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Assessment of the Labour Market During the COVID-19 Pandemic

Abstract: The COVID-19 pandemic has prompted governments to take radical measures to contain the virus and protect their citizens. These included successive restrictions on social distance, which have led to closing many enterprises in various industries and dismissing their employees. Introducing restrictions has significantly weakened many countries' economies. Stock markets have noted sharp declines. Therefore, public protection has led to severe consequences for the labour market. Attempts at defining them have been undertaken in the body of literature. However, they focus mainly on analysing selected indicators. According to the authors, it is worth analysing the correlation between the number of deaths as the variable that best reflects the disease's severity and selected unemployment rates. It was assumed that the number of deaths is a factor significantly distinguishing the periods before and after the pandemic. Therefore, it is possible to assess the correlation between the pandemic and the labour market condition.

Keywords: *labour market, COVID-19 pandemic, deaths, unemployment, Poland*

1. Introduction

The COVID-19 pandemic has prompted governments to take radical steps to contain the virus and protect their citizens (Lee et al., 2020; Goodyear-Smith et al., 2020; Devi, 2020). These included successive restrictions on social distance, which have led to closing many enterprises in various industries and dismissing their employees (Kassa, 2021; Lesi, 2020; Widiastuti et al., 2021). The introduction of restrictions has significantly weakened the economies of many countries, and stock markets have started to record sharp declines (Cox et al., 2020). Therefore, public protection has led to severe consequences for the labour market. Attempts at defining them have been undertaken in the body of literature. However, they focus mainly on analysing selected indicators (Beland et al., 2021; Raimo et al., 2021). According to the authors, it is worth analysing the correlation between the number of deaths as the variable that best reflects the severity of the disease and selected unemployment rates.

It was decided to use the number of deaths as one of the few factors describing the pandemic recorded before and after its onset to study this relationship. It allowed us to distinguish between the pre- and post-COVID-19-onset study periods and compare them.

The first SARS-CoV-2 cases were noted in the Chinese city of Wuhan in December 2019 (Lau et al., 2020), and the virus has rapidly spread worldwide. As a result, the World Health Organization (WHO) declared a Public Health Emergency of International Concern in January 2020 (Velavan & Meyer, 2020), and two months later, officially recognised it as a pandemic. Governments have taken drastic measures to contain the virus, gradually introducing restrictions that have led to closing many enterprises in various industries and dismissing their employees.

Global supply chains have been disrupted amid a sharp downturn in China's economy following the onset of the pandemic (Lee et al., 2020). Consequently, the companies dependent on Chinese supplies have begun experiencing a reduction in production and sales. Restrictions limiting the free movement of people and goods between countries hindered the global economy. Besides, the unpredictable, violent consumer reactions to the pandemic have distorted consumption patterns and triggered market anomalies.

Protection of the public by closing certain industries was aimed at specific consequences for the labour market and considered the greatest challenge since the Great Depression before World War II (Guan et al., 2020; International Labour Organization, 2020). Poland also noted a sharp increase in unemployment (EC, 2020; MFW, 2020). Therefore, the unemployment rate in relation to the COVID-19 pandemic is the subject of numerous studies, a selection of which are presented in Section 2.

The article aims to analyse the unemployment rate in Poland in relation to the periods before and after the COVID-19 pandemic. It was conducted at a certain level of generalisation, as only selected publicly available empirical data were included. First of all, it focused on the possibility of using the number of deaths as a variable to characterise the pandemic's

impact and compare the two periods. It allowed formulating the first research question (Sandberg & Alvesson, 2011), i.e., whether the number of deaths is a factor that can be used to analyse the pandemic's impact on selected changes in society – in this case, in the labour market.

Moreover, it has been noted that many scholars use particular indicators and measures related to unemployment and their change over time, only in the period following the pandemic onset. However, according to the authors, such an analysis does not fully reflect the changes in the labour market, as other factors affecting employment are not considered. In addition, the reference point for comparison is missing. An interesting analysis showing changes caused by the pandemic would be an analysis of the correlation between the number of COVID-19 infections and a selected unemployment indicator. However, such a study would be limited only to the pandemic and would not include the pre-pandemic period, thus lacking a period of comparison. Therefore, the authors proposed using the number of deaths variable while formulating a second research question, i.e., whether the analysis of the number of deaths in correlation with unemployment indicators will make it possible to assess changes caused by the pandemic. The final inquiry is the third research question: how does the COVID-19 pandemic expressed by the number of deaths affect selected unemployment-related factors.

