of the variation in the time series consumer price index is explained by the linear trend function.

Figure 8. Consumer price index per month



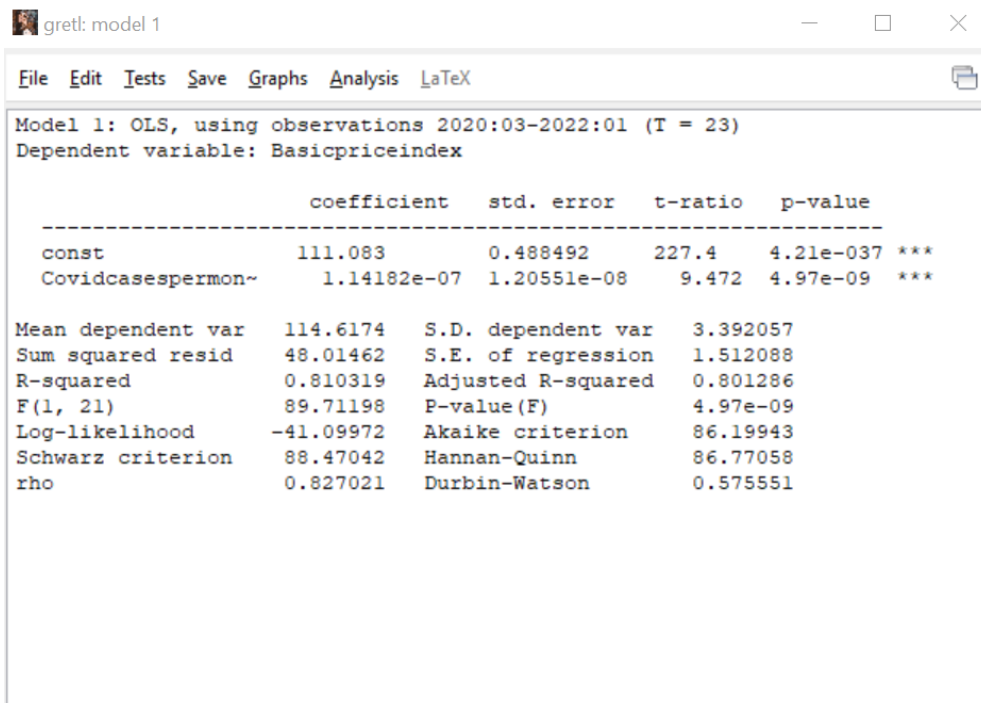
Source: Own Calculations

Figure 9. Consumer price index graph per month



Source: Own Calculations

Figure 10. Regression model of Covid-19 basic price index



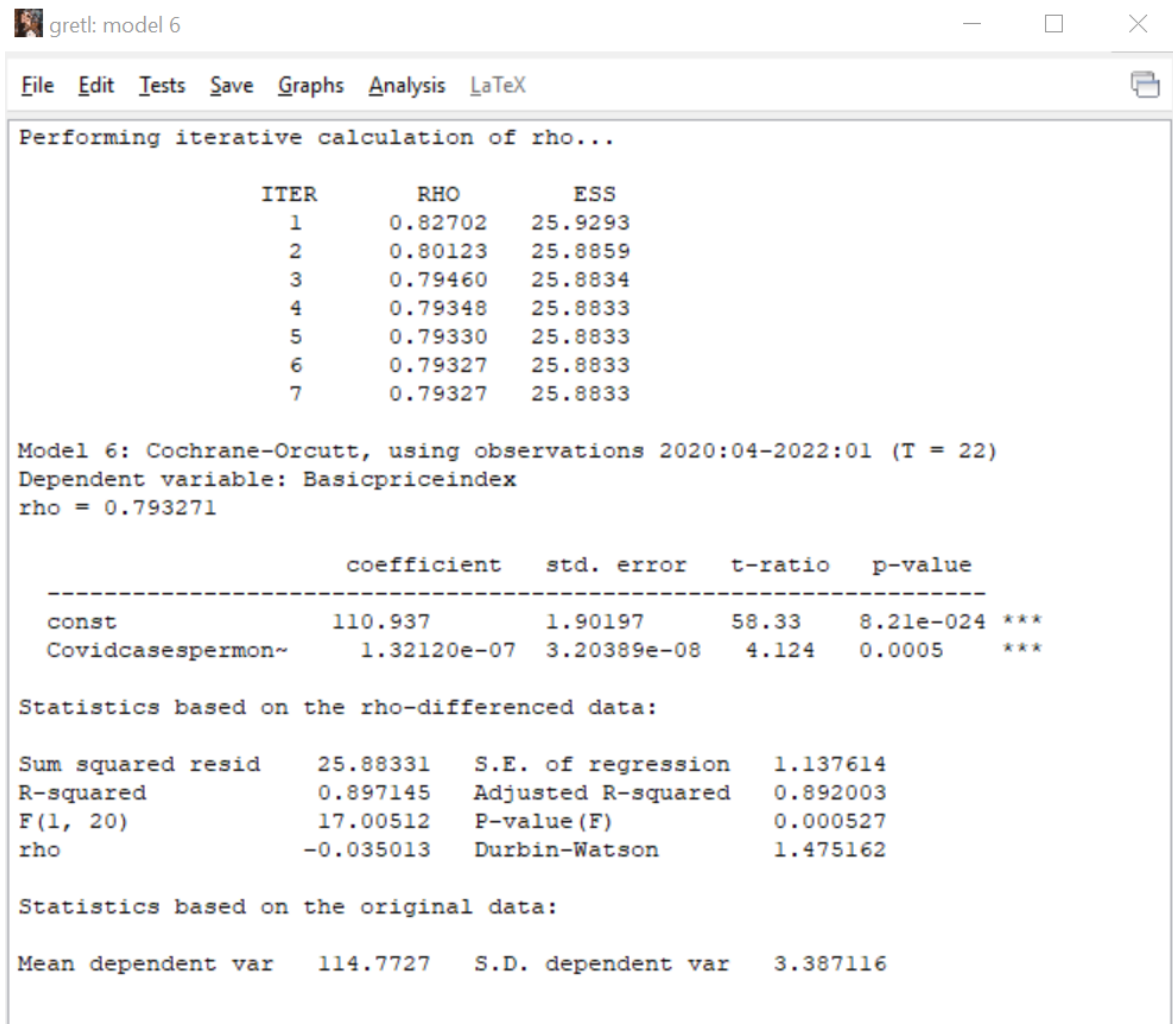
Source: Own calculations

The last step of the research is to build the Regression model in linear form.

$$CPI = f(\text{Covid cases per month})$$

The time series contains 23 observations, and the dependent variable is the CPI. According to the Durbin-Watson test, there is most probably autocorrelation among the residuals. The model can be improved by using the AR1 error in Gretl.

Figure 11. Improved regression model of Covid-19 basic price index



Source: Own calculations

According to the p-value, the parameter covid cases are significant.

The coefficient of determination is approximately 89 percent of the variation in time series covid cases is explained by analysed relationship. The f-test provides a good result, and the quality of the model is high. It means that the explanatory variables were chosen properly. So, according to our calculations, we have interpreted the results.

$$Y_1 = 110,937 + 1,32x_2$$

The Covid cases increase the consumer index increases.

Finally, based on our results we can reject and accept some hypotheses.

Hypotheses:

1. The Covid cases increase, the consumer index increases.

