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Evaluation of the impacts of the COVID-19 pandemic on the development of the unemployment rate in Slovakia: counterfactual before-after comparison

Abstract

Research background: The COVID-19 pandemic, which hit the world in the first quarter of 2020, has impacted almost every area of people's lives. Many states have introduced varying degrees of measures to prevent its spread. Most of these measures were, or still are, aimed at reducing or completely stopping the operation of shops and services, or in some cases, also the large manufacturing companies. However, as many companies have failed to cope with these restrictions, unemployment has risen in almost all EU countries. A similar situation was also observed in Slovakia, where the mentioned measures also had a significant impact on unemployment.

Purpose of the article: In this study, we deal with the quantification of the impact of a pandemic, or more precisely, anti-pandemic measures, on the development of the registered unemployment rate in Slovakia.

Methods: This quantification is based on the counterfactual method of before-after comparison, which is one of the most widely used methods in the field of impact assessments and brings very accurate results, based on real data. In the analysis, we use officially published data on the unemployment rate in Slovakia during the years 2013–2020 on a monthly basis. Such a long time series, using statistical methods of its decomposition and modelling of its trend, will allow predicting the development of the unemployment rate in Slovakia, assuming a counterfactual situation of no pandemic, and compare this development with the actual situation that occurred during 2020.

Findings & Value added: The study results indicate an increase in the unemployment rate in Slovakia during 2020 by 2–3% compared to the trend of its development, which would have occurred without a pandemic. Given the counterfactual method used, this difference can be described as the impact of the COVID-19 pandemic. The results of the study can be used in practice in the design and implementation of measures introduced to mitigate the impacts of the pandemic on unemployment and, in the long-term perspective, also to eliminate these effects as much as possible. It can also be used as a theoretical tool in conducting impact assessments, which have so far been carried out very rarely in Slovakia.

Introduction

The COVID-19 pandemic and its global impact affect all spheres of life in modern society, and for the first time in recent history, we are facing such a global problem. The world economy and the economies of individual countries must face the nature of the disease, its intense spread, and subsequent drastic anti-pandemic measures. Slovakia is no exception, and the Slovak economy is very strongly affected by the pandemic and its consequences. Due to the impact of the disease on human health, the crisis caused by this disease also has a negative impact on the economic performance of individual countries around the world. We can rank the Slovak Republic among the most affected countries in the context of the economic downturn and employment, when the positive development on the labour market, which has persisted so far, has been disrupted. After a long-term declining unemployment rate, it has started to rise rapidly since March 2020.

The impact of the pandemic is especially a forced constraint in the business sector and a reduction in consumer demand. Due to the above factors, employers began to compensate for cost reductions through mass redundancies in their companies. According to a report prepared by the Institute of Social Policy of the Slovak Republic, the month-on-month comparison of unemployment shows that only in August 2020 a slight decrease in the unemployment rate was recorded. If we considered the unemployment rate in individual regions of the Slovak Republic, we would find that it did not

develop in the same way. The highest unemployment was recorded in the Nitra Region and the Trencin Region, while the lowest unemployment was in the Bratislava Region and the Žilina Region (Baliak & Belin, 2020).

Because the government's untying restrictions consisted of opening borders with individual neighbouring states, relaunching establishments, restaurants, and hotels, the unemployment rate gradually declined. But then, due to the negative pandemic situation, the government was again forced to tighten anti-pandemic measures and unemployment rose again. The data obtained from the Central Office of Labour, Social Affairs and Family of the Slovak Republic records an unemployment rate of 7.81% as of 31 January 2021. The Slovak industry, as the most important sector of the economy, is also highly dependent on developments in foreign markets. Measures to prevent the spread of coronavirus also slow down the economic activity of our main trading partners.

As part of the pandemic, the government has taken measures to support employment and minimise the impact on individual industries. These measures provide support to employers who were obliged to close down or were forced to close down when the emergency was declared. For example, the employee's retention allowance varied depending on whether the employer was subject to an obligation to suspend or reduce its operating activities. Other approved measures include compensation for the decline in revenues in self-employment or labour flexibility. In addition, the government has adopted new legal changes in employment, particularly instruments such as the home office and the "kurzarbeit". In the area of loans, several support instruments were also adopted, such as loan benefits for entrepreneurs, where we include deferral of loan repayments and leasing, credit options in the form of obtaining a COVID loan with a minimum interest rate provided by EXIMBANK SR for entrepreneurs (SBA, 2020).

