

Analysis of Key Macroeconomic Indicators and Their Relationship to Unemployment in the Czech Republic

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Abstract

The Czech Republic boasts one of the lowest unemployment rates in the European Union, indicating a demand-supply imbalance in the labour market. This situation has implications for other labour market-related variables, such as nominal wages and labour productivity. In 2021, there was a significant increase in the inflation rate, reaching 15.1%. This development also impacted the trajectory of real wages.

This article uses statistical analysis to predict the future economic trends of essential macroeconomic indicators related to the labour market. The dependence of individual variables on the unemployment rate will be determined through correlation analysis. Additionally, the study aims to assess the degree of independence between the unemployment rate and selected economic indicators, including nominal wages, labour productivity, real wages, and inflation.

Future developments will be forecasted based on linear time series regression models for each examined variable. The statistical results will be economically interpreted in light of the current economic situation.

Overall, the results of the correlation analysis indicate a significant statistical relationship between unemployment and nominal wages, suggesting a strong negative correlation between these variables. This finding aligns with macroeconomic expectations that an increase in unemployment leads to a decrease in the rate of nominal wage growth. The correlation analysis between unemployment and inflation reveals a moderate indication of a negative relationship between the two variables. However, the correlation analysis between unemployment and labour productivity and between unemployment and real wages indicates weak and insufficient evidence of any significant relationship between these variables. Therefore, further analyses and consideration of additional factors are necessary to obtain a more comprehensive and reliable understanding of these relationships.

Key Words

unemployment, correlation analysis, Spearman correlation coefficient, prognosis, wage

JEL Classification: E24, C02

Introduction

Economic performance, unemployment rate, and GDP are crucial macroeconomic factors influencing regional development (Mura et al., 2020; Vigliarolo, 2020). The study (Wang & Le, 2018) emphasizes the significant influence of unemployment as a leading macroeconomic indicator of economic growth.

The results of other studies (Mura et al., 2020; Pawęta, 2018) indicate a weak relationship between unemployment and real GDP in the Visegrad Group (V4) countries. Pawęta (2018) highlights that the crisis had a delayed impact on the V4 economies. Their research findings suggest that the post-crisis period influenced the economies and labour markets

of the V4 countries. Research from Nigeria (Adelowokan et al., 2019) demonstrates that poverty resulting from unemployment has a significant short-term impact on economic growth while showing a positive relationship. The unemployment rate and GDP have also been affected by the Covid-19 pandemic. The results of the study by Su et al., (2022) emphasize that the pandemic significantly increases the unemployment rate in predominantly European economies. Furthermore, they found that employment trends in European countries are almost similar to those observed in the United States.

The reviewed empirical studies provide insights into the intricate relationship between economic performance, unemployment rate, GDP, and regional development. They reveal varying degrees of association, with some indicating a weak connection while others highlight more significant effects. The Covid-19 pandemic has introduced additional dynamics, significantly impacting the unemployment rate and employment trends. Understanding these relationships and their implications is vital for formulating effective economic policies and promoting sustainable regional development. Further research is needed to explore the underlying mechanisms and identify strategies to mitigate the adverse effects of unemployment on economic growth.

1. Methods of Research

Data for the analysis of fundamental macroeconomic indicators were obtained from identified primary and secondary sources. Publicly available databases, such as the Czech Statistical Office and Czech National Bank, provided relevant quantitative information. Additionally, information from conferences, professional literature, trade journals, and workshops related to the topic was utilized. The data will be analyzed for the years 2008 to 2022, which were available at the time of publication.