So, due to the interpreted results of the Regression model, we must accept the hypothesis, the variables are highly correlated.

4.4 Assessment of Czech main economic aggregates forecasted using ARIMA

Firstly, I'm going to analyse the time series model and forecast them using data from the Eurostat Database in R. "Eurostat's main role is to process and publish comparable statistical information at the European level. We try to arrive at a common statistical 'language' that embraces concepts, methods, structures, and technical standards. Eurostat does not collect data. This is done in the Member States by their statistical authorities. They verify and analyse national data and send them to Eurostat. Eurostat's role is to consolidate the data and ensure they are comparable, using the harmonized methodology. Eurostat is the only provider of statistics at the European level and the data we issue are harmonized as far as possible."

What I'm going to do is to download some data from Eurostat using the Eurostat package in R, analyse the time series, model, and forecast the next 8 quarters for each of the following 6 aggregates:

1. GDP (gross domestic product at market prices)
2. Consumption (final consumption expenditure)
3. Gross Capital (gross capital formation)
4. Exports (of goods and services)
5. Imports (of goods and services)
6. Salaries (wages and salaries)

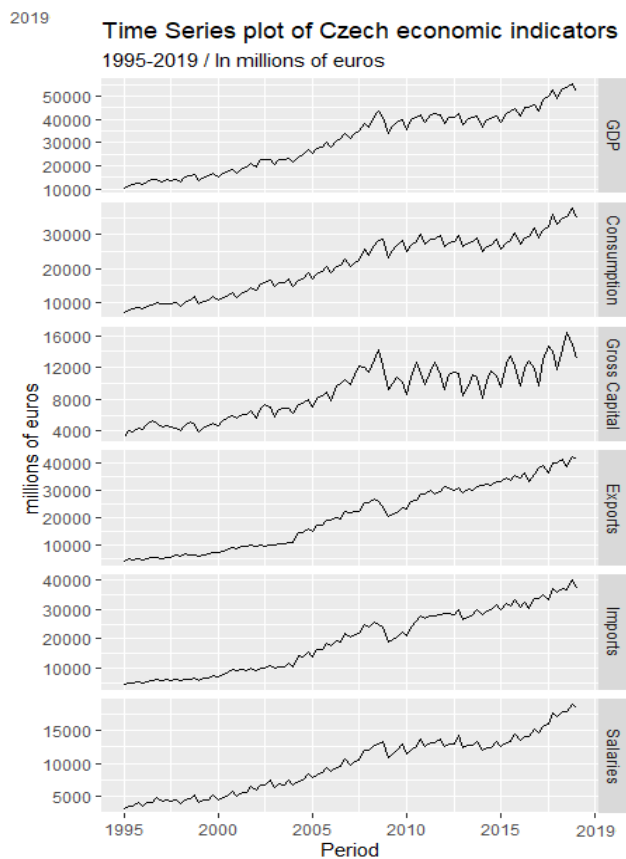
We will have 6-time series with quarterly frequency starting in 1995 and ending in Q1 2019.