The aim of the paper is to determine and quantify the development of unemployment in the Slovak Republic due to the impact of approved government regulations against the spread of this pandemic, using the counterfactual before-after comparison method. As the topic of quantifying the impacts of the COVID-19 pandemic on the development of unemployment has not been addressed by authors in Slovakia so far, we see a scientific gap that we want to fill with this study. We consider applying the before-after comparison method of impact assessment to be the main benefit and strength of this study, as it brings very accurate results of the impact evaluation. Furthermore, we see potential opportunities to use the results of this study mainly in designing active labour market policy instruments aimed at increasing the employment and employability of those jobseekers who lost their jobs, mainly due to the anti-pandemic measures. And, last but not

least, intervention tools for enterprises to support job retention of their employees in both the pandemic and post-pandemic periods. Implementing such labour market policy instruments is not a short-term issue, as mitigation and complete elimination of the impacts of a pandemic can take a long time. Therefore, intervention instruments will need to be put in place to target affected groups and meet their objective. This opportunity comes with the arrival of a new programming period. Still, it can be assumed that some of the effects of the pandemic will need to be eliminated in the next programming period. In addition, in the light of current developments of the disease, the continuation of the pandemic and other unemployment problems can be expected.

The rest of the paper is organised as follows. The literature review starts with analysing previous economic crises in the labour market, such as the global financial crisis. It then highlights the current state of the issue of unemployment caused by the COVID-19 pandemic in countries all over the world. In the second section, the methodology of the analysis is briefly described, and the data used in the study are characterised. The third section states the result of the analysis and indicates the changing trend of the development of unemployment in Slovakia, which is affected by the COVID-19 pandemic. In the discussion, we compare the study results with the results of similar studies by other authors and suggest a possible further direction of the study. The last chapter summarises the conclusions of the study.

Literature review

The outbreak of the COVID-19 pandemic has brought unprecedented disruption to world economies and led to the loss of income and high unemployment (Dang & Viet Nguyen, 2021; Padhan & Prabheesh, 2021). In line with the data available to the International Labour Organization (ILO), we can say that the increase in unemployment depending on the development of the pandemic situation has varied considerably across the world's countries. Countries like the US and Canada have seen a sharp rise in unemployment. On the contrary, a more subdued rise in unemployment prevailed in European countries. Regarding the overall impact of the pandemic in 2020, new estimates made by the ILO confirm the enormous distortions of the labour market. Comparing the year 2020 to the last quarter of 2019, we record a loss of 8.8% of global working time, representing approximately 255 million full-time jobs, given the assumption of a 48-hour working week (ILO-OECD, 2020). The situation on the labour market, which is also

related to the employment rate of the population, or the number of unemployed people, is currently addressed by many foreign as well as domestic authors.

The current crisis, or its impact, is often compared to the previous world financial crisis in 2008–209. In their study, Van der Wielen and Barrios (2020) analyse individualists' fears of possible job losses that far exceed the levels observed during the Great Recession. In the study Shibata (2020), the author analyses the effects of the current pandemic COVID-19 crisis and the global financial crisis in 2008–2009 on the characteristics of workers, jobs and wage distribution in the USA. The authors found that young and less-educated workers were more affected in recessions, whereas more affected groups of the population are women and Hispanics during the actual pandemic crisis. During both recessions, workers at low-income earnings were strongly affected. A large share of newly unemployed was on temporary layoff during the COVID-19 recession, unlike the Global Financial Crisis.

Every crisis, whether financial or, in the present case, a crisis associated with a pandemic situation, affects all macro indicators and, therefore, also employment. The impact of the global crisis on the youth unemployment rate was addressed by Liotti (2020), whose econometric results confirm the fact that the recession during the economic crisis of 2008–2009 had an adverse effect on youth unemployment in particular. Kunieda *et al.* (2017), in their study, explains the severity of financial crises and the consequences that will occur if the economy gets depressed. According to these authors, the previous financial crisis increased the unemployment rate in the US labour market from 4.7% to 9.7% during those years.

In addition to the mentioned global financial crisis, some authors have, of course, analysed the impact of other crises on the problem of unemployment. For example, Choi *et al.* (2020) focused on the impact of the 1997–1998 Asian financial crisis. The authors focused on the long-term impact of such a crisis on the young generation's unemployment and analysed the impacts on men and women separately. According to the authors, their study results could serve to evaluate or predict the impacts of the actual COVID-19 crisis from a long-term perspective. However, the authors choose the Asian financial crisis as an opportunity to quantify long-term impacts, as the financial crisis in 2008–2009 was eleven years ago, only short or medium-term impacts can be evaluated.

Similarly, as the previous financial crisis, the current crisis caused by the COVID-19 pandemic also has a strong impact not only on unemployment in almost every country globally and is analysed by several authors. The relationship between wage growth and the unemployment gap, known

as the Phillips wage curve, is discussed by Bonam *et al.* (2021). When comparing the estimate of the Phillips wage curve across euro area countries, wages have changed over time, but not evenly across them. While before the COVID-19 pandemic, the differences in unemployment narrowed significantly, wages were affected by lower growth rates than assumed in the traditional Phillips curves. A similar topic of wages in European countries is addressed in his publication by Palomino *et al.* (2020). Sumner *et al.* (2020) point out that the negative effects of the current crisis could erase global progress in reducing poverty. Then, in some regions, the negative effects may lead to the same poverty level as 30 years ago, especially in regions where workers are employed in tourism or producers affected by declining global demand (Bargain & Aminjonov, 2021).