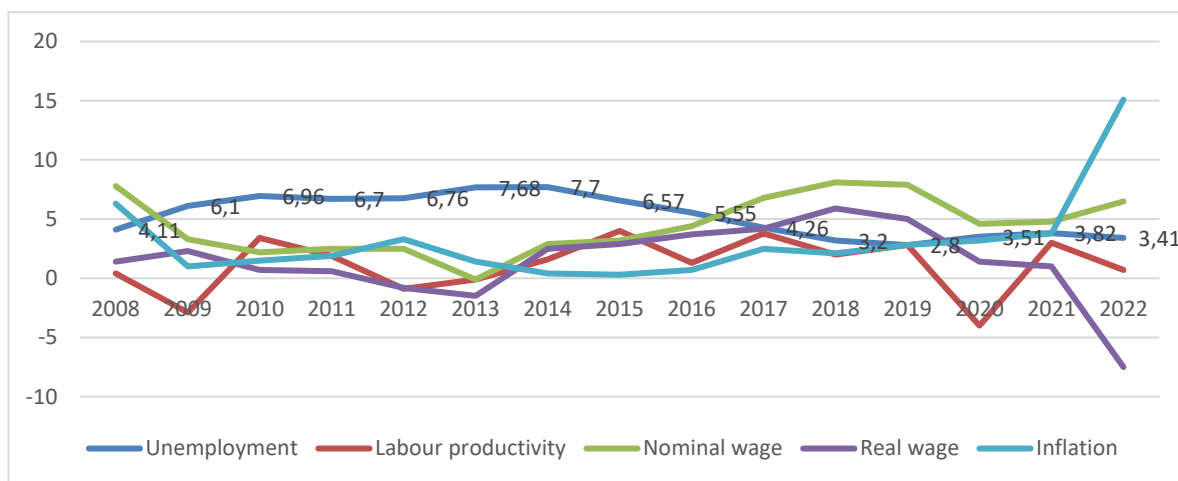
Correlation analysis allows for assessing the extent to which the change in one variable is associated with the change in another variable. A positive correlation indicates that an increase in the value of one variable is associated with an increase in the value of the other variable. In contrast, a negative correlation indicates that an increase in the value of one variable is associated with a decrease in the value of the other variable. To quantify the degree of correlation between variables, Spearman's correlation coefficient will be used, which is suitable for evaluating relationships between variables that may not be linear (Hedvičáková & Pozdílková, 2023). This coefficient is used to assess relationships between variables that are not necessarily continuous or exhibit a non-linear relationship. The values of Spearman's correlation coefficient range between -1 and 1. Values close to 1 indicate a strong positive correlation, while values close to -1 indicate a strong negative correlation.

The paper aims to evaluate the situation in the labour market and its future development, as well as to demonstrate the degree of independence among economic indicators. Four variables will be examined in the article: nominal wages, labour productivity, real wages, and inflation. The correlations between these variables will be evaluated using correlation analysis and Spearman's correlation coefficient, thereby demonstrating which variables are dependent on the unemployment rate. Values approximately between -0.5 and 0.5 indicate uncorrelated (independent) variables. The objective is to demonstrate the degree of independence between the unemployment rate and selected economic indicators such as nominal wages, labour productivity, real wages, and inflation. The graphical representation of the correlations will be conducted using Matlab.

2. Results of the Research

The last examined years have brought significant changes that have had an impact on the analyzed economic variables. In 2019, the world was hit by the Covid-19 pandemic. Subsequently, there was a war conflict in Ukraine and a massive increase in energy and food prices. These aspects have had impacts on the inflation rate, which reached 15.1% in the Czech Republic in 2022 (see Fig. 1). Because there is a labour demand surplus in the Czech labour market compared to labour supply, there has not been a significant increase in the unemployment rate. Therefore, the Czech Republic has one of the lowest unemployment rates among EU countries.

Fig. 1: Development of economic variables in percentages



Source: authors' calculations, data from (Czech Statistical Office, 2023)

In this chapter, a correlation analysis of unemployment and selected indicators will be conducted: nominal and real wages, labour productivity, and inflation. Other variables will not be extensively discussed in this paper due to its scope.

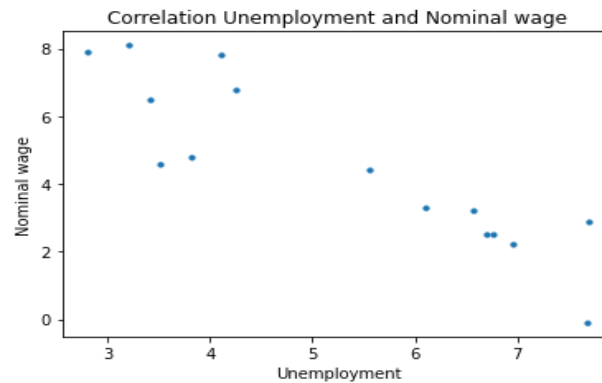
Tab. 1: Correlation analysis

	Unemployment	Nominal wage	Labour productivity	Real wage	Inflation
Unemployment	1.000000	-0.892370	-0.002344	-0.133566	-0.497666
Nominal wage	-0.892370	1.000000	0.185378	0.297095	0.418914
Labour productivity	-0.002344	0.185378	1.000000	0.264067	-0.114283
Real wage	-0.133566	0.297095	0.264067	1.000000	-0.741902
Inflation	-0.497666	0.418914	-0.114283	-0.741902	1.000000