4.5 Data acquisition & exploratory analysis

We try to determine patterns in the time-series data during exploratory analysis, such as:

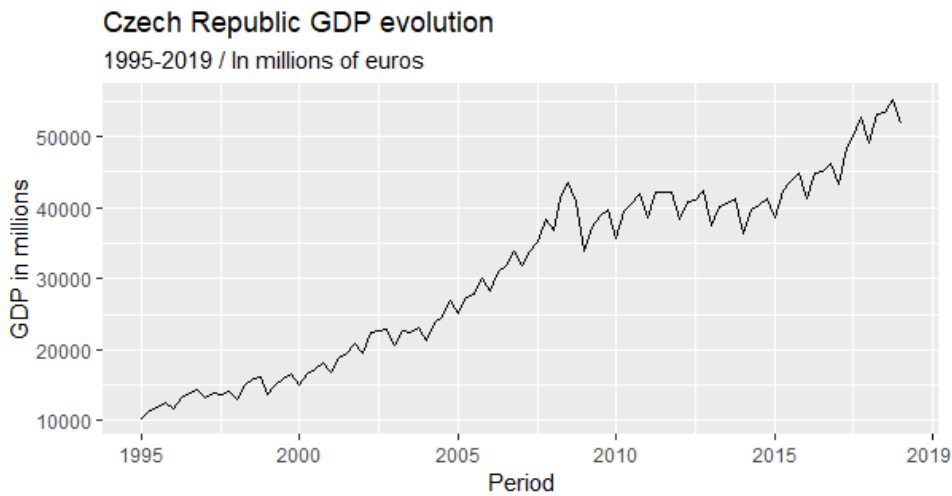
- Seasonality. Because of the calendar, there is a period pattern (e.g. quarter, month, weekday)
- Cyclicity. There is a pattern when the data shows the rise and fall that are not of a fixed period (duration usually of at least two years) Below there is a time series plot of the Czech economic aggregates from 1995 till 2019. According to it, we can see an upward trend, starting from 1995 and decreasing in 2019. The biggest decrease was in the Gross Capital indicator.

Figure 12. Time Series plot of Czech economic indicators



Source: Own calculations

Figure 13. Czech Republic GDP evolution



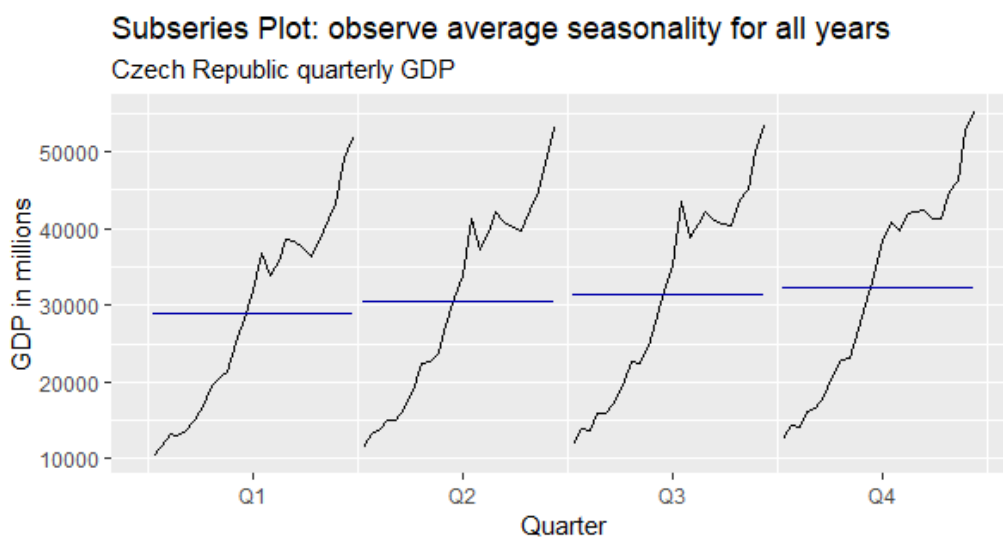
Source: Own calculations

The GDP plot above has a few output results:

