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Content

Assessment of the impact of unemployment and GDP on the average wage and forecast of the average wase in the Czech Republic

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Abstract

The aim of this thesis was to evaluate the impact of unemployment and GDP on the average wage in the Czech Republic from 2011 to 2023 and to create a forecast for the average wage for the year 2024. Statistical methods including correlation and regression analyses were employed to assess the influence of unemployment and GDP on the average wage in the Czech Republic. The results revealed an inverse relationship between unemployment and the average wage, while GDP had a positive effect on the average wage. The forecast for the average wage in 2024 was 53,098 CZK, indicating continued growth. The research provided valuable insights for policymakers and other stakeholders. The main limitations of the study include the omission of additional factors such as changes in tax policy, inflation, and technological innovations, as well as reliance on historical data.

Keywords: Average wage, gross domestic product, unemployment, prognosis, regression

Introduction

In the current economic environment, analyses and predictions of the average wage in the Czech Republic are of fundamental importance not only for economic policy and business decisions, but also for individuals and households. The dynamics of the average wage reflect the economic development of the country, social changes and the level of the

population's standard of living. Therefore, it is crucial to understand the social demand for accurate and reliable prediction of the average wage and its importance for the economy and society as a whole. That is why I decided to focus on the forecast of the average wage in the Czech Republic and evaluate the factors that influence it.

Research conducted by Meixnerová & Krajnák (2020), which examined the impact of macroeconomic indicators such as GDP, unemployment, implicit tax rate on labor and consumer price index on minimum and average wages in the V4 countries, is one of the models for this work. Its conclusions support the importance of predicting the average wage and show that macroeconomic factors have a significant impact on this prediction. Another research indicating that long-term trends in the economy can affect the level of the average wage in the future is the analysis of the economic development of the Czech Republic by Bílková (2023). This provides us with additional context for predicting the average wage in the future. Another work focusing on a macroeconomic factor with an impact on the average wage is the research on the progressivity of personal income tax in the Czech Republic (Krajnák 2023). The structure of the tax system can have a significant impact on individual incomes and thus on the average wage in the country.

Society is not only the recipient of wages, but of course also a fundamental factor directly influencing the level of wages. It is not only about education, experience and development, but also about secondary social pressures on wage equality. It is precisely social policy that Turečková et al. (2022) focused on in their work. They used income inequality as an indicator for measuring the effectiveness of social policy. Their study can help me understand how social policies affect the structure of income and thus the level of the average wage.

Employers and employment as such are the third most important factor and, together with the already mentioned company and the state, the most influential factors on wages. At the same time, however, it is not true that the offer of a higher wage is the only motivation for a person to change jobs and thus increase wages. People evaluate jobs according to many factors. A look at the quality of employment and the fact that differences in wages are not the only factor in assessing the quality of employment was prepared by Ledic & Rubil (2021). This gap can affect the level of the average wage, because the quality of employment can influence individuals' decisions regarding their employment and remuneration - wages.

The aim of the work is to conduct a detailed assessment of the impact of unemployment and GDP on the average wage in the Czech Republic for the years 2011-2023 and to make a short-term forecast of the average wage in the Czech Republic for 2024.

In connection with the objective, the following research questions are set:

VO1: What is the impact of unemployment and GDP on the average wage in the Czech Republic? The period 2011-2023 will be evaluated.

VO2: What will be the development of the average wage in the Czech Republic based on the influence of GDP and unemployment in 2024.

Methods and Data

Date

The source of data for Average Wages 2011-2023, GDP 2011-2023, GDP Forecasts 2024 and Unemployment 2011-2023 will be the Czech Statistical Office (CZSO, 2024). These data will be used to answer VO1 using analysis. Secondary data from the Ministry of Finance of the Czech Republic (Ministry of Finance of the Czech Republic, 2024) and their Macroeconomic Predictions – April 2024 will also be used. The source of the unemployment value will be the analysis by Zeman (2024) from the analysis published under the banner of the Institute for Politics and Society. As part of the data preparation for the analysis, a check will be made to ensure that no values are missing, outliers will be identified and the normality of the data will be verified. A Z-score will be calculated to detect outliers. Data for which the Zscore exceeds 2 or falls below –2 will be considered an outlier. The Zscore will be calculated as follows. The average of all values from one group (GDP, average wages, unemployment) will be calculated. The average is subtracted from the ordinal value and raised to the power. The exponentiation will create imaginary squares and also remove negative values. The average of the squares will be calculated and then the square root of the average of the squares. This will give the standard deviation. Using the standard deviation, it will be easy to calculate the Zscore by subtracting the average of the ordinal values from the ordinal value and dividing by the standard deviation. The result will be the Zscore. Values >2 and <-2 are considered outliers.