Source: authors' calculations in Matlab, data from (Czech Statistical Office, 2023)

The result of the correlation analysis between unemployment and nominal wage (-0.892370) indicates a strong negative relationship between unemployment and nominal wage (see Tab. 1 and Fig. 2). This means that as unemployment increases, the nominal wage decreases, and vice versa. This negative correlation may be a result of economic factors such as supply and demand in the labour market.

Fig. 2: Correlation of unemployment and nominal wage

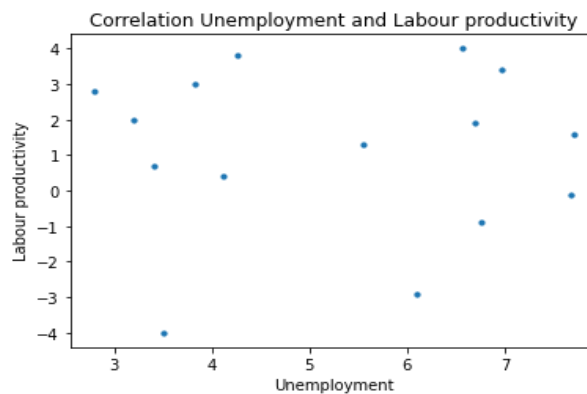


Source: authors' own calculations in Matlab, data from (Czech Statistical Office, 2023)

The result of the correlation analysis between unemployment and labour productivity (-0.002344) suggests independence between these two variables. A correlation value close to zero indicates no significant statistically detectable relationship between unemployment and labour productivity (see Tab.1 and Fig. 3).

However, many other factors can influence the relationship between unemployment and labour productivity, such as economic conditions, political measures, technological advancements, etc.

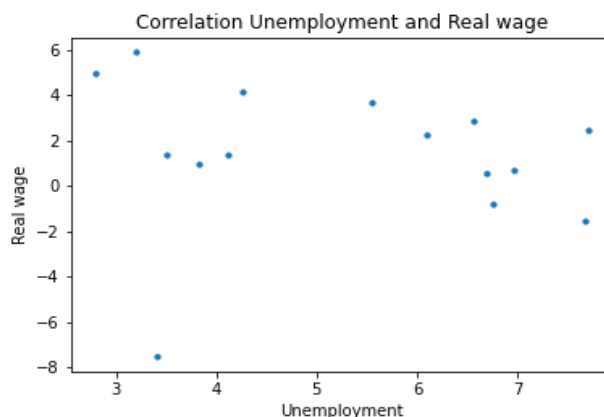
Fig. 3: Correlation of unemployment and labour productivity



Source: authors' own calculations in Matlab, data from (Czech Statistical Office, 2023)

The value of -0.133566 suggests a slight tendency that as unemployment increases, real wages might slightly decrease, and conversely, as unemployment decreases, real wages might slightly increase (see Tab. 1 and Fig. 4). However, this correlation is very low and can be influenced by many other factors that were not considered in this analysis. Among the main factors influencing the relationship between unemployment and real wages are factors such as inflation, economic growth, the labour market, political measures, etc.

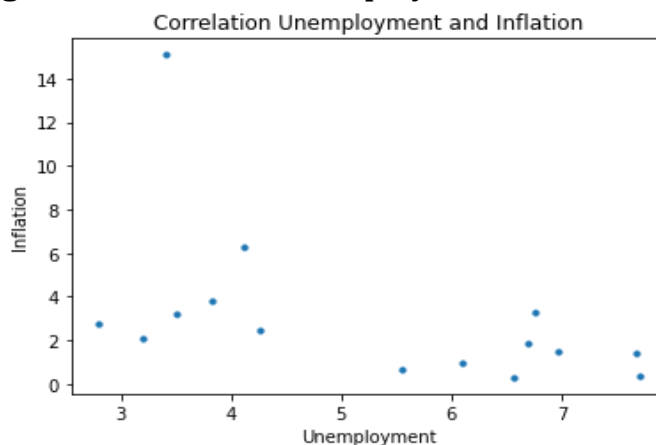
Fig. 4: Correlation of unemployment and real wage