The considerations allowed the authors to formulate the research hypothesis – it was assumed that the number of deaths is a factor significantly distinguishing the periods before and after the pandemic, and based on it, it is possible to assess the correlation between the pandemic and the labour market condition. In addition, three research objectives were formulated:

1. To assess whether the number of deaths is a variable that significantly differs between before and after the pandemic onset and can be used in analyses of the assessment of COVID-19 impact on selected factors.
2. To test the correlation between the number of deaths and selected unemployment indicators and infer the significance of this impact.
3. To assess how much the number of deaths affects the unemployment rate and the number of unemployed.

The article includes an introduction with a literature review. Then, an analysis of the number of deaths in the context of the COVID-19 pandemic onset is presented. The next section examines the correlation coefficient between the number of deaths and selected labour market related indicators, i.e., the number of unemployed, unemployment rate, employment, and wages. The whole is concluded with a summary.

2. Literature Review

The spread of the hitherto unknown COVID-19 virus has completely changed people's lives worldwide in a very short time. This virus has attacked our health and way of life, the job market, and the global economy (Lau et al., 2020; Lee et al., 2020).

Research carried out in the European Union shows that the COVID-19 pandemic has caused more than 25% of respondents across the EU to lose their jobs temporarily (23%) or permanently (5%). Moreover, more than half of employed people have to contend with reduced working hours, resulting in lower wages (Ahrendt et al., 2020). It shows that unemployment in the context of the COVID-19 pandemic is a very important subject of numerous analyses in various countries.

One of the first important studies on unemployment is Beland et al. (2020), who examined the short-term effects of the COVID-19 pandemic in Canada on the self-employed, that is, those who own small businesses. Considering the period from February to May 2020, it was found that the pandemic led to a significant decrease in the number of small companies. Additionally, a significant decrease in the working time of women, immigrants and less educated people was noticed during the same period.

The impact of the coronavirus pandemic on economic factors and policy interventions has also been analysed by Li and Kapri (2021). The results show that the countries that rely heavily on the service sector and international trade are more likely to be negatively affected by the COVID-19 pandemic. The study also concludes that these very countries would be able to mitigate the consequences of the spread of the virus by implementing restrictions and introducing stricter policies.

The COVID-19 pandemic has had a significant impact on the Romanian labour market in terms of three main criteria: the number of jobs (unemployment and underemployment), the quality of work (wages and access to social protection) and the impact on specific groups more vulnerable to negative labour market performance (Davidescu et al., 2021; Crețan & Light, 2020). Measures aimed at reducing labour force participation and social interaction (such as restrictions to curb the pandemic) reduce the demand for labour and indirectly contribute to higher unemployment rates.

Raimo et al. (2021) studied the impact of the pandemic on the labour market in individual Spanish municipalities and tried to determine the impact of restrictions on labour supply and demand, in addition to factors that affect employment levels. They found that employment during the first months of the pandemic was influenced by the characteristics of the business structure and showed the relationship between the economic activity of the municipality and the demographic characteristics of its population, which shape the regional labour market (Raimo et al., 2021).

Svabova et al. (2020) describe the evolution of the unemployment rate and the number of newly registered unemployed in Slovakia from November 2019 to October 2020, i.e., during the COVID-19 pandemic. In addition, they examined the impact of the government's

measures to prevent the coronavirus spread to different business sectors and identified the sectors most affected by the pandemic, i.e., where unemployment increased the most (Svabova et al., 2020).

The literature on the impact of the COVID-19 pandemic is voluminous due to the importance and topicality of this subject. In this area, the vital matter is data availability limited by the pandemic, the recording method, and archiving times (Danilova, 2020).