Table 1: Consolidated secondary data

Year	GDP mil.	Average salary	Unemployment rate
2024	7447243	It will be predicted	0.0320
2023	7344421	43341	0.0270
2022	6786742	40317	0.0220
2021	6108717	38277	0.0281
2020	5709131	36176	0.0255
2019	5791498	34578	0,0202
2018	5410761	32051	0,0225
2017	5110743	29638	0,0289
2016	4796873	27764	0,0395
2015	4625378	26591	0,0505
2014	4345766	25768	0,0611
2013	4142811	25035	0,0695
2012	4088912	25067	0,0698
2011	4062323	24455	0.0672

Source: Own processing according to Czech Statistical Office and Ministry of Finance of the Czech Republic.

Methods

The normality of the data will be verified in the R software. It provides a wide range of statistical tests and graphs that allow you to examine the distribution of the data. Using the Shapiro-Wilk test to verify the normality of the data. The significance level will be set at n and α = 10%. Hypotheses will be set

H 0 - the assumption of normality of the data is met and H1 - the assumption of normality of the data is not met.

As part of the exploratory analysis, histograms of quantities will be compiled, which will allow a distribution and trend graph to be displayed. The basic visualization will be followed by a correlation analysis between the individual indicators. Average wage x unemployment, average wage x GDP, HPD x unemployment. Excel software and Spearman's correlation coefficient will be used to determine the correlation. The output will be coefficients ranging from 1 to –1, where strong positive correlations will be closer to +1, strong negative correlations closer to -1, and weak correlations closer to 0. These coefficients will be interpreted to answer VO1. The coefficients will also be needed to predict the average wage in 2024, but they will be different coefficients than those obtained from Spearman's correlation analysis. The correlation coefficients will show the strength of the influence and whether the influence is positive or negative. A regression analysis will be performed in Excel, which will provide us with coefficients suitable for regression for the year 2024. These coefficients will express the rate at which the quantities increase or decrease. These coefficients will be used in a linear regression with the formula

$$Y=\beta 0 +\beta 1\ X1 +\beta 2\ X2 +\epsilon, \quad (1)$$

where:

Y = average salary 2024,

β0 = will be the value of the average wage at zero HPD and zero unemployment, i.e. zero,

β1 will be the coefficient for unemployment vs average wage in 2024 from the regression analysis,

X1 will be the predicted unemployment in 2024,

β2 will be the coefficient for GDP x average wage in 2024 from the regression analysis,

X2 will be the predicted GDP in 2024.

Y will be the answer to VO2.

The expected results are an inverse relationship between unemployment and average wage, a conversion relationship between GDP and average wage. The expected result is also the predicted growth of the average wage for the year 2024.

Results

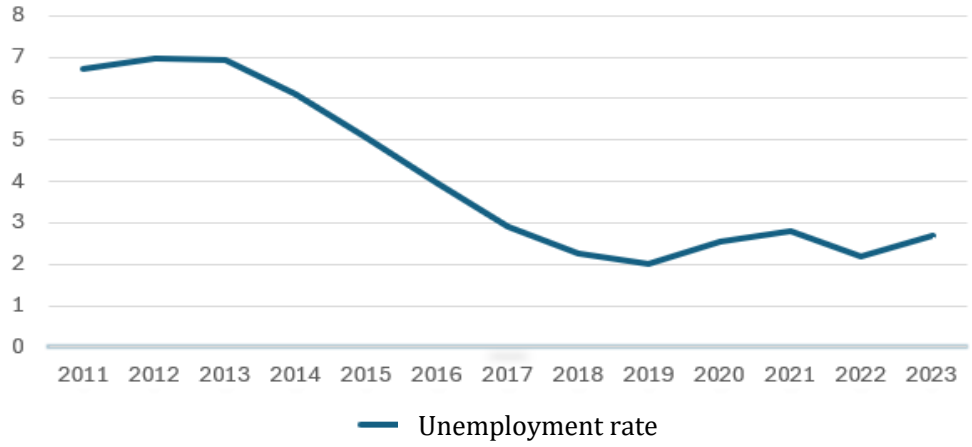
For secondary, it is confirmed that all necessary values are obtained and none are missing. 2012-2023 for GDP, unemployment and average wage. Also 2024 for GDP and unemployment. All necessary data are ready.

Outlier identification. It is performed for each of the variables separately. The values for the period 2011-2023 are averaged. The average is subtracted from each value in the series and raised to the power. The standard deviation is calculated using the average of the obtained values. Furthermore, the average initial value is subtracted from the initial value of the variable for each year and divided by the standard deviation. It is found that the only outlier deviating from the range of -2 to 2 zscore is the GDP of 2023 with a zscore of 2.05.