Source: authors' own calculations in Matlab, data from (Czech Statistical Office, 2023)

The result of the correlation analysis between unemployment and inflation (-0.497666) indicates a moderately strong negative correlation between these two variables (see Tab. 1 and Fig. 5). The value of -0.497666 suggests that as unemployment decreases, inflation might slightly increase, and vice versa. This relationship is consistent with expectations according to economic theory, which suggests an inverse relationship between unemployment and inflation, known as the Phillips curve.

Fig. 5: Correlation of unemployment and inflation



Source: authors' own calculations in Matlab, data from (Czech Statistical Office, 2023)

Further analyses and consideration of additional factors can help to understand better these relationships and dynamics between unemployment and the selected variables.

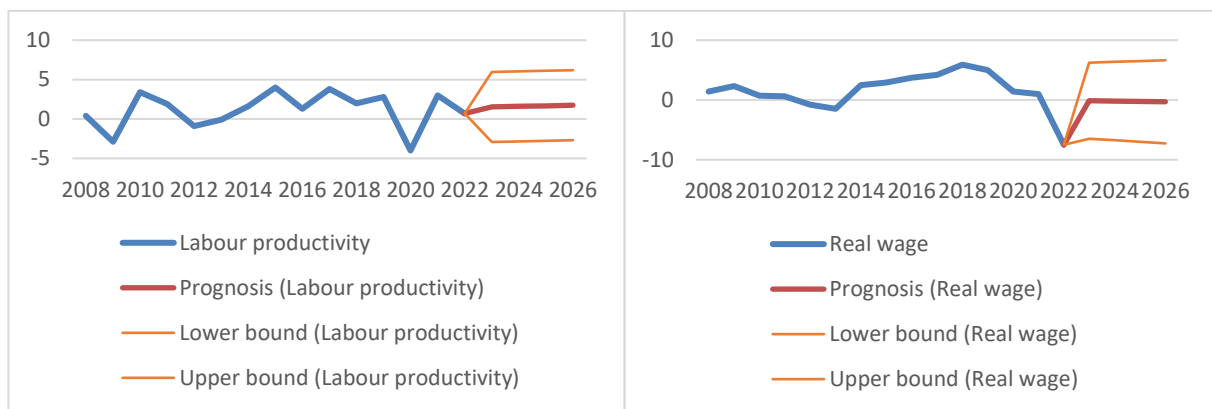
The following graphs show the projected future development of the examined economic indicators. A linear regression model was used for prediction (see Fig. 6 – 8). In this model also lower bound and upper bound were computed using MATLAB software. The lower bound and upper bound of the beta estimate in the regression model is negative or positive for each predictor. The model results show some significant estimates of the beta parameter, but the upper and lower bounds for the beta estimates tend to be in opposite directions for almost all variables. For details see (Montgomery, 2006).

Fig. 6: Forecast of the unemployment rate and nominal wages in percentage



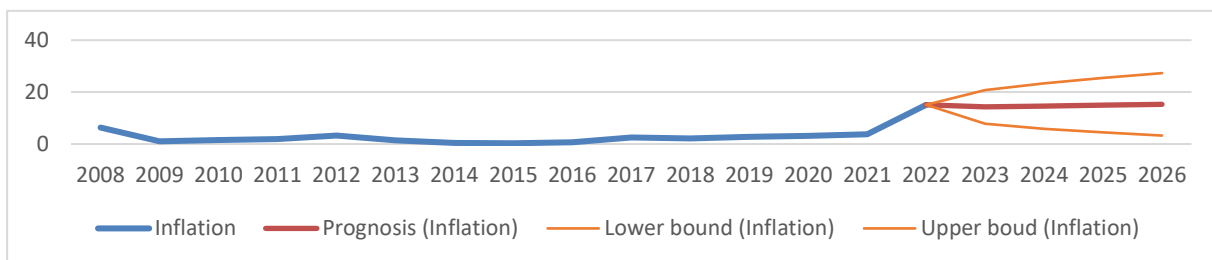
Source: authors' own calculations, data from (Czech Statistical Office, 2023)