Therefore, the authors utilise various means to find reliable information characterising the pandemic. For example, Kong and Prinz (2020) used high-frequency Google search data, combined with data on the announcement dates of nonpharmaceutical interventions (NPIs) like stay-at-home orders, mandatory quarantines for travellers, nonessential business closures, large gatherings bans, school closures, and restaurant and bar limitations during the COVID-19. The goal was to assess the impact of these restrictions on the increase in unemployment rates. It was shown that they were not the direct cause of the increase. The study of Wojtkowiak and Szajner (2021) used data from a monthly online survey assessing how the public is adapting to the new conditions of work at home, which is also a common problem (Khandelwal et al., 2020). However, the most commonly used are individual indicators and measures related to unemployment and their change over time (Mayhew & Anand, 2020; Kapoor, 2020), but they are limited to studying the impact of only the time parameter. Therefore, the authors postulate the validity of using methods such as correlation analysis (Kong & Prinz, 2020) or statistical tests such as Kruskal-Wallis (Wojtkowiak & Szajner, 2021) for other important variables. Such analyses were found, for example, in Bauer and Weber (2021), where data for the inflow of workers from employment to unemployment by regions was used to study the impact of the shutdown in Germany, finding that it contributed to unemployment in as many as 60% of cases. Barbieri Góes and Gallo (2021) proposed a two-equations dynamical system that captures the interactions between the epidemiological evolution of COVID-19 and its effect on the economy. The unemployment and recovery rates were used for the study. It was indicated that the unemployment shock is partly influenced by COVID-19 infections and partly stochastic. Such analyses are very interesting and desirable, but the most commonly used variables date from the pandemic onset, making comparisons impossible, such as the number of confirmed COVID-19 cases and deaths variable used by Kong and Prinz (2020).

To summarise the literature review, several aspects should be pointed out. The first one is the necessity to conduct research concerning individual regions/countries because, as the authors point out, the type of restrictions introduced, regionalisation, demographic characteristics of the population, etc., significantly affect the labour market (Beland et al., 2020; Raimo et al., 2021; Li & Kapri, 2021; Davidescu et al., 2021). Therefore, the subject of this study was Poland. The second conclusion is related to the difficulty of obtaining data to analyse factors associated with COVID-19. It is problematic due to the lack of information to compare the period before and after the pandemic onset and limited access to datasets and long archiving or aggregation times. Therefore, one of the research objectives was to verify

whether the number of deaths is a variable that is significantly different before and after the pandemic and can be used in comparative analyses. This information was confirmed, which made it possible to conduct a correlation analysis between the number of deaths and selected unemployment indicators and infer the significance of this relationship, and finally, assess the extent to which the number of deaths affects the unemployment rate and the number of unemployed. If all these objectives are met, it will be possible to confirm the research hypothesis established in the introduction.

The study was conducted on the example of Poland, but it is possible to replicate the proposed methodology for any other country.

3. Results

3.1. Study of the number of deaths variable as an indicator of economic change

The study began by analysing the number of deaths variable to verify whether the pandemic outbreak significantly impacted it. The study sample was monthly data from 2012 to 2021, which means that 120 observations were analysed. The number of deaths by year and basic descriptive statistics are presented in Table. 1.

Table 1. Basic descriptive statistics of the deaths in Poland variable

year	mean	median	standard deviation	min	max
2012	31714	31875	1933	27553	34478
2013	31989	30882	3085	29438	40017
2014	30981	31116	1623	28181	33442
2015	33275	32476	2739	29626	38574
2016	31634	31493	1934	29298	34624
2017	32375	30626	4127	28585	43337
2018	32009	32758	3505	22356	36249
2019	34148	33357	2184	31611	38911
2020	39835	34927	10202	32570	64398
2021	40597	38698	7135	32971	54569

Table 1 shows that the mean and median values for 2019–2021 are significantly higher than those in the earlier period, which can also be seen in Figure 1.

Due to the high incidence of COVID-19 during the winter months, an analysis of the number of deaths by month was performed. Figure 2 presents a plot of the number of deaths in Poland in each month, divided into the period before and after the pandemic onset.