The normality of the data is verified in the R software for each variable separately using the Shapiro-Wilk test. For GDP, the resulting p-value is 0.3132, for unemployment the p-value is 0.01466 and for the average wage the p-value is 0.1351. Normality is met for GDP and the average wage when their p-value is higher than 0.1, which is the established significance level $\alpha = 10\%$. Unemployment does not meet the normality of the data and for rejecting H0,,the assumption of normality of the data is met". H1,,the assumption of normality of the data is not met" is not rejected.

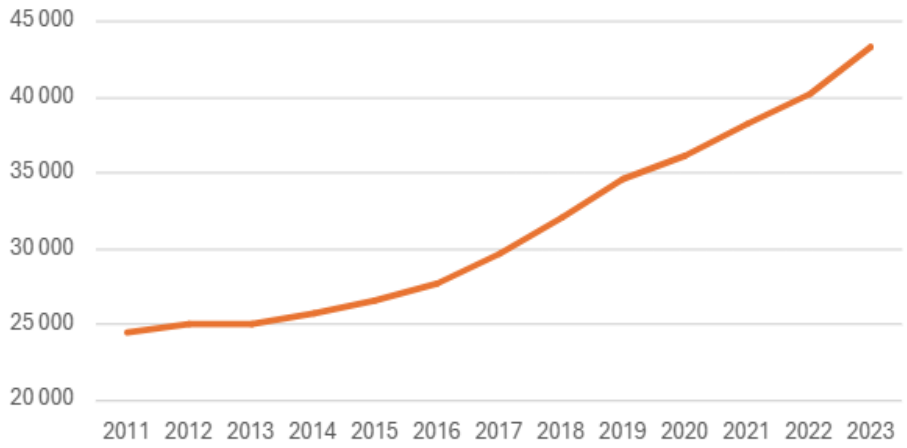
Exploratory analysis. Graphs of quantities are compiled for the research period 2011-2023.

Figure 1: Unemployment rate in the Czech Republic 2011 – 2023



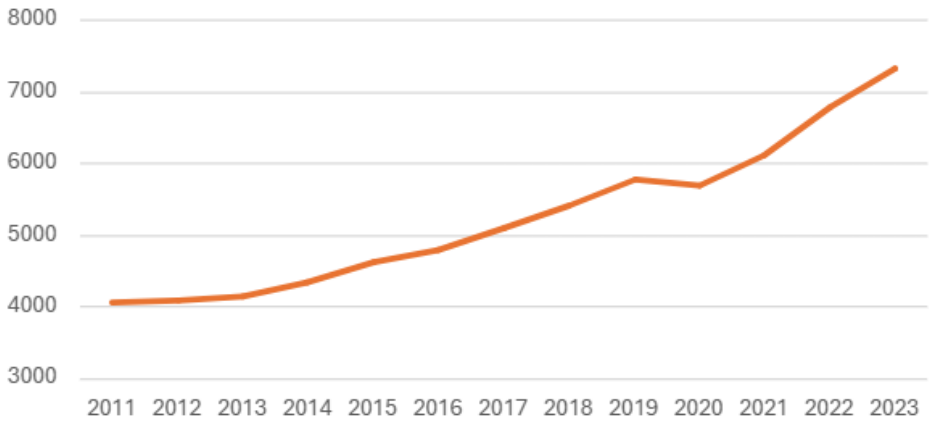
Source: Own processing.

Figure 2: Average wage in the Czech Republic 2011 - 2023



Source: Own processing.

Figure 3: Gross domestic product of the Czech Republic 2011 - 2023



Source: Own processing.

Correlation analysis. To use Spearman's rank correlation coefficient, ranks are first prepared in Excel for individual values of quantities using the RANK function. In other words, for each value of a given quantity, the order that the value would take if the values were compared according to size is determined. Each value is given its rank in the row of its quantity and it is important to maintain the order of the ranks, according to the order of the initial values. The KORREL function is then used for all combinations of rank rows. That is, GDP vs. average wages, where the correlation coefficient is rounded to 0.989. GDP vs. unemployment, the correlation coefficient is -0.863. The last correlation coefficient is average wages vs. unemployment, which is -0.841.