As Bauer and Weber (2020) found in their study, this problem has also affected the developed countries, examining the unemployment rate caused by insulation measures in Germany. The authors found that 60% of the significantly increased inflow of unemployment in April 2020 was due to weaning anti-pandemic measures. Huang *et al.* (2020) focus on a representative pattern of small businesses in the US between March and April 2020, which were associated with business closures, which privately 20–30% increases the number of unpaid workers in the food sector, leisure sector, and sector of entertainment. Sobieralski (2020) focuses on analysing the effects of COVID-19 shocks on the unemployment rate in airlines in the US, whose revenues have been severely crippled due to closed borders and national restrictions. Recovery from shock can take an average of four to six years. This study also stresses that measures introduced in fiscal policy since the early days of the pandemic, such as part-time programs, have not alleviated the expected economic sentiment. In Bhar and Malliaris (2021) study, the authors address the issue of restrictions in the form of maintaining social distance and other measures to mitigate the consequences of the pandemic crisis, which was declared by the WHO on 11 March 2020 (Binder, 2020). The Fed also tried to respond promptly to the situation in the US in order to be able to stabilise the financial system and the US economy as soon as possible. Thus macroeconomic variables, which include the unemployment rate, did not develop negatively. A similar issue in the analysis of the Fed's steps to mitigate the effects of the COVID-19 pandemic on US households and businesses and to support the functioning of the market is addressed by Fleming *et al.* (2020).

Pandemic has a strong impact on unemployment also in less developed countries. For example, the studies Ababulgu Abasimel and Wana Fufa (2021); Ranchhod and Daniels (2021) analyse the impact of the pandemic

on unemployment in countries on the African continent and found a rapid increase in unemployment rates.

The impact of the pandemic is undoubtedly spared around the countries of Central Europe. In Slovakia, some sectors are not so affected by the current crisis, but the others are affected very strongly. According to the study (Hosoff *et al.*, 2020), the highest unemployment in Slovakia was recorded in the following sectors of the economy: food sector and accommodation — 144 million employees, retail and wholesale — 482 million employees, administrative services — 157 million employees, and the area of engineering production — 463 million employees.

Other recent studies advocate the unemployment-to-population ratio and the relative inactivity-to-population ratio as two key indicators capturing the macroeconomic health of the labour market, which further complement traditional unemployment and employment rates. For example, countries such as Poland, Korea, and the USA had a limited share of unemployed, but a high proportion of inactive people in the working-age population in 2019. In countries such as France and Spain, it was the opposite (Baert, 2021). Finally, the interaction between pandemic and economic dynamics has been studied in theoretical modelling (Eichenbaum *et al.*, 2020).

Research methodology

The main approach in assessing the impacts of the COVID-19 pandemic on unemployment in Slovakia during 2020 is based on a counterfactual comparison using the before-after comparison method. This approach is based on creating a counterfactual situation that would have occurred in the absence of a pandemic (Cerulli, 2015).

Let's mark the situation associated with the treatment, in this case, a pandemic, as "1" and, conversely, the situation associated with the absence of a pandemic with the value "0" (Dvoulety & Lukes, 2016; Stefanik, 2014; Stefanik *et al.*, 2020). The indicator variable for the existence of a pandemic is D. Thus, the situation associated with a pandemic is indicated by the value of the variable $D = 1$ and vice versa, the situation without a pandemic is $D = 0$. The aim of the impact evaluation is to compare what the values of the result variables would be in case a pandemic occurred ($D = 1$), and in case it did not occur ($D = 0$) (Frondel & Schmidt, 2005; Kruppe & Lang, 2018).

The impact of the treatment (pandemic) is evaluated and quantified by the result variables in a period t after the treatment (Liu & Wang, 2020). These result variables are generally denoted $Y_{t0} = Y_t | D = 0$ in a situation

without a pandemic, and $Y_{t1} = Y_t|D = 1$ in a situation in a pandemic. Such a designation makes it possible to directly formulate the causal effect of the program as the difference of the values of the result variable $Y_{t1} - Y_{t0}$, or in general, without time-subscript as $Y_1 - Y_0$.

However, in reality, we cannot accurately measure the impact of a pandemic, so instead of calculating the difference in the result variables $Y_1 - Y_0$, we estimate the expected value of this difference so that the impact of the pandemic is given by the expected value

$$ATE = E(Y| D = 1) - E(Y| D = 0), \tag{1}$$

that is the so-called Average Treatment Effect (ATE), i.e. in other words, the total average impact of the pandemic expressed as the difference between the average values of the result variables in the situation $D = 1$ and the counterfactual situation $D = 0$ (Pelucha *et al.*, 2019; Potluka *et al.*, 2016).

The main problem addressed by the counterfactual impact evaluation is that the situation without the treatment, i.e. in our case, without a pandemic, is only hypothetical (Svabova & Kramarova, 2021). Thus, the data on the values of the result variables Y_0 in the case of $D = 0$ cannot be measured. The expected value of $E(Y|D = 1)$ is thus counterfactual and expresses what would have happened on average if the pandemic had not occurred. This problem of data unavailability cannot be solved by more measurements or by obtaining more detailed data, because such data do not exist (Stefanik, 2014). In reality, only one of the situations can always occur: either the measure has occurred or has not occurred. Thus, of the two result variables Y_0 and Y_1, only one is always measurable. In the literature, this fact is called the "fundamental problem of evaluation" or, more generally, the "fundamental problem of causal inference" (Trivellato, 2011).