Figure 2 shows a clear seasonality in the number of deaths. They are highest in the winter months when the incidence of the respiratory disease tends to be higher, but the differences

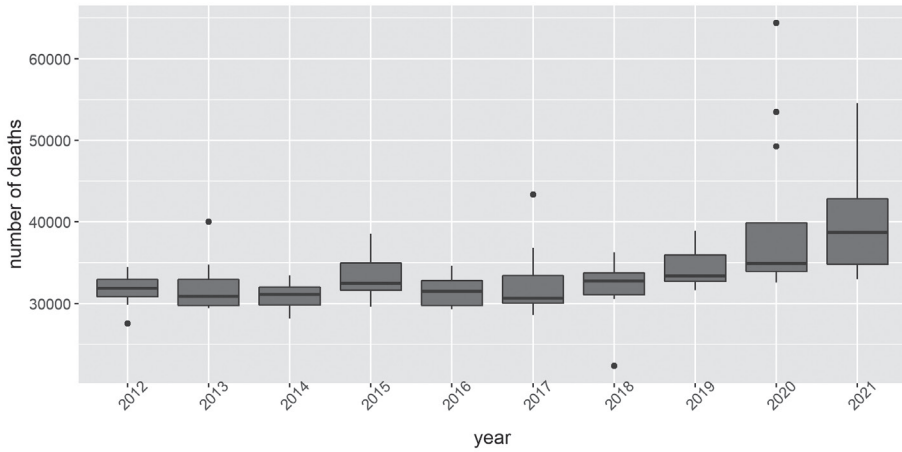


Figure 1. Box plot of the number of deaths in Poland

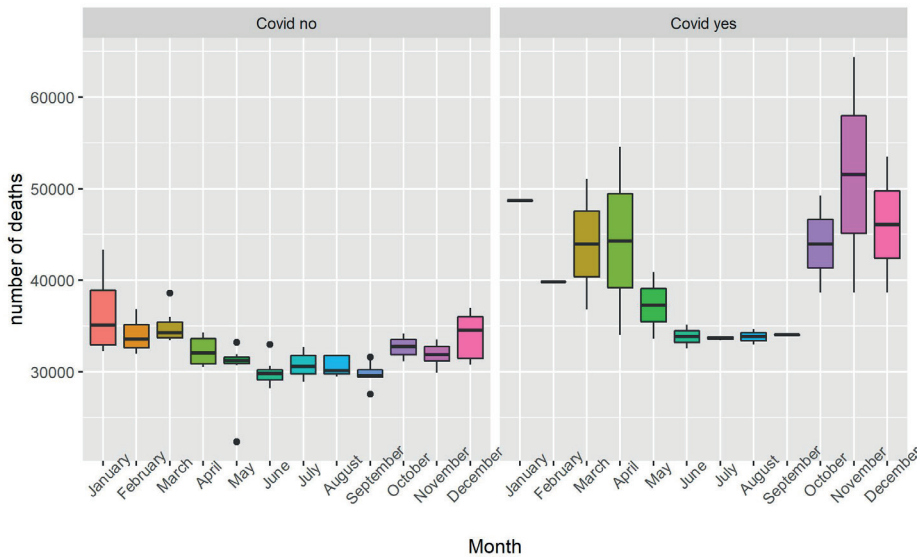


Figure 2. Box plot of the number of deaths in Poland

are much more pronounced compared to the pre-COVID period. The study adopted the COVID binary variable, which defines the periods before the pandemic (COVID no) and during the pandemic (COVID yes).

The assumption of a significant difference in the number of deaths in Poland before and after the pandemic onset was confirmed by statistical tests. Selection of a proper test requires

checking the normality of distribution of the variable in the group and the homogeneity of variance. The Shapiro-Wilk test was used to analyse the normality of the distribution. The goodness of fit of the distribution of deaths was not confirmed in either the pre-pandemic period ($W = 0.9443$, $p\text{-value} = 0.0004$) or post-pandemic onset ($W = 0.8138$, $p\text{-value} = 0.0008$). Homogeneity of variance was checked next. Levene's test was used for this purpose. Levene's test statistic was $F\text{ value}=32.079$ and $p\text{-value}=1.061 \cdot 10^{-7}$. It means that neither the condition of normality of distribution nor homogeneity of variance is satisfied, so the non-parametric Kruskal-Wallis test was used to check whether the COVID variable significantly affects the number of deaths. The Kruskal-Wallis test statistics: $\chi\text{-squared} = 30.255$, $df = 1$, $p\text{-value} = 3.788 \cdot 10^{-8}$, which means that the COVID variable significantly affects the number of deaths and can be a measure of changes occurring in the economy.

