

Economic Impacts of the Covid-19 Pandemic on the National Economy of the Czech Republic

Eva Hoke^{a*}, Marek Tomaštík

Tomas Bata University in Zlín, Faculty of Logistics and Crisis Management, Studentske nam. 1532, Uherské Hradiště
 hoke@utb.cz

The paper deals with the analysis of the impact of Covid-19 on the economy of the Czech Republic. The Covid-19 pandemic is an extreme burden and crisis for our economy, and not just ours. The health crisis spilled over into the economic crisis at lightning speed. The paper focuses on analyzing and evaluating the effects of the Covid-19 pandemic on the economy of the Czech Republic. The author's team focused on two variables, namely gross domestic product and unemployment in the Czech Republic. The dependence of macroeconomic variables is investigated through one of the primary statistical analysis methods - regression analysis. The paper aims to propose a model that explains the relationship between these two variables in the conditions of the Czech Republic through empirically determined data on the level of gross domestic product and unemployment. Based on this model, it will be possible to estimate/predict the further development of unemployment depending on the expected development of GDP. Attention will also be paid to estimating whether and, if so, how the described relationship is changing in connection with the current development of the Czech economy during the ongoing Covid-19 pandemic.

1. Introduction

The impact of the Covid-19 pandemic on the world economy is immense. Both companies, tiny and medium-sized enterprises, and the public sector are critically endangered. (Hoke et al., 2021) A crisis of this nature can cripple the economy on a large scale, mainly because of the preventive measures applied in the fight against Covid-19. The ongoing COVID-19 crisis has placed a unique role on policy to soften the adverse economic impacts faced by many firms. (Dörr et al., 2021) The rationale for these restrictions was to save lives and prevent health systems from being overwhelmed. These restrictive policies have produced unprecedented effects on household incomes, which governments have addressed via extraordinary measures such as furlough payments and the direct support targeted at those who were more in need during the pandemic. (Clark et al., 2021) The revenue shortfall weakened aggregate demand and, with it, GDP growth. Many studies have looked at the economic downturn and rising unemployment. (Bourquin and Waters, 2021; Ferrera et al., 2021; Kalenkoski and Pabilonia, 2021; Yagi and Managgi 2021) The spread of COVID-19 initiated important debates among economists about the proper role of government in dealing with pandemics. (Geloso, 2021) The lockdown announced on March 2020 entailed the closure of borders and schools, the cancellation of public events, and the shutdown of all non-essential shops, museums, cinemas, and similar establishments. (Lastauskas, 2021) Beyond the humanitarian tragedy of the COVID-19 pandemic, the virus also has a growing impact on local economies and the global economy. (Kuckertz et al., 2020) Although many governments have taken many restrictive measures, the impact on GDP and then unemployment is indisputable.

The primary feature of developed economies is a high economic growth rate, which creates the preconditions for a high living standard of population-based on high incomes from economic activities. (Ivanová and Grmanová, 2021) The Czech Republic is a developed country with a stable economy with minimal macroeconomic indicators and solid financial stability fluctuations. GDP in the Czech Republic recorded relatively stable growth in 2010-2019. The only exception was 2012, when GDP fell by 0.8% yearly. The average GDP growth in the period 2010-2019 reached 2.4%. In contrast, 2020 marked a year-on-year decline, with GDP falling by 5.6% yearly. Based on the above, one of the main reasons for the decline in GDP in the Czech Republic

can be assumed measures taken by the Czech central authorities in connection with the pandemic, especially measures that limited economic activity such as closing or significant reduction of selected sectors of the economy - especially services or a significant part of the trade-in goods and the closure of school facilities. The government offset the adverse effects of the mentioned measures through fiscal measures to support both final consumption and exports. In connection with the effects of the Covid-19 pandemic, the following chapter will also analyze the development of only two selected fundamental economic indicators in the Czech Republic, namely the development of GDP and unemployment, including their relationship. (Czech Statistical Office, 2021) The other macroeconomic indicators will not be examined.