- There is an overall positive trend
- There is no visible increased/decreased variability in the trend
- There appears to be some seasonality, but this needs to be investigated further
- There is no cyclicity
- There is a significant disruption in GDP growth between 2008–2009

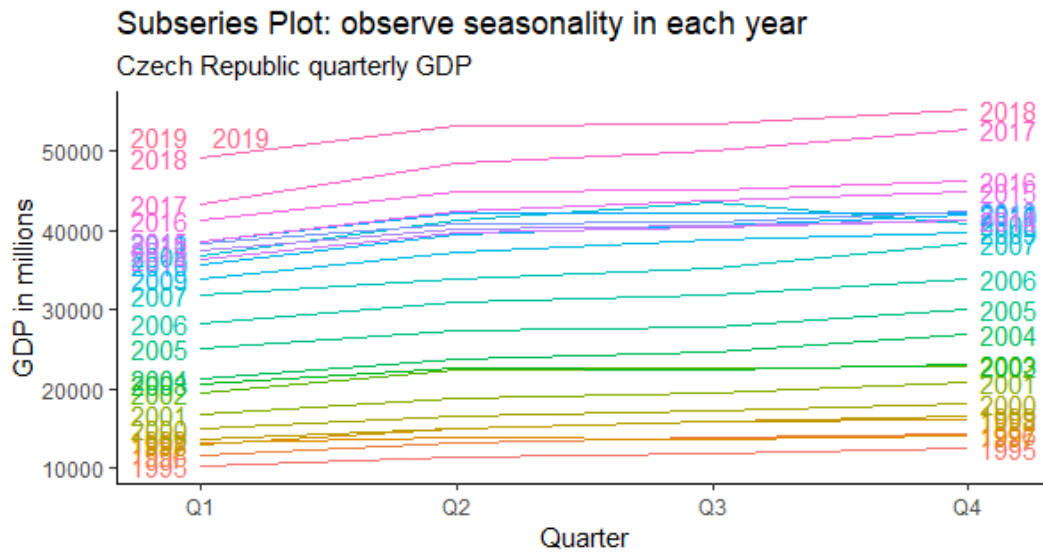
We can examine seasonality using two plots:

Figure 14. Plot: observe average seasonality for all years



Source: Own calculations

Figure 15.Subseries Plot: observe seasonality each year



Source: Own calculations

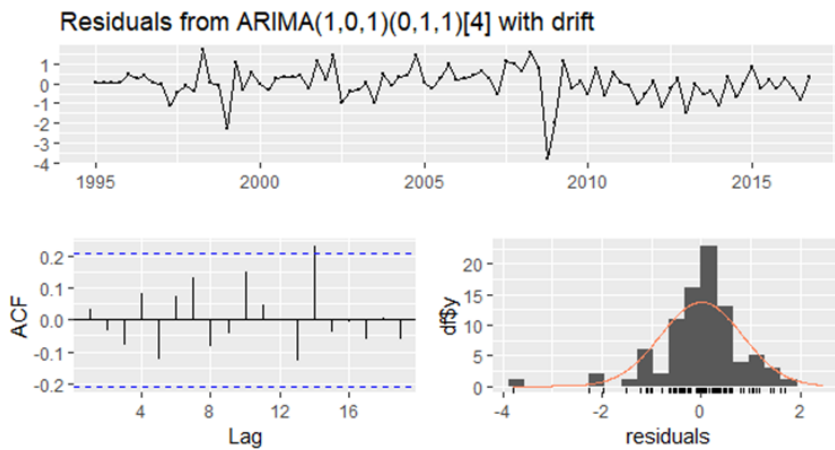
Both of these plots show that GDP performance is seasonal with better performance in Q3 and Q4 and lower performance in Q1 and Q2. In addition, we can define a big decline in 2020 year which was affected by the pandemic situation.

4.6 Modeling with ARIMA

ARIMA models are one of the most common methods for predicting time series. It is the most frequently used method for time series forecasting, to describe the data's autocorrelations.

The forecast library's `auto.arima()` function generated the final fitted model. It evaluates a series of models and returns the best one based on AIC, AICc, or BIC value. After fitting the ARIMA model, it is needed to test the residuals are well-behaved (no more outlines) and resemble white noise. The residuals are shown below.

Figure 16. Residuals from the Arima model



Source: Own calculations

Because the residuals are correctly specified, there is no real pattern, and autocorrelations are not large, we may state that the model is fairly good.

Seasonal ARIMA (1,0,1)(0,1,1)[4] is the final model. The center slot in each portion of the model indicates that both seasonal and initial differences were considered. In addition, the last slot in each portion of the model has been used to choose one lagged error and one seasonal lagged error. The first slot in the model indicates that two autoregression terms were utilized. There were no seasonal autoregression phrases employed.