The hypothetical counterfactual value of the result variable Y_0 is estimated by various methods. In this study, given the nature of the available data, we apply one of the most common impact assessment strategies, the before-after comparison method. The basic idea of this method is to create an acceptable counterfactual situation by comparing the situation "after" the pandemic with itself in the situation "before" the pandemic. Or, more precisely, the development of the situation before the pandemic with the actual situation. That means we model and predict the hypothetical future development of the indicators — result variables, based on their historical development and compare this hypothetical counterfactual situation with the real values of these indicators in the pandemic.

The identification condition for this approach is that in the observed period after the treatment, there are no other changes that could cause changes in the values of the result variables. Thus, we assume that their values would follow the same trend in the post-pandemic period (but in the counterfactual situation without the pandemic) as they did in the pre-pandemic period. Thus, any other change in the environment with possible influence on the result variables in the impact period (observable and measurable, but also unobservable unmeasurable) would cause the incorrectly attributed change in their values as the effect of the pandemic. This is an important identifying assumption in the issue of counterfactual evaluations. However, it can also be considered a weakness of this evaluation approach, because if we do not find a suitable method to quantify the impact of non-measurable factors in the model, the evaluation results may be skewed and inaccurate. As a result, the created counterfactual situation would not be sufficiently accurate, and the quantification of the impact would not be valid (Arco-Tirado *et al.*, 2018; Frondel & Schmidt, 2005; Svabova *et al.*, 2019). In our model, we try to avoid this influence of immeasurable factors by monitoring four result variables, characterising the unemployment situation in Slovakia over a longer time. By decomposing the time series, we get to know its components and, based on the findings, we predict future development based on historical development. At the same time, we consider the situation in Slovakia to be relatively stable in the period under review, with no significant effects (except for a pandemic and related anti-pandemic shutdown measures) that would impact the changing unemployment situation that did not occur in 2020.

In this study, we use four indicators as the result variables that we assume to be significantly affected by the anti-pandemic measures. These four indicators are the following:
− inflow of newly registered jobseekers,
− number of available jobseekers,
− unemployment rate calculated from the number of jobseekers,
− registered unemployment rate.

All data are recorded on a monthly basis, covering the period of the years 2013–2020. The data source is the publicly available database of the Center for Labor, Social Affairs and Family of the Slovak Republic (COLSAF SR). This office publishes detailed monthly statistics on unemployment in Slovakia. In addition to the mentioned selected result variables, the database also contains data on the structure of unemployed persons based on their gender, age, level of education, sector of their last job, region of their permanent residence etc.

The selected four result variables characterise unemployment in Slovakia, each in a slightly different way. We consider the *inflow of newly registered jobseekers* as a time series with a seasonal component because these new registrations in the database of unemployed fluctuate during the year. This fluctuation also depends on other factors, such as season of the year (some jobs are seasonal, with employers giving their employees contracts only for part of the year), graduation of high schools and universities and the like. This seasonality is characteristic mainly for some sectors. We will analyse this time series using its decomposition by an additive model. Then, we will create a hypothetical counterfactual situation based on the prediction of the development of the inflow of newly registered jobseekers for the individual months of 2020. This counterfactual situation describes what would have happened in the situation without the COVID-19 anti-pandemic shut-down measures using a one-dimensional time series regression model with a linear trend and seasonality represented by dummy variables.

Figure 1 shows the development of this variable in the period from January 2013 to December 2020.

The other three result variables, number of available jobseekers, unemployment rate calculated from the number of jobseekers and registered unemployment rate, are considered stationary time series. We assume autoregressive dependence without the trend component. The presence of autocorrelation is verified using the Durbin–Watson test. The result of this test is Durbin–Watson statistic, with a value between 0 and 4. Values from the interval ⟨0;2) indicate positive autocorrelation and values from the interval ⟨2;4) indicate negative autocorrelation. The degree of autocorrelation is determined using the autocorrelation function (ACF) and the partial autocorrelation function (PACF). Based on these findings, we will create an autocorrelation regression model of these three output variables, which will be used to model their hypothetical development in the counterfactual situation of the absence of a pandemic during the individual months of 2020. The development of these three result variables is in Figure 2.

Given the development of indicators during the period under review and individual months of 2020, especially since April 2020, when the pandemic came to Slovakia and the first strict government restrictions were introduced, we expect a significant impact on these unemployment indicators in Slovakia. This impact is also visible in Figure 2, where the development of all variables immediately changed.