2. Methodology

The goal of the paper is thanks to regression analysis to propose a model using empirically obtained data on the level of GDP and unemployment, which explains the relationship between these two quantities in the conditions of the Czech Republic and possibly estimate/predict the further development of unemployment depending on the expected development GDP. Subsequently, through further investigation, estimate whether and, if so, how the described relationship changes in connection with the current development of the Czech economy in the current period Covid-19 pandemic. Regression analysis is one of the most used statistical analysis methods of multidimensional data. It allows the expression of the relationship between the variable we want to describe (explained variable or response) and a set of explanatory variables (regressors) by the regression promotions function. (Neubauer et al., 2016) The data were obtained from the official pages of the Czech Statistical Office (CSO, 2021).

3. Results and Discussion

For the purpose of examining the relationship of quantities, a linear regression model with one explanatory variable (regressor) will be used, which can be expressed in the following form (1):

$$Y = \beta_1 + \beta_2 X + e \quad (1)$$

where Y is a random variable, X is a given, a real variable, β_1, β_2 are unknown parameters (constants) and e is a random variable/error.

For the construction of the model it is necessary to estimate the parameters β_1 and β_2 using the measured data, when for the values x_1, x_2, \dots, x_n of the variable X the values y_1, y_2, \dots, y_n of the variable Y are observed and we assume that

$$y_i = \beta_1 + \beta_2 x_i + e_i, i = 1, 2, \dots, n. \quad (2)$$

The values y_1, y_2, \dots, y_n are burdened with errors e_1, e_2, \dots, e_n , which we assume are independent random variables that are unsystematic, ie the mean value $E(e_i) = 0$, they are homogeneous, ie they have the same variance $D(e_i) = \delta^2, i = 1, 2, \dots, n$, and have a normal distribution. (Neubauer et al., 2016) After compiling the regression model, a verification will be performed whether the estimated regression parameters and the overall model are statistically significant at the selected level of significance α . The suitability of the selected model will then be assessed by promoting the so-called determination index (R^2). This number takes the values $(0, 1)$. The closer R^2 is to 1, the stronger we consider the given statistical link, and thus well captured by the regression model used. Conversely, the closer it gets to 0, the more we consider the dependence to be weaker and the regression function less concise. (Neubauer et al., 2016) The input data for the construction of the regression model will be the values of the level of GDP and unemployment in the Czech Republic in the period 2010 - 2020. GDP is at basic prices in 2015 (in millions of CZK). The input data are summarized in the following table 1. The data are evaluated until 2020. When writing the paper, data from 2021 were not yet available.

Table 1: Development of unemployment and GDP in the Czech Republic (2010-2020)(CSO, 2021)

Year	Unemployment (%)	Gross Domestic Product
2010	7.4	4 252 881
2011	6.8	4 327 747
2012	7.0	4 293 774
2013	7.0	4 291 803
2014	6.2	4 388 888
2015	5.1	4 625 378
2016	4.0	4 742 737
2017	2.9	4 987 876
2018	2.3	5 147 421
2019	2.0	5 266 512
2020	2.6	4 973 928

For the purposes of compiling a linear regression model, the level of GDP is an explanatory variable (X), and unemployment is an explained variable (Y). The construction of the regression model was performed using the MS Excel application, while the testing of the statistical significance of individual parameters of the regression line and the model as a whole was performed at the significance level $\alpha = 0.05$. The resulting values obtained using the "Regression" tool in MS Excel are shown in the following tables 2.