Figure 17. Model accuracy

	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1	Theil's U
Training set	-23.035	826.653	534.911	0.01	1.854	0.258	0.076	NA
Test set	2438.752	2758.201	2438.752	4.88	4.880	1.178	0.393	0.81

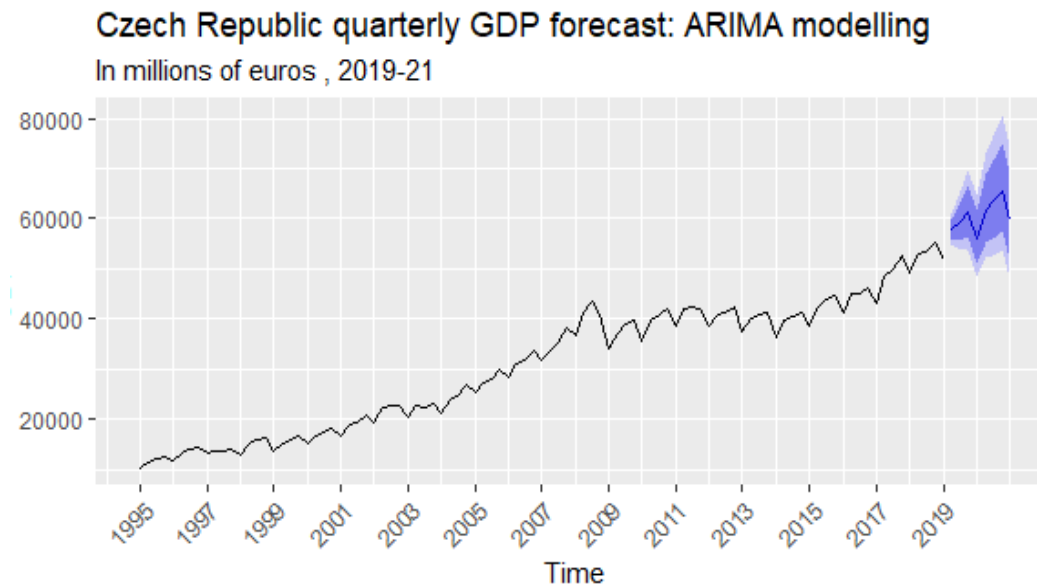
Source: Own calculations

Finally, the accuracy of the model is evaluated. MAPE is one of the accuracy metrics that we can look at (mean absolute percentage error). In this scenario, the MAPE for the test set is 1.9 percent. So, I can say that 1.7 percent is a reasonable error rate to make a forecast.

4.7 Forecasting of Czech economic aggregates

The main goal of the forecast of Czech economic aggregates is to predict values during Covid-19 from 2019 to 2020. Moreover, to determine how close the observed values from Eurostat and the predicted values are.

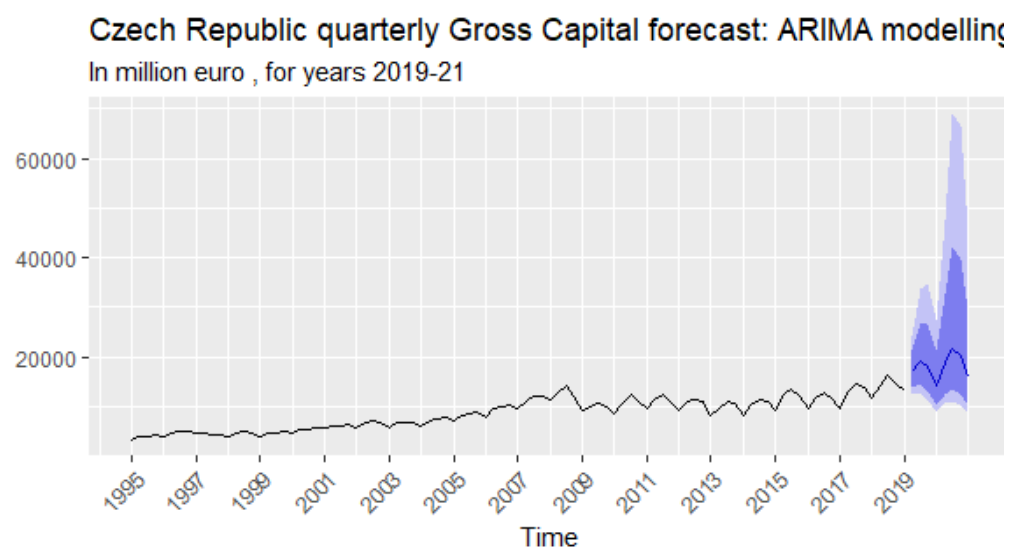
Figure 18. Czech Republic quarterly GDP forecast



Source: Own calculations

Our prediction for Czech Republic GDP for the next eight quarters shows a continuation of the decreasing trend due to Covid 19 while also reflecting seasonality appropriately. GDP at current prices will decrease to 59, 879 million euros in the first quarter of 2021, representing an 8.6 % decrease over the first quarter of 2021, according to this forecast. In comparison with observed values on the Eurostat data, GDP at current prices in the first quarter of 2021 will decrease to 53,240 million euros representing a 7% decrease over the first quarter of 2021.