Results

The first analysed result variable was the inflow of newly registered jobseekers. The development of the time series of this indicator is shown in Figure 1. We focused on the period from January 2013 to March 2020, which was the month when the first diagnosed cases of COVID-19 appeared in Slovakia. We assume that the effects of anti-pandemic measures were first reflected in the unemployment indicators in April 2020 and then also in the following months of 2020. We decomposed the time series by additive decomposition into trend, seasonal and error components. Figure 3 shows the trend component of the inflow of newly registered jobseekers. The trend component was calculated using a moving average.

Furthermore, we assume the seasonal component of the time series of this result variable, which we include in the regression model in the form of dummy variables, representing the individual months of the year. We model the trend of inflow of newly registered jobseekers on time and these seasonal dummy variables. The created prediction model is in Table 1. This model is statistically significant (p-value of the ANOVA test = 4.2111e-12) and describes 56.2% of the variability of the dependent variable (R-square = 0.562).

Using this trend model, we can predict the hypothetical development of this variable under the counterfactual assumption of the absence of a pandemic. The real and predicted values of this result variable are in Table 3. Then, we compare the prediction with the real development and quantify the evaluation parameter ATE, where:

$$E(Y_0) = E(Y \mid D = 0) = 17\ 754.77 \tag{2}$$

and

$$E(Y_1) = E(Y \mid D = 1) = 20\ 630.33, \tag{3}$$

whereas the expected value of the result variable is estimated using the average value in the observed period (April 2020–December 2020). Thus,

$$ATE = E(Y_1) - E(Y_0) \doteq 2\ 875.57, \tag{4}$$

so we can say that pandemic caused an increase in the number of newly registered jobseekers by on average 2 876 jobseekers monthly. Given the average number of newly registered jobseekers monthly in the period one

year before the pandemic, this is an increase of 16.63% and given the development trend; this is an increase of 16.19%.

We further analyse the development of variables: number of available jobseekers, unemployment rate calculated from the number of jobseekers and registered unemployment rate. Figure 4 shows the ACF and PACF functions for these three variables.

From the graph of the ACF functions, we can see that the coefficients of correlation between the time series and its delay by one month have the highest value. If we look more closely at the PACF graphs, which show the partial correlation coefficients between the series and their delays, we get a similar result. The time series values of these variables are most strongly influenced by the time series delayed by one month. Other delays in the PACF function do not exceed the specified confidence interval. Therefore, we will use the AR(1) model to model these time series.

Table 2 contains the models for the time series of all the three result variables. These three models are statistically significant (ANOVA test p-values are all less than all usually used significance levels and R-squares are 0.9955; 0.9964, and 0.9984, respectively).

Based on these models, we can predict the values of the result variables for April 2020–December 2020, in a counterfactual situation without a pandemic and get the expected values of $E(Y_0) = (Y | D = 0)$. Then, we can quantify the actual situation under the pandemic and compute the expected value $E(Y_1) = E(Y | D = 1)$, where expected values of the result variables are estimated by their average values in the observed period. Then, the average impact of the pandemic on the unemployment in the period under the review in Slovakia is given by the ATE:

$$ATE = E(Y_1) - E(Y_0). \tag{5}$$

Table 3 lists the real values of the four analysed variables in the situation under the pandemic and their predicted values under the counterfactual situation without the pandemic. The estimates and averages of the first two variables are round to whole numbers, as they are the number of jobseekers. The other two variables have the values rounded to two decimals.

The evaluation results are summarised in Table 4, together with the result mentioned above for the inflow of newly unemployed.

Discussion

The evaluation shows that the estimated impact of the pandemic is an increase in all mentioned four result variables, describing the situation of unemployment in Slovakia in the year 2020. The increase in the number of newly unemployed people was by on average 2875 persons monthly. On the number of all available jobseekers, it increased on average by 47 151 persons monthly. Given relative numbers, the estimated increase in the number of new unemployed is by on average 16.19% monthly. The number of all available jobseekers in Slovakia increased by on average 30.5% monthly. Compared to the previous 12 months (April 2019–March 2020), the number of newly unemployed increased by on average 16.63% and the number of all available jobseekers increased by on average 47.13%. The difference between the counterfactual estimate and the previous year comparison is caused by the decreasing trend of these two times series, used to estimate their hypothetical development in the counterfactual situation without the pandemic.

This impact evaluation of the pandemic on the development of the unemployment rate shows that during the months of 2020 affected by the COVID-19 pandemic, the estimated increase in the unemployment rate calculated from the number of jobseekers is on average by 2.12%. Or, in relative numbers, the estimated increase in the unemployment rate is by on average 35.25% compared to the hypothetical counterfactual situation in 2020 without the pandemic. In comparison with the previous 12 months, this unemployment rate increased on average by 33.94% of its average value. On the registered unemployment rate, the estimated impact is on average 2.84%. In relative numbers, the increase in the unemployment rate is by on average 62.94% of its hypothetical predicted value in the situation without the pandemic. Compared to the previous 12 months, the registered unemployment rate increased by on average 47.66% of its value.