Table 2: Results of the regression model for the period 2010 – 2020 (Own processing)

Regression statistics	
Reliability value R (determination index R^2)	0.980
Observation	11
Significance F (P-Value)	5.876E-09

Table 3: The resulting values (Own processing)

	Coefficients	Mean Errors	P-Value	The upper limit of the 95%	The lower limit of the 95%
Limit (parameter β_1)	30.803	1.239	1.320E-09	28.001	33.606
GDP (parameter β_2)	-5.564E-07	2.648E-07	5.876E-09	-6.163E-06	-4.965E-06

Based on the construction of the regression model, a regression line in the form of:

$$y = 30.803 - 5.564E-06x \quad (3)$$

Confidence intervals (Lower 95%, Upper 95%) for parameters β_1 i β_2 do not contain 0, therefore these parameters are statistically significant at the level of significance $\alpha = 0.05$. For the whole model, the p-value (significance F) is lower than the specified significance level α ($5.876E-09 < 0.05$). Therefore, the null hypothesis can be rejected and it can be stated that the chosen model is statistically significant. The resulting model can be used for prediction and description dependencies of given variables. The extent to which the created statistical model captures the relationship between GDP and unemployment can then be assessed according to the index of determination. We succeeded in the considered regression dependence explain 98% of the variability of the variable Y, which is unemployment. The following graph shows the relationship between GDP and unemployment, including the representation of the regression line, the regression function and the determination index (R^2).

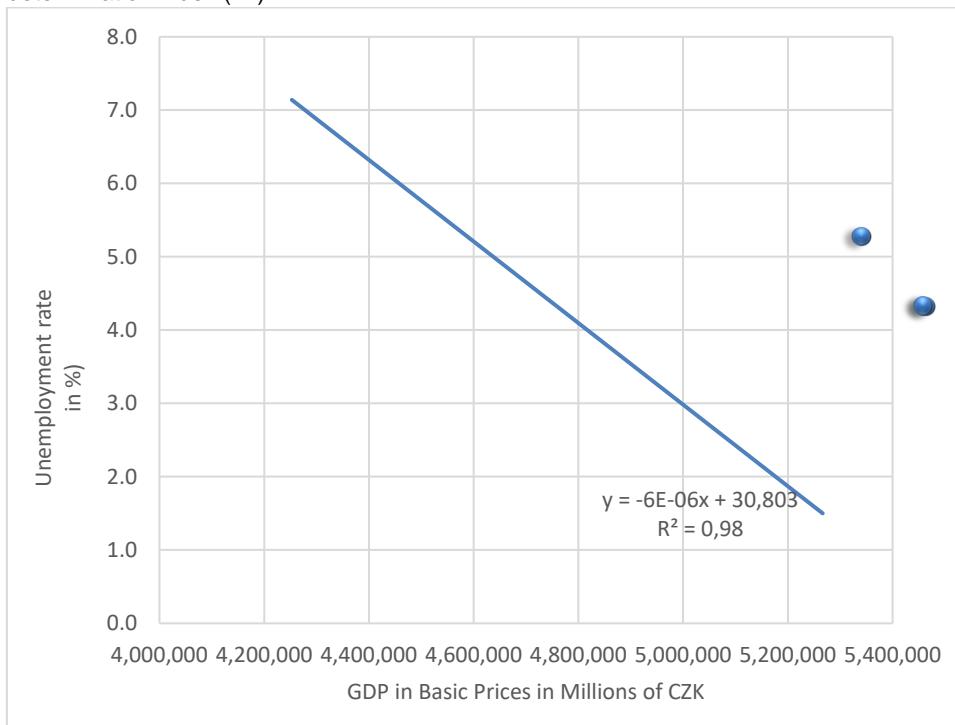


Figure 1: Relationship between GDP and Unemployment (2010 - 2020) (Own processing)

The created model can be used to predict the further development of the unemployment rate depending on the development of the GDP level. The CNB expects year-on-year GDP growth in the Czech Republic of 3.4% in 2021. (Czech National Bank, 2021). Based on this prediction, the amount of GDP for 2021 (at constant 2015 prices) can be expected:

$$\text{GDP 2021} = 4\,973\,928 \cdot 1.034 = \text{CZK } 5\,143\,042 \text{ millions}$$

Using the created model, it is possible to predict the level of unemployment in the Czech Republic in 2021 in the amount of:

$$y = 30.803 - 5.564E-06x$$

$$y = 30.803 - 5.564E-06 \cdot 5\,143\,042$$

$$y = 2.2 \%$$

Based on the established model of the relationship between GDP and unemployment, the rate is expected unemployment in 2021 at 2.2%.