Table 2: Processed data with assigned ranks

Year	GDP million	GDP Rank	Average salary	Rank average salary	Unemployment rate	Unemployment rate
2024	7,447,243	XXX	XXX	XXX	0.0320	XXX
2023	7344421	1	43341	1	0.0270	9
2022	6 786742	2	40317	2	0.0220	12
2021	6 10871	3	38277	3	0,0281	8
2020	5 5709131	5	36176	4	0,0255	10
2019	5 5791498	4	34578	5	0,0202	13
2018	5410761	6	32051	6	0,0225	11
2017	5110743	7	29638	7	0,0289	7
2016	4796873	8	27 764	8	0,0395	6
2015	4625378	9	26591	9	0,0505	5
2014	4345766	10	25 768	10	0,0611	4
2013	4142811	11	25035	12	0,0695	2
2012	4088912	12	25067	11	0,0698	1
2011	4062323	13	24455	13	0.0672	3

Source: Own processing.

Table 3: Coefficients obtained by correlation analysis

Coefficients		
GDP x Wage	GDP x Unemployed	Salary x Unemployment
0.989	-0.863	-0.841

Source: Own processing.

Regression analysis. First, it is necessary to determine the coefficients for the final linear regression. A separate regression analysis in Excel is used to determine the coefficients. The columns contain data on average wages in absolute values, GDP in absolute values (not in billions or millions), and unemployment rates, where the units of numbers are whole percentages (so the shapes of the numbers are 2.7 2.2 2.81, etc., not 0.0027 0.022, etc.). The integrated Regression function in the Data and Data Analysis tab is used. The area of average wage data for the years 2011-2023 is marked in the input area Y. The columns of GDP and unemployment for the years 2011-2023 are marked in the input area X. The Labels checkbox is checked and the regression result is generated on a new sheet of the workbook.

Table 4: Regression result in Excel

Regression statistics	
Multiple R	0.987238448
Reliability value R	0.974639753
Set reliability value R	0.969004143

Error page value	992.9988116
Observation	12

	Difference	**SS**	**World Cup**	**F**	**Significance F**
Regression	2	341059861.8	170529930.9	172.9430678	6.58705E-08
Residue	9	8874419.759	986046.6399		
Total	11	349934281.6			

	Coefficients	**Error page value**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower95.0%**	**Upper 95.0%**
Limit	-6478.261055	5151.963651	-1.257435319	0.240243992	-18132.81253	5176.29042	-18132.81253	5176.29042
7.34442E+12	6.97644E-09	7.57661E-10	9.207870137	7.08059E-06	5.2625E-09	8.69039E-09	5.2625E-09	8.69039E-09
2.7	357.2796527	333.2534499	1.072095886	0.311581923	-396.592026	1111.151331	-396.592026	1111.151331

Source: Own processing in MS Excel SW.

Two coefficients are obtained in rows, where it is known that the first row is the coefficient for the first column of the input area X and the second row is the coefficient for the second column. The coefficients 0.0000000069644 for GDP and the coefficient 357.2796527 for unemployment are obtained. The coefficients are inserted into the final linear regression equation for the forecast of the average wage for the year 2024. I insert the values into the formula:

$$Y=\beta 0 +\beta 1\ X1 +\beta 2\ X2. \quad (2)$$

Where:

Y = average salary 2024,

β0 = is the value of the average wage at zero HPD and zero unemployment, i.e. zero,

β1 is the coefficient for GDP vs average wage in 2024 from the regression analysis, i.e. 6.97644×10^{-9}

X1 is the predicted GDP for 2024, i.e. 7,447,242 million

β2 is the coefficient for unemployment x average wage in 2024 from the regression analysis, i.e. 357.2796527

X2 is the predicted unemployment rate for 2024, which is 3.2%. It is entered as 3.2 because the coefficient was calculated with absolute values.

$Y = 6.97644 \times 10^{-9} \times 7{,}447{,}242{,}000{,}000 + 357.2797 \times 3.2$. The result is 53098.53202. (CZK)

Discussion

Research question 1: What is the impact of unemployment and GDP on the average wage in the Czech Republic?

Research has shown that there is a significant relationship between unemployment, GDP and average wages. Correlation analysis revealed a negative relationship between unemployment and average wages, meaning that as unemployment falls, average wages rise. This result is consistent with the theory that higher unemployment reduces pressure on wage growth because more people are competing for the same job. A positive relationship was found between GDP and average wages, suggesting that a growing economy supports wage growth. This result is consistent with the expectation that economic growth leads to higher productivity and profits, which in turn allows firms to pay higher wages.

Research question 2: What will be the development of the average wage in the Czech Republic based on the influence of GDP and unemployment in 2024?

The predicted average wage for 2024 was determined based on a regression analysis of data from 2011-2023. The model predicted that the average wage in 2024 would be CZK 53,099 . This estimate was based on historical unemployment and GDP trends.