The development of the unemployment rate in Slovakia (7.4% at the end of second-quarter 2020) was also addressed by Hlawiczka and Kollar (2021). They analysed several macroeconomic indicators during the corona crisis, where it was found that the Slovak labour market looks worse than in neighbouring euro area countries (7.1% to the second quarter of 2020). In their studies, some foreign authors also estimated the impact of the pandemic on unemployment in 2020–2021. For example, Barrot *et al.* (2020) estimate that a 10% increase in state-level labour restrictions in the US led to a 3% drop in employment and a 1.87% drop in the market value of firms in April 2020 alone. The unemployment rate in this period was the highest in American history, at 14.7% (BLS, 2021; Goes & Gallo, 2021). It is

a very similar increase in the unemployment rate as was estimated in our study in Slovakia, although these are very different countries.

The effects of COVID-19 shocks are also studied by Kikuchi *et al.* (2021), who found that women are the most affected in the labour market in contingent, low-skilled positions performing social and inflexible work (Mongey *et al.*, 2020). In their research, Dang and Viet Nguyen (2021) found that women are 24% more likely to lose jobs permanently due to an outbreak of COVID-19 and expect their income to fall by as much as 50% more than men. We mention these studies because, in a similar analysis, we see the potential continuation of this research, where more detailed analysis and quantification of the pandemic impacts should be conducted on individual segments based on gender, regions in Slovakia or focused on disadvantaged groups of the unemployed, such as young graduates. It is also possible to focus the study on identifying sectors of the economy most affected by the pandemic, as was done in the authors' studies mentioned above.

Conclusions

The effects of the COVID-19 pandemic largely influence the economic performance of the economy in the Slovak Republic. To reduce coronavirus infection, the Slovak Republic has adopted many restrictions and anti-epidemiological measures, which result in a negative impact on the Slovak labour market. The negative impact of COVID-19 is faced not only by large enterprises, but also by small and medium-sized ones, whose share in employment in the corporate economy is over 70%. In employment, in the Slovak economy, this share is more than 50%. The restriction of business activities of companies operating in Slovakia caused a decrease in consumer demand, which put pressure on employers to reduce costs through redundancies. This study aimed to quantify the impact of pandemic measures on the development of the registered unemployment rate in Slovakia. Based on the quantification of pandemic measures impact on the registered unemployment rate development, performed using the counterfactual method of before-after comparison for the period 2013–2020, we have found that there was a monthly increase in the number of not only newly unemployed persons, but also all available jobseekers in the Slovak Republic. The average monthly increase in the newly unemployed was around 16.19%, representing an increase of 16.63% on average compared to April 2019-March 2020. The increase in all available jobseekers averaged 30.5% per month, representing an average increase of 47.13% compared to April 2019-March

2020. Based on the achieved results, we have also found that the total registered unemployment rate in the Slovak Republic increased by 2-3% in the period of the COVID-19 pandemic compared to the period during which this pandemic was not yet been in Slovakia. These findings point to the fact that the COVID-19 pandemic has a significant impact on the development of unemployment in the Slovak Republic. Anti-epidemiological measures impact the registered unemployment rate not only in Slovakia as a whole, but also in its regions. Therefore, in future research, we would like to focus on monitoring and quantifying the impact of the COVID-19 pandemic on the unemployment rate in regions of Slovakia.

From the long-term perspective, the study can be seen as a contribution to the scientific background and as an output for a possible further comparison in the event of a similar recession that would affect the world economy, as is usually done nowadays when the current crisis is compared with the last financial crisis started in 2008. Unemployment research and evaluation is a frequent and very topical issue. Therefore, we see the long-term value of the article, especially at the macroeconomic level, when the government could support the business sector and reintegrate the unemployed into working life in the shortest possible time. Based on the results found, micro-level recommendations can also be given to companies that should adapt to digital technologies, transform jobs and create conditions for employees to eliminate laying off as possible. It should also be borne in mind that the current crisis is still not over, and with the threat of another wave of the disease, the impact of the pandemic will continue, which will again most likely translate into rising unemployment rates. In this case, the results of this study can be used to implement rapid aid instruments for enterprises and also to set up intervention instruments for the unemployed people to increase their employability, placeability on the labour market and sustainability in the found employment. The effects of the pandemic must first be mitigated and then tried to be eliminated completely. For this purpose, the intervention measures of active labour market policy will undoubtedly serve in the current, but probably also in the next programming period. Thus, the results of this study are applicable in practice, where they can be used in setting up the conditions and parameters of the interventions to mitigate the pandemic impacts on unemployment. Several measures for the unemployed jobseekers already are in practice, whose main aim is to increase their employability and sustainability in the labour market. However, these measures currently need to be updated to reduce unemployment caused by pandemic shut-down measures. The results of this study can be used to quantify the resources needed for this purpose.

As the strengths of this study, we consider a sufficiently long time series of monthly data on unemployment in Slovakia, on the basis of which it is possible to analyse in detail the development of these indicators and make a forecast for the following periods. Furthermore, the strength of this study is also the application of a counterfactual impact assessment approach, which yields very accurate results through before-after comparison. On the other hand, as a weakness of this study, we consider the fact that the analysis was carried out comprehensively for the whole of Slovakia, for example, regardless of sectors of economic activity, as some sectors were significantly affected by the pandemic, but on some of them, the pandemic did not have a significant impact. A more detailed analysis could therefore yield more accurate results.