The following paragraphs will describe the situation taking into account the relationship between GDP and unemployment already in the situation when the Czech Republic was affected by the Covid-19 pandemic. However, in order to better analyze the impact of the Covid-19 pandemic and related measures taken on the Czech economy, ie on the development of unemployment based on GDP, it is necessary to focus in more detail on the period before and during the pandemic. Therefore, the method of regression analysis in this subchapter is applied to data in the period from 2016 to 2020. As the course of the Covid-19 pandemic in this period covers only 1 year, or especially Q2 to Q4 2020, data for individual quarters of the observed period. The development of the level of GDP and unemployment for individual quarters in the years 2016 to 2020 is shown in the following table.

Table 4: The unemployment and level of GDP in the Czech Republic (period 2016 – 2020)(CSO, 2021)

Quarter	Unemployment (%)	Gross Domestic Product
1Q/2016	4.7	1 164 520
2Q/2016	4.5	1 174 201
3Q/2016	4.3	1 179 417
4Q/2016	4.0	1 185 684
1Q/2017	3.8	1 198 163
2Q/2017	3.5	1 212 425
3Q/2017	3.2	1 229 069
4Q/2017	2.9	1 246 969
1Q/2018	2.7	1 259 041
2Q/2018	2.5	1 268 884
3Q/2018	2.4	1 277 527
4Q/2018	2.3	1 286 855
1Q/2019	2.2	1 294 495
2Q/2019	2.1	1 301 189
3Q/2019	2.1	1 310 885
4Q/2019	2.0	1 316 628
1Q/2020	2.0	1 312 190
2Q/2020	2.2	1 276 896
3Q/2020	2.3	1 259 080
4Q/2020	2.6	1 242 867

Again, using the "Regression" tool in MS Excel, it was first built linear regression model of the relationship between the level of GDP and the unemployment rate for the period 2016 - 2019, ie for period before the outbreak of Covid-19 in the Czech Republic. The resulting regression shape function is:

$$y = 25.101 - 1.770E-05x \quad (4)$$

The parameters β_1 i β_2 and the model as a whole were subsequently tested for statistical significance (at significance level $\alpha = 0.05$, with the following results:

Parameter $\beta_1 = 25.101$; confidence interval $(23.220; 26.983)$ does not contain 0; Parameter $\beta_2 = -1.770E-05$; confidence interval $(-1.921E-05; -1.619E-05)$ does not contain 0. In the case of the whole model, the p-value (significance F) is lower than the specified level significance α ($4.797E-13 < 0.05$). Coefficient of determination $R^2 = 0.98$.

It follows from the above that both the individual parameters and the linear regression model as a whole are statistically significant at the level of significance $\alpha = 0.05$. Given the level of the coefficient of determination of

0.98, it can be stated that the regression model explains 98% of the variability variable Y, which is unemployment.

When applying the set linear regression model for the period 2016 - 2019 to predict the level of unemployment to the level of GDP corresponding to the level reached in the 4th quarter of 2020, the expected unemployment rate should be 3.1%. However, the real unemployment rate reached only 2.6%.

Due to the fact that the real unemployment rate in 2020 did not reach the expected rate of 3.1%, but the unemployment rate reached only 2.6% and due to the fact that the government implemented individual fiscal measures to help mitigate the impact of Covid-19, therefore, another linear regression model was constructed, this time for the period 2020 (the year affected by the Covid-19 pandemic). The final form of the regression function for the period 2020 is:

$$y = 11.714 - 7.407E-06x$$

Even in this case, the parameters β_1 and β_2 and the model as a whole were tested for statistical significance (at the significance level $\alpha = 0.05$), with the following results:

Parameter $\beta_1 = 11.714$ confidence interval $(2.583; 20.845)$ does not contain 0; Parameter $\beta_2 = -7.407E-06$ confidence interval $(-1.458E-05; -2.344E-07)$ does not contain 0. In the case of the whole model, the p-value (significance F) is lower than the specified level significance $\alpha(0.0471 < 0.05)$. Coefficient of determination (R^2) = 0.908. It follows from the above that despite the relatively low number of observations (only 4 quarters) both individual parameters as well as the linear regression model as a whole are statistically significant on significance level $\alpha = 0.05$. The following graph then graphically shows a comparison of these two periods, ie the period 2016- 2019 and the period of 2020, which divides the outbreak of the Covid-19 pandemic.

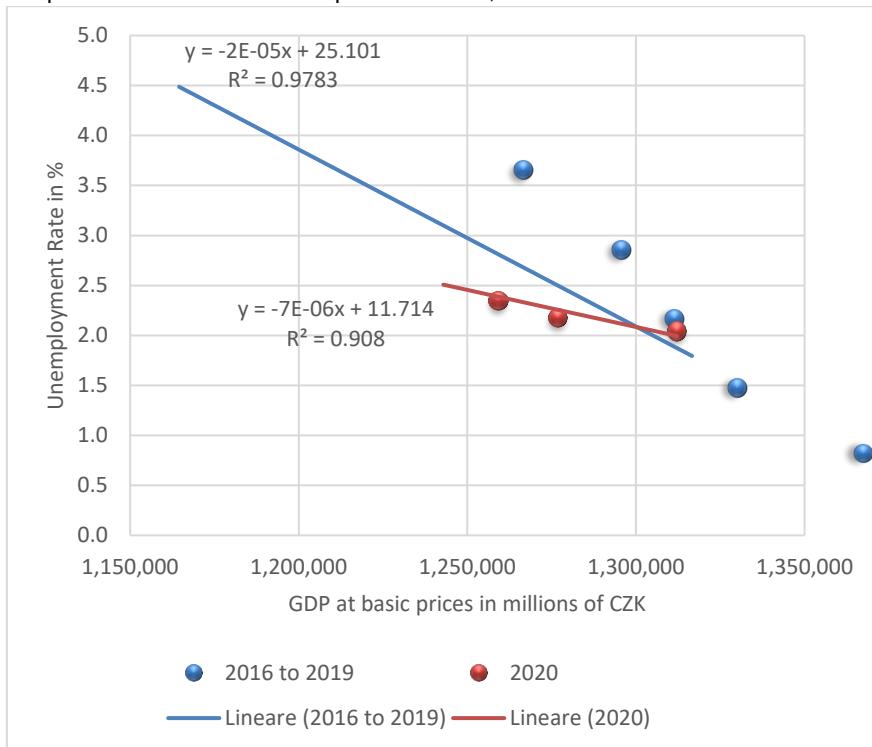


Figure 2: Relationship between GDP and unemployment (2016 - 2020, quarterly data) (Own processing)

It should be noted that the time associated with the Covid-19 pandemic is relatively short for performing comprehensive analyzes of the impacts of the pandemic on the Czech economy; only four quarters are available. Therefore, the developed model, which examines the period of the ongoing Covid-19 pandemic, includes only four observations. Therefore, there is a risk of some inaccuracy associated with the developed model and the interpretation of its results. For this reason, the results should be considered preliminary, which may be adjusted in light of future developments. From the performed analysis, despite the mentioned risks associated with a low number of periods, it can be assumed that in 2020 the sensitivity of changes in the unemployment rate to changes in GDP decreased significantly. The elasticity of the curve in the period of 2020 compared to the curve showing the years 2016 - 2019 has decreased significantly, the slope of the function is lower than in the period before the Covid-19 pandemic. From this, it can be concluded that the conditions in the

Czech economy changed significantly during the Covid-19 pandemic, mainly due to fiscal measures taken by the government. The aim of these measures was both to mitigate the decline in GDP levels and to stabilize the labor market and maintain employment. To this end, numerous subsidy packages have been approved to support compensation for losses for both employers and employees and to maintain employment.