Current data from March 2024 from the Czech Statistical Office show that the average wage is CZK 46,013. This means that the prediction is very close to the reality that has developed so far, which confirms the reliability of the model used. The deviation may be caused by short-term economic fluctuations or specific sectoral changes that were not included in our model. An upward deviation could also be caused by the GDP outlier identified by Zscore in 2023, where the value deviated from the upward trend.

The research results are in line with the conclusions of Meixnerová & Krajňák (2020), who also confirmed that macroeconomic factors such as GDP and unemployment have a significant impact on the average wage. In addition, the conclusion of the research study by Sokolová & Mohelská (2023) confirms that the level of the average wage can vary depending on regional differences, which may be another factor that could explain the small deviation between the predicted and actual wage.

Omran & Bilan's (2024) research on the relationships between foreign direct investment, unemployment, and GDP in Egypt supports our conclusions by showing how macroeconomic factors can influence wages across countries. Although this research focuses on a different region, similar mechanisms are at work in the Czech Republic.

Conclusion

The aim of this work was to conduct a detailed assessment of the impact of unemployment and GDP on the average wage in the Czech Republic for the years 2011-2023 and to make a short-term forecast of the average wage in the Czech Republic until

2024. The aim of the work was achieved using statistical analysis and regression models, which allowed us to examine the relationships between macroeconomic indicators and the average wage.

The analysis used historical data on average wages, unemployment and GDP. It was found that unemployment has an inverse relationship with average wages, which confirms the theoretical assumptions that with increasing unemployment, average wages fall. GDP has a positive effect on average wages, which is in line with the expectation that economic growth leads to wage increases.

The resulting average wage forecast for 2024 was CZK 53,098. The current average wage as of March 5, 2024 is CZK 46,013, indicating continued growth. This result indicates that the models and methods used were effective and reliable. The predicted increase is therefore approximately CZK 10,000, which is in line with the current development, which has already recorded an increase of over CZK 2,000 in the first two months and part of March.

The impact of unemployment and GDP on average wages: The analysis showed that unemployment has a negative impact on average wages, while GDP has a positive impact. These conclusions are consistent with economic theory and confirm the results of previous studies.

Average wage forecast: The short-term forecast for 2024 was CZK 53,098, which is higher than the current average wage as of March 5, 2024 (CZK 46,013), but given the growth rate in the first two months and part of March, the predicted increase is realistic.

Comparison with other authors: The results of this work are in line with the research of Sokolová & Mohelská (2023) on the determinants of job satisfaction and Prokopyev (2023) on the differences between the average wage in metropolitan areas and rural areas. The findings of this work also confirm the conclusions of the studies of Meixnerová & Krajňák (2020) on the strong correlation of the average wage with macroeconomic factors.

Correlation analysis and theory generally argue that there is an inverse relationship between unemployment and average wages, meaning that higher unemployment should lead to lower average wages, other things being equal. This relationship is based on the assumption that higher unemployment increases the supply of labor, which puts downward pressure on wages.

However, the regression analysis revealed a positive coefficient for unemployment, suggesting that even the increased unemployment rate actually led to an increase in average wages. This result may be initially surprising, but there are several possible explanations. One is that the theoretical inverse relationship between unemployment and wages only holds above a certain level of unemployment. If the unemployment rate is low (for example, below 5%), a slight increase in it can have the opposite effect on wages.

This situation can occur when the labor market is very tight and employers are forced to increase wages to attract and retain qualified workers, even if unemployment is rising slightly. Therefore, if the increase in the unemployment rate does not change the fact that the unemployment rate remains low, the effect of unemployment on wages can still be positive. This may be important for understanding the specific conditions of the Czech labor market during the analyzed period.

Limited factors: The model does not take into account some other factors that could affect the average wage, such as changes in tax policy, inflation, or technological innovation.

Dependence on historical data: The model is based only on historical data and assumes that future trends will be similar to past ones. Unexpected economic shocks or significant structural changes could jeopardize the accuracy of predictions.

Regional differences: The model does not take into account regional differences that may affect the average wage. As Prokopyeva (2023) shows, average wages can vary considerably between metropolitan and rural areas.

Seasonal fluctuations: This work does not take into account seasonal fluctuations that can affect short-term changes in average wages. Only annual values are taken into account.

Availability of secondary data: The methodology requires that secondary data on GDP and unemployment predictions be available, which may be a limitation if they are unavailable or of low quality.

This work provides valuable insights into the relationship between unemployment, GDP, and average wages in the Czech Republic. Our findings may be useful for economic policymakers, entrepreneurs, and other stakeholders interested in wage developments and economic trends.

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