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Acknowledgements

Annex

Table 1. Model for the trend of *inflow of newly registered jobseekers*

Variable	Unstandardised Coefficients		t	Sig.
	B	**Std. Error**		
(Constant)	20 758.785	306.884	67.644	0.000
time	- 44.920	5.782	-7.769	0.000
season_9	2 298.462	518.932	4.429	0.000
season_7	1 924.565	518.819	3.710	0.000
season_8	1 522.628	518.843	2.935	0.004
season_6	1 408.188	518.859	2.714	0.008
season_5	1 386.668	518.963	2.672	0.009

Source: own calculations based on the data from COLSAF SR.

Table 2. Autoregressive model for the number of available jobseekers, unemployment rate calculated from the number of jobseekers, registered unemployment rate

Dependent Variable	Variable	Unstandardised Coefficients		t	Sig.
		B	**Std. Error**		
number of available jobseekers	(Constant)	2299.36	1784.64	1.29	0.201
	available jobseekers_1	0.982	0.007	143.51	0.000
unemployment rate_jobseekers	(Constant)	0.070	0.067	1.04	0.299
	unemployment rate jobseekers_1	0.985	0.006	160.95	0.000
registered unemployment rate	(Constant)	-0.060	0.044	-1.36	0.178
	registered unemployment rate_1	0.994	0.004	226.05	0.000

Source: own calculations based on the data from COLSAF SR.

Table 3. Real and estimated values of result variables

| Month	Inflow of new unemployed		Number of available jobseekers		Unemployment rate_jobseekers [%]		Tegistered unemployment rate [%]	
	Real situation–pandemic	Counterfactual situation–estimate	Real situation–pandemic	Counterfactual situation–estimate	Real situation–pandemic	Counterfactual situation–estimate	Real situation–pandemic	Counterfactual situation–estimate
04/2020	29275	16986	180756	145293	7.43	6.09	6.57	4.87
05/2020	19504	18327	198256	147594	7.96	6.07	7.20	4.78
06/2020	21755	18304	203586	149894	8.20	6.05	7.40	4.69
07/2020	22529	18775	209786	152194	8.44	6.03	7.65	4.60
08/2020	16605	18328	208362	154495	8.37	6.01	7.60	4.51
09/2020	24012	19059	203649	156795	8.18	5.99	7.43	4.42
10/2020	20689	16716	201281	159095	8.12	5.97	7.35	4.33
11/2020	16515	16671	201948	161396	8.14	5.95	7.38	4.25
12/2020	14789	16626	207184	163696	8.30	5.93	7.57	4.16
average	20630	17755	201645	154495	8.13	6.01	7.35	4.51

Source: own calculations based on the data from COLSAF SR.

Table 4. Quantification of the impact of the pandemic on unemployment

| Variable	Inflow of new unemployed	Number of available jobseekers	Unemployment rate _jobseekers [%]	Registered unemployment rate [%]
Counterfactual situation – estimate $E(Y_0)$	17 755	154 495	6.01	4.51
Real situation – pandemic $E(Y_1)$	20 630	201 645	8.13	7.35
ATE	2 875	47 151	2.12	2.84
impact [%]	+16.19	+30.5	+35.25	+62.94
Comparison with previous 12 months [%]	+16.63	+47.13	+33.94	+47.66

Source: own calculations based on the data from COLSAF SR.

Figure 1. Development of the inflow of newly registered jobseekers in January 2013–December 2020 in Slovakia
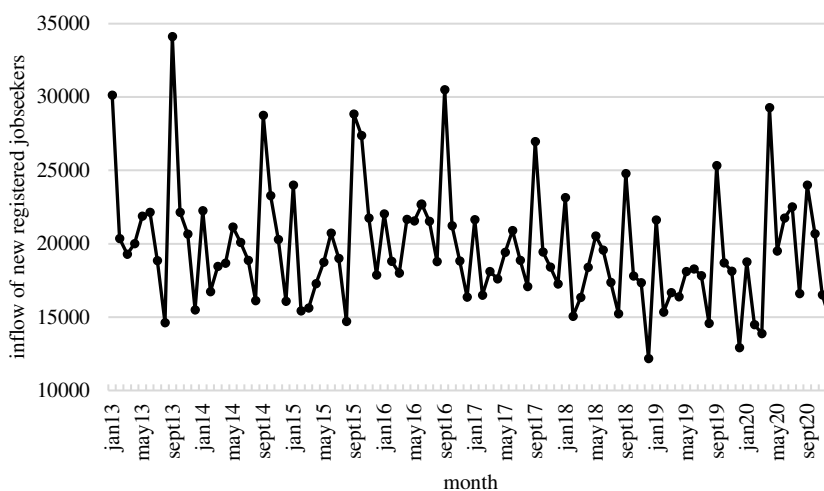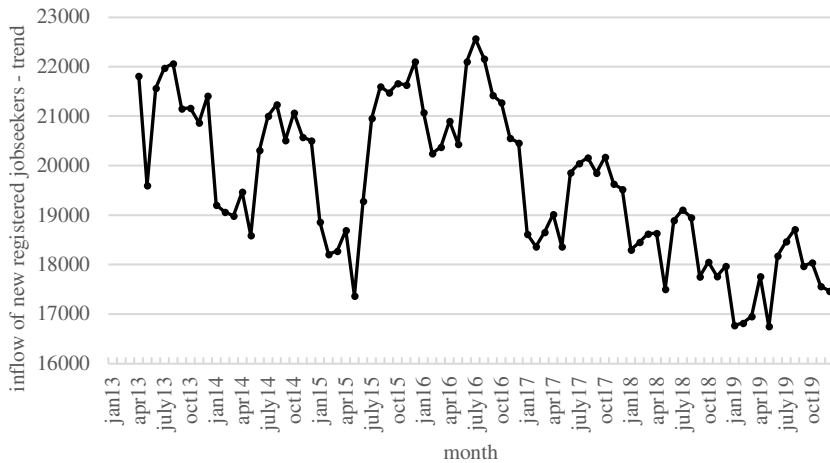