Fig. 7: Forecast of labour productivity and real wage in percentage



Source: authors' own calculations, data from (Czech Statistical Office, 2023)

Fig. 8: Forecast of inflation in percentage



Source: authors' own calculations, data from (Czech Statistical Office, 2023)

The previous figures show an expected slight decrease in the unemployment rate (see Fig. 6), roughly stagnant nominal wages (see Fig. 6), labour productivity (see Fig. 7), and real wages (see Fig. 7). The model also predicts stagnation in the inflation rate (see Fig. 8). However, this is a highly inaccurate prediction due to the outlier inflation value in 2022 compared to previous years. According to the forecast of the Czech National Bank, the inflation rate is expected to decrease to 11.2% in 2023 and 2.1% in 2024 (CNB, 2023). The development of unemployment will influence the level of nominal and real wages.

When comparing the forecast figure of unemployment and nominal wages, a negative correlation, as calculated above, is evident. An increase in one variable corresponds to a decrease in the other variable.

3. Discussion

The results of the analysis of the relationship between the unemployment rate and labour productivity in the Czech Republic may vary depending on specific periods, available data, and analysis methods. When interpreting the results, it is also essential to consider whether the correlation was calculated based on long-term or short-term data (Mačí, 2020). Short-term fluctuations in the labour market and wage changes can influence the correlation results, while a long-term analysis would provide a clearer picture of the relationship between these variables.

The results of the correlation analysis suggest a strong negative correlation between the unemployment rate and nominal wages and a moderately strong negative correlation between the unemployment rate and inflation. This result supports the theory of the Phillips curve, which is an economic model relating to unemployment and inflation. In 1958, A.W. Phillips published an article analyzing the relationship between the unemployment rate and the rate of change in nominal wage rates based on empirical data. His results showed a negative relationship between the rate of wage inflation and the unemployment rate - a lower unemployment rate is associated with a higher inflation rate and vice versa. This relationship later became known as the original wage version of the Phillips curve.

In the 1960s, P.A. Samuelson and R.M. Solow expanded on this theory and focused on the growth rate of nominal wages and price inflation. They demonstrated that a high unemployment rate is associated with a decrease in the inflation rate. However, in the late 1960s and early 1970s, there was a significant change in the economic situation, where factors other than unemployment (such as oil shocks) began to affect the movement of price levels and wage levels. These oil shocks increased both the price level and unemployment, along with a decline in output. These new factors contradicted the expectations based on the classical Phillips curve. As a result, the empirical mismatch between inflation and various measures of slack was interpreted by some researchers as evidence that the Phillips curve weakened or even disappeared (Blanchard et al., 2015; McLeay & Tenreyro, 2020; Vigliarolo, 2020). Although a slightly strong negative correlation between the unemployment rate and inflation has been shown, the authors agree that the Phillips curve has weakened. In the Czech Republic, there is a long-term shortage of labor force that does not respond to the market situation. This area will be further analyzed. On the contrary, some studies state that the Phillips curve always applies, even today (McLeay & Tenreyro, 2020).

Further research needs to be expanded to include additional variables and potentially involve the analysis of multiple countries. It is also necessary to examine the impacts of the current economic situation on the development of unemployment and other macroeconomic indicators. Due to the time lag emphasized by researchers such as (CNB, 2023), Mura et al. (2020) and Pawęta (2018), it is essential to reanalyze this period with a time interval in mind.

Conclusion

The overall result of the correlation analysis between unemployment and nominal wages (-0.892370) can be considered a significant statistical indicator, indicating a strong negative relationship between these two variables. This situation aligns with

macroeconomic assumptions that an increase in unemployment leads to a reduction in the pace of nominal wage growth.

The result of the correlation analysis between unemployment and labour productivity (-0.002344) can be regarded as very weak and insufficient evidence of any significant relationship between these two variables. Similarly, the result of the correlation analysis between unemployment and real wages (-0.133566) can be considered a very weak indication of a relationship between these two variables. It is advisable to conduct further analyses and consider additional factors to achieve a more comprehensive and reliable understanding of this relationship.