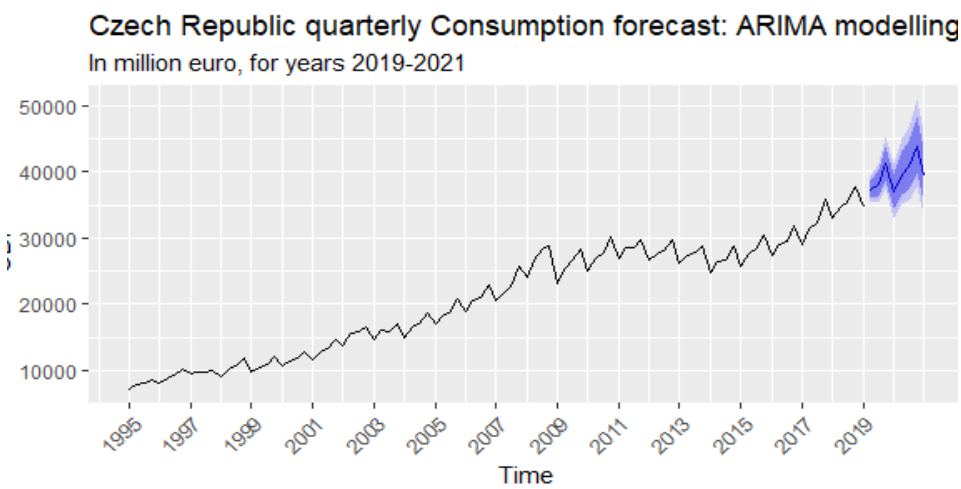
Figure 19. Czech Republic quarterly Gross Capital forecast



Source: Own calculations

The prediction for Czech Republic Gross Capital for the next eight quarters shows a continuation of the increasing trend, but it starts to decrease in 2019. Gross Capital at current prices will decrease to 15,923 million euros in the first quarter of 2021, representing a 1 % decrease over the first quarter of 2021, according to this forecast. Comparing the predicted value to the observed value, Gross Capital at current prices over the first quarter of 2021 will decrease to 14,312 million euros and has a 1% decrease over the first quarter.

Figure 20. Czech Republic quarterly Consumption forecast

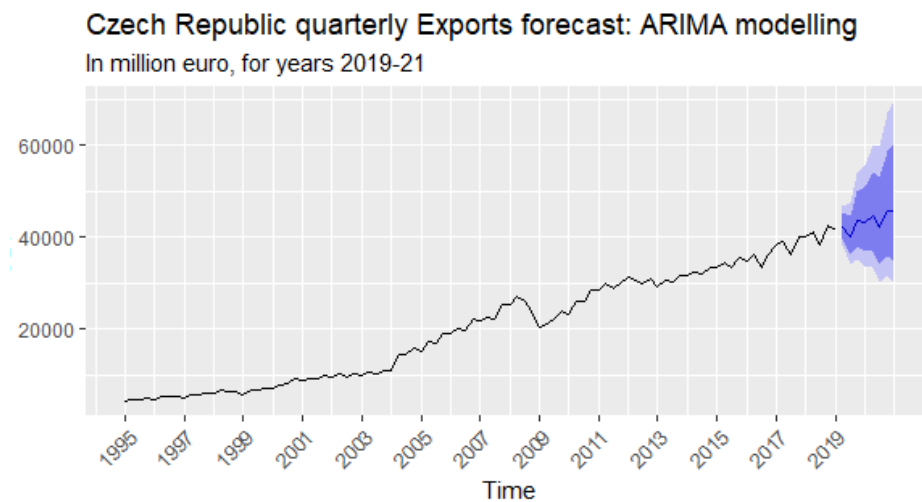


Source: Own calculations

The consumption forecast is increasing and has an upper ward trend, but in 2019 it decreases. The forecast shows that in the 2021 first quarter, the consumption will decrease dramatically to 39,373 million euros. In addition, consumption will decrease by 10.2 %. The covid-19 doesn't have a direct influence on consumption as it has on GDP. Comparing

the predicted value to the observed, the expenditure on consumption decreased to 34,474 million euros.