4. Conclusions

The Czech Republic was hit hard by the pandemic. In the fall of 2020, it became the worst-affected country globally. Never in the history of the Czech Republic has it happened that part of the national economy was shut down suddenly. The Czech Republic was an economy with minimal macroeconomic imbalances and solid financial stability. The Covid-19 pandemic has shown that, although the Czech Republic is a small, landlocked country, the foundations of solid financial stability and slight macroeconomic imbalances have helped to manage this pandemic to the extent possible to protect citizens' health. The economic impact of this pandemic is already significant, and, unfortunately, given the duration of this pandemic, these not only economic problems will deepen. The paper aimed to analyze and evaluate the effects of the Covid-19 pandemic on the Czech economy. Given the measures taken, mainly targeted at GDP and unemployment, these two leading economic indicators were examined in the analysis. There was abstracted from other macroeconomic variables. From the above analyzes and subsequent evaluation, it can be stated that the Covid-19 pandemic had a significant impact on the overall economy of the Czech Republic in terms of GDP and unemployment. The relationship between these quantities was investigated using regression analysis. The results show that the selected indicators have a strong inverse relationship. In 2020, thanks to the measures taken and individual subsidy programs implemented under Covid-19, conditions in the Czech economy changed, which resulted in a lower-than-expected increase in unemployment depending on the decline in GDP.

Acknowledgments

This research was supported by the project RVO/FLKŘ/2021/04 Risk management and crisis management in organizations during the COVID-19 pandemic.

References

- Bourquin P., Waters T., 2021, Jobs and job quality between the Great Recession and the eve of COVID-19, *Fiscal Studies*, 1–16.
- Clark A.E., D'Ambrosio C., Lepinteur A., 2021, The fall in income inequality during COVID-19 in four European countries, *J Econ Inequal* 19, 489–507.
- Czech National Bank, 2021, Czech Republic, <www.cnb.cz/en> accessed 12.06.2021.
- Czech statistical Office, 2021, Czech Republic, <www.czso.cz/csu/czso/home> accessed 13.05.2021.
- Dörr J.O., Licht G., Murmann, S., 2021, Small firms and the COVID-19 insolvency gap, *Small Bus Econ*, 1–31.
- Ferrera M., Miró J., Ronchi S., 2021, Walking the Road Together? EU Polity Maintenance during the COVID-19 Crisis', *West European Politics*, 44, Nos. 5–6, 1329– 1352.
- Geloso V., Hyde K., Murtazashvili I., 2021, Pandemics, economic freedom, and institutional trade-offs, *Eur J Law Econ.* 1–25.
- Hoke E., Peterek K., Heinzova R., 2021, Quality management systems in selected public organizations. *Chemical Engineering Transactions*, 86, 475–480.
- Ivanová E., Grmanová E., 2021, The Sustainability of EU Labor Immigration in Terms of Poverty Inequalities and Employment. *Sustainability*, 13(4): 2265.
- Kalenkoski C.M., Pabilonia S.W., 2021, Impacts of COVID-19 on the self-employed, *Small Bus Econ*, 1–28.
- Kuckertz A., Brändle L., Gaudig A., Hinderer S., Morales Reyes C.A., Prochotta A., Steinbrink K.M., Berger E.S.C., 2020, Startups in Times of Crisis – a Rapid Response to the COVID-19 Pandemic, *Journal of Business Venturing Insights* 13: e00169.
- Lastauskas P., 2021, Lockdown, employment adjustment, and financial frictions, *Small Bus Econ*.
- Neubauer J., Sedlačík M., Kříž O., 2016, *Basics of Statistics: Applications in technical and economic fields*, 2nd extended edition, Czech republic, Prague: Grada Publishing, ISBN 978-80-247-5786-5.
- Yagi M., Managgi S., 2021, Global Supply Constraints from the 2008 and COVID-19 Crises, *Economic Analysis and Policy*, 69, 514–528.