The result of the correlation analysis between unemployment and inflation (-0.497666) can be considered a moderately strong indication of a negative relationship between these two variables. However, this relationship is not absolute and may be influenced by other factors such as changes in labour productivity, international trade, wage expectations, and central bank policies. Additionally, the identified correlation alone does not provide information about the causal relationship between unemployment and inflation.

The analysis results are also influenced by other variables, such as the macroeconomic situation. In 2019, the examined variables were primarily affected by the Covid-19 pandemic, the conflict in Ukraine, and a sharp increase in energy and food prices. All these factors contributed to significant inflation growth. Due to a shortage of workers in the labour market and the resulting imbalance of labour demand and supply, the unemployment rate increased gradually. According to macroeconomic predictions, the unemployment rate should not significantly increase unless a recession occurs.

Acknowledgement

The work was supported by the internal project “SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept”, 2023, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic. The authors are grateful to the student Zdeněk Novák, who collaborated on feedback on the concept and editing of the article.

References

- ADELOWOKAN, O. O. A., BABASANYA, A. O., MAKU, O. E., & ADESOYE, A. B. (2019). Unemployment, poverty and economic growth in Nigeria. *Journal of Economics and Management*, 35, 5–17. <https://doi.org/10.22367/jem.2019.35.01>
- BLANCHARD, O., CERUTTI, E., & SUMMERS, L. (2015). Inflation and Activity – Two Explorations and their Monetary Policy Implications (Č. w21726; s. w21726). National Bureau of Economic Research. <https://doi.org/10.3386/w21726>
- CNB. (2023). *CNB forecast – Spring 2023*. <https://www.cnb.cz/en/monetary-policy/forecast/>
- CZECH STATISTICAL OFFICE. (2023). *Key macroeconomic indicators*. https://www.czso.cz/csu/czso/hmu_ts
- HEDVIČÁKOVÁ, M., & POZDÍLKOVÁ, A. (2023). Analysis of Healthcare Expenditures in the Czech Republic (J. Maci, P. Maresova, K. Firlej, & I. Soukal, Ed.; s. 215–223). Hradec

- Economic Days 2023, Hradec Králové, <https://doi.org/10.36689/uhk/hed/2023-01-021>
- MAČÍ, J. (2020). Is There a Trend of Euroization of EU Countries Still Using Their National Currencies? Trade and Invoicing. *E+M Ekonomie a Management*, 23(4), 182–196. <https://doi.org/10.15240/tul/001/2020-4-012>
- MCLEAY, M., & TENREYRO, S. (2020). *Optimal Inflation and the Identification of the Phillips Curve*. UNIV OF CHICAGO Press. <https://doi.org/10.3386/w25892>
- MONTGOMERY, Douglas C., Elizabeth A. PECK a G. Geoffrey VINING. *Introduction to linear regression analysis*. 4th ed. Hoboken, N.J.: Wiley-Interscience, 2006. ISBN 9780471754954.
- MURA, L., ZSIGMOND, T., KOVÁCS, A., & BALOGHOVÁ, É. (2020). Unemployment and GDP relationship analysis in the Visegrad four countries. On-line *Journal Modelling the New Europe*, 34, 118–134. <https://doi.org/10.24193/OJMNE.2020.34.06>
- PAWEŁA, B. (2018). Impact of the Global Financial Crisis on the Business Cycle in the Visegrad Group. *Entrepreneurial Business and Economics Review*, 6(3), 43–58. <https://doi.org/10.15678/EBER.2018.060303>
- SU, C.-W., DAI, K., ULLAH, S., & ANDLIB, Z. (2022). COVID-19 pandemic and unemployment dynamics in European economies. *Economic Research-Ekonomska Istraživanja*, 35(1), 1752–1764. <https://doi.org/10.1080/1331677X.2021.1912627>
- VIGLIAROLO, F. (2020). Economic phenomenology: Fundamentals, principles and definition. *Insights into Regional Development*, 2(1), 418–429. [https://doi.org/10.9770/IRD.2020.2.1\(2\)](https://doi.org/10.9770/IRD.2020.2.1(2))
- WANG, C.-N., & LE, A. (2018). Measuring the Macroeconomic Performance among Developed Countries and Asian Developing Countries: Past, Present, and Future. *Sustainability*, 10(10), 3664. <https://doi.org/10.3390/su10103664>