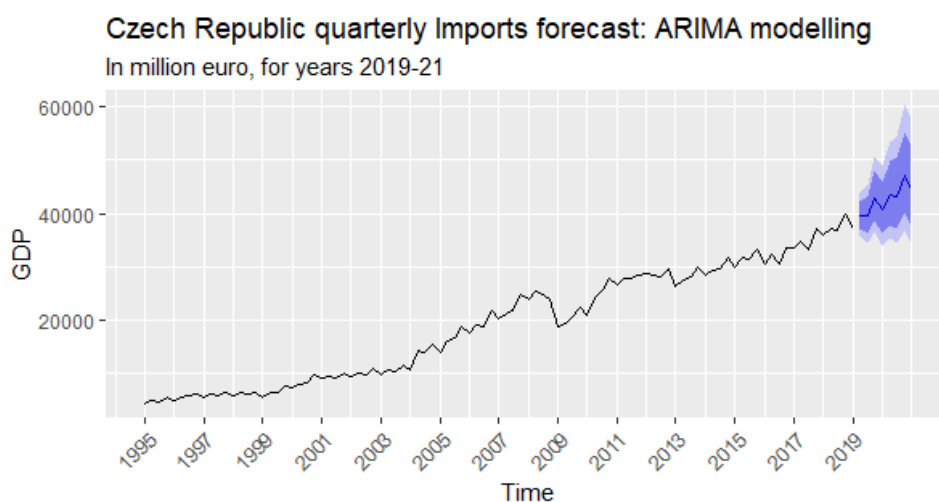
Figure 21. Czech Republic quarterly Exports forecast



Source: Own calculations

Our prediction for the Czech Republic's quarterly Exports forecast for the next eight quarters shows a continuation of the increasing trend. Despite this, exports at current prices will decrease to 45,587 million euros in the first quarter of 2021, representing an 8 % percent decrease over the first quarter of 2021, according to this forecast. In comparison with the real values, the Exports will decrease to 42,062 million euros in the first quarter of 2021.

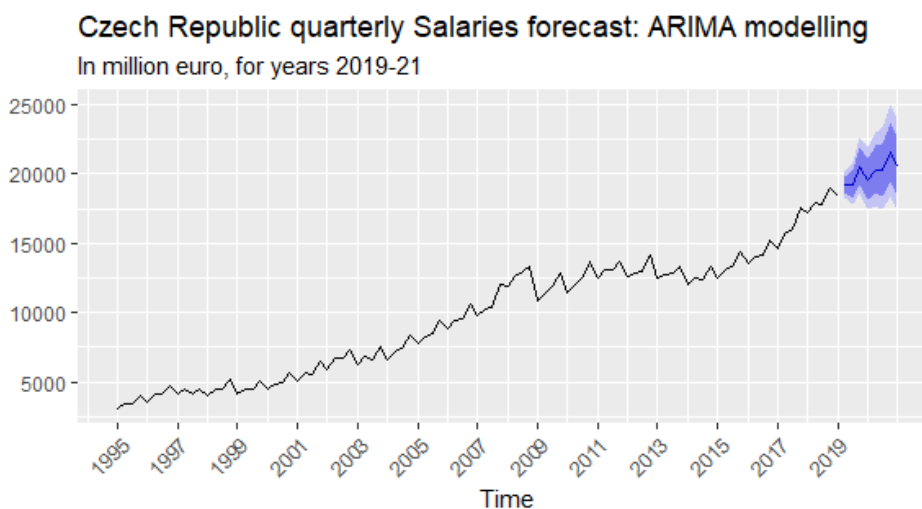
Figure 22. Czech Republic quarterly Import forecast



Source: Own calculations

The Salaries forecast is increasing and has an upper ward trend but in 2019 it starts to decrease. The forecast shows that by 2021 first quarter, the imports will decrease to 44,696 million euros. In comparison with the 2020 year, salaries will decrease by 7 %. According to the real values taken from Eurostat, the imports in the first quarter of 2021 decreased to 37,608 and it is a 3 % decrease compared to 2020.

Figure 23.Czech Republic quarterly salaries forecast



Source: Own calculations

The Salaries forecast is increasing and has an upper ward trend. The forecast shows that by 2021 first quarter, the salaries will decrease to 20,532 million euros. In comparison with the 2020 year, salaries will decrease by 5 %. The covid-19 has a direct influence on salaries, which can be seen in the forecast. According to the real values taken from Eurostat, the salaries in the first quarter of 2021 decreased to 18,597 and it is an 8 % decrease compared to 2020.

To summarize, the predictions are not precise, but the predicted values are close to the observed. During the first quarter, the growth of the indicators is not observed in the 2021 year, it is only seen as an accurate downtrend in all analysed variables.

5 Results and Discussion

The COVID-19 pandemic has caused a worldwide health crisis, requiring several governments to implement stringent preventive measures to stem the virus's spread, including national lockdowns and social distance measures (Huang et al. 2020). With the

spread of the Covid-19 pandemic, more measures were implemented, and many businesses closed.