Source: own calculations based on the data from COLSAF SR.

Figure 2. Development of the number of available jobseekers and unemployment rate in January 2013–December 2020 in Slovakia
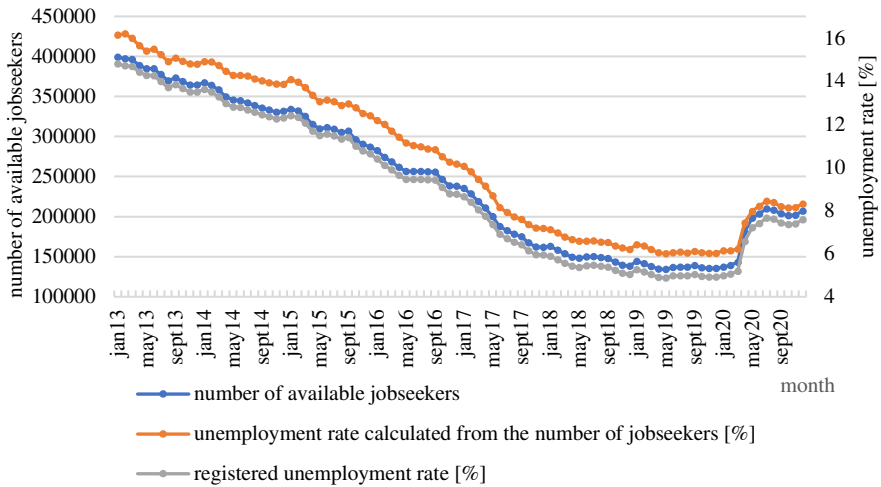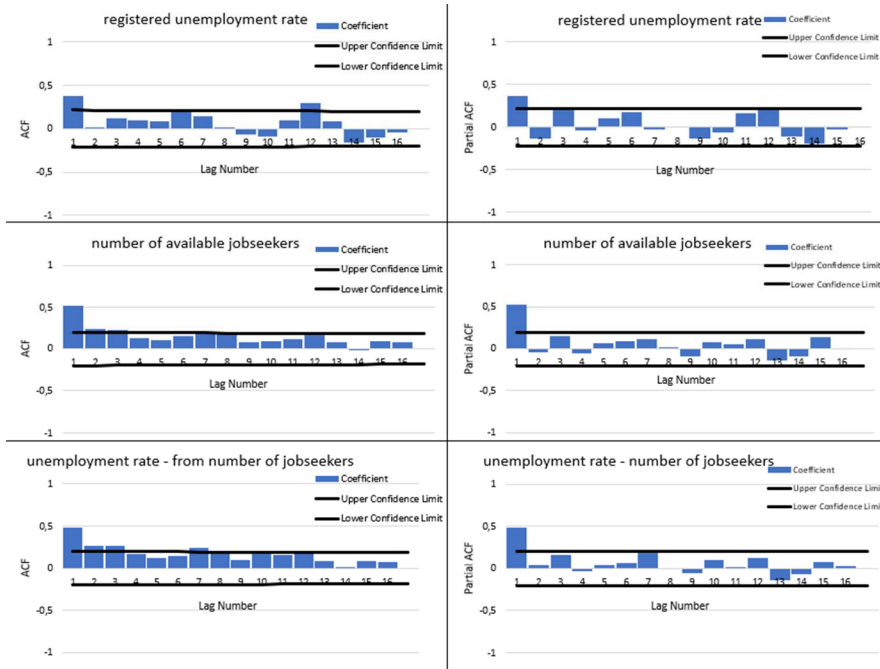

Source: own calculations based on the data from COLSAF SR.

Figure 3. Trend of the inflow of newly registered jobseekers in January 2013 – March 2020 in Slovakia

Source: own calculations based on the data from COLSAF SR.

Figure 4. ACF and PACF function for the result variables

Source: own calculations based on the data from COLSAF SR.