Since 2020, the GDP rate has started to decrease in the Czech Republic dramatically from 3.02% in 2019 to -5.7% in 2020. Also, the Unemployment rate has increased, as many businesses were temporarily closed. Despite the fact of the increased unemployment rate, in the Czech Republic, it's the lowest in Europe. In the labour market in the years 2019-2020, the number of vacancies has decreased but several unemployed increased.

There was investigated if there is a relationship between Covid-19 and Consumer prices per month and confirmed that the consumer prices were influenced by the number of cases. And the consumer prices drastically become high.

The rebound of the global economy following the Covid-19 outbreak has generated turmoil in global commodities markets, pushing commodity prices to new highs. In 2021, the average price of Brent crude oil, the main component index, was 71 USD per barrel. Due to its low levels last year, the price has risen by more than 70% in comparison to 2020 and 11% in comparison to 2019. The Organization of Petroleum Exporting Countries and its associate states began to gradually lift production limits in the second quarter of 2021.

According to the most recent information, consumer prices climbed at a quicker rate, reaching up to a 4.6 percent year-on-year rise in 2021, the quickest rate in the preceding thirteen years. Both external and domestic inflationary pressures, particularly an increase in core prices, were to blame. Fuel, housing, and energy prices have all risen dramatically. The length and nature of the lockdown, as well as the social isolation measures enforced by governments to contain the pandemic's spread, have resulted in asymmetric consequences not only between countries but also between business sectors and inside each country's demand-supply networks. (BFPG 2020).

Despite the long and difficult pandemic situation in the Czech Republic, the situation improves from 2022. The government helped many businesses and workers to survive during a pandemic and tried to stabilize and decrease the number of cases by implementing mandatory vaccination. There are many difficulties on the path to a stable economy, but the Czech Republic is on it.

6 Conclusion

The purpose of the bachelor thesis was to analyse the direct impacts of the covid-19 on the Czech economy. The primary goal of the first section of the thesis is to define the main economic aggregates and explain concepts of the Czech economic indicators. Furthermore, in this section measures implemented by the Czech government are explained, and how the government helped businesses to survive through the pandemic. The Czech government helped many businesses and workers to not lose jobs, but unfortunately some of the businesses closed.

The second section of the bachelor thesis includes the economic performance of the Czech Republic, where the most suffering businesses such as services are mentioned and analysed. Also, the consumer prices and commodity prices are reviewed. In the second part, we made a time series and a correlation analysis to see how the number of cases influenced the consumer price. Finally, the variables are highly correlated, and the hypothesis is accepted because the number of cases affected the Consumer price. The second analysis is made by using software R, where the predicted values were compared to the observed. All the variables have a decrease during 2019-2020, which is shown on the graph. The biggest decrease is in the variable Consumption at 10 % and the smallest at 1 % in the variable Gross Capital. The predicted values are close to the observed value, but the difference is also seen.

In general, it is important to note that the issue of covid-19 is a debated topic because it influenced everyone. Nowadays, the situation became clearer and thanks to mandatory vaccination, the number of cases decreased. Some of the economic aggregates such as GDP from 2021 starting to grow as the economic situation on market improves.

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Appendix 1

GDP and main components (output, expenditure and income) from 2019 to 2021

NA_ITEM (Labels)	GDP	Consumption	Gross capital	Exports	Imports	Salaries
Time						
2019-Q1	51,930.8	34,700.6	12,885.3	41,399.7	37,229.1	18,435.9
2019-Q2	56,483.5	36,936.9	14,292.3	42,556.8	37,981.5	19,278.9
2019-Q3	57,622.3	37,665.6	15,884.5	40,441.2	37,669.3	19,101.3
2019-Q4	59,542.6	40,481.6	18,016.5	42,289.9	40,301.4	20,569.6
2020-Q1	53,475.5	36,081.5	12,839.9	40,476.1	36,465.5	19,232.5
2020-Q2	49,843.3	33,825.6	13,279.5	31,524.8	29,436.3	17,152.9
2020-Q3	55,130.2	36,397.2	14,428.1	37,827.8	33,727.2	18,786.4
2020-Q4	56,823.2	38,457.8	15,751.2	43,142.3	38,599.7	20,116.7
2021-Q1	53,240.6	34,474.9	12,457.2	42,062.0	37,608.4	18,597.3
2021-Q2	60,095.3	39,525.3	14,991.6	44,903.2	42,033.7	20,697.4
2021-Q3	61,743.2	41,147.3	15,813.5	40,580.1	40,620.1	20,954.1
2021-Q4	64,001.7	44,735.7	17,767.6	45,705.0	45,785.1	22,741.6

Source : Eurostat