3.2 Analysis of selected factors related to unemployment in Poland

Unemployment is the phenomenon of a lack of gainful employment for those able and willing to work at typical wage conditions found in the economy (Blustein et al., 2020; Ganong et al., 2020; Baek et al., 2021). The main cause of unemployment is usually the insufficient number of job vacancies in relation to the number of applicants. Additional factors may include, for example, defective labour market organisation, lack of appropriate education and qualifications of the unemployed, and too low wage rates. However, unemployment is at its greatest during periods of economic crises.

Polish law defines an unemployed person as “not employed and not performing any gainful work, capable and ready to take up employment on a full-time basis in a given profession or service” (Dz.U. 2004, no. 99 item 1001). Based on this definition, indicators are determined that describe the labour market. In this paper, the following factors are selected to study unemployment in terms of COVID-19 (CSO, 2022): registered unemployed, the unemployment rate as of the end of the period, average employment in the enterprise sector, average real gross monthly salary in the enterprise sector, average nominal gross monthly salary in the enterprise sector.

The correlation coefficient was used to analyse the relationship between the number of deaths and the factors. The results of correlation coefficient calculations for the number of deaths before and after the COVID-19 pandemic, along with the results of statistical significance of the correlation coefficient, are presented in Table 2.

A comparison of the correlation coefficients is presented in Fig. 3.

Before the pandemic onset, the interdependence of all selected coefficients was very low; moreover, the significance test did not allow us to reject the null hypothesis that the population correlation coefficient is not significantly different from zero. Thus, there is no significant linear relationship in the population (at the $\alpha=0.05$ significance level). However, the results were presented mainly to provide background (reference point) to the situation after the pandemic. It was not the intention of the authors to indicate that increased death

Table 2. The coefficient of correlation of the number of deaths with selected measures and indicators before and after the pandemic onset

	number of deaths before COVID-19	p-value	number of deaths after COVID-19	p-value
number of unemployed	-0.089	0.383	0.433	0.044
unemployment rate	-0.105	0.306	0.440	0.041
employment	0.219	0.031	0.175	0.437
salary	0.019	0.856	0.360	0.100
nominal salary	0.252	0.052	0.235	0.292

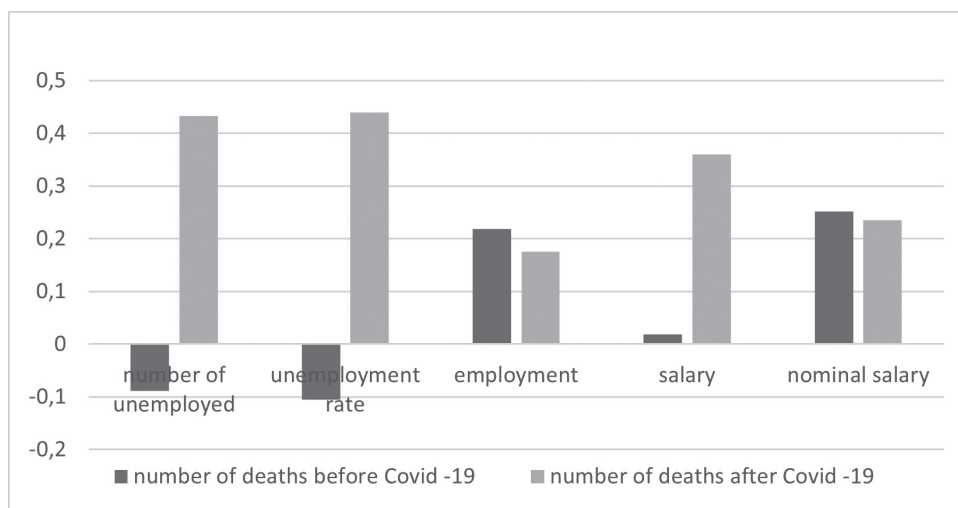


Figure 3. Comparison of the correlation coefficients

rates result in lower unemployment. The authors wanted to show that in the pre-pandemic period, the correlation coefficient was very small for all the variables studied, and in addition, there was a negative relationship for the number of unemployed and unemployment rate variables.

These results were supposed to provide a background for the results from the COVID-19 pandemic period, during which the relationship between the number of deaths and the number of unemployed and the unemployment rate was positive, i.e., changes caused by the pandemic significantly affected unemployment in Poland. In contrast, this relationship was previously slight and had a negative sign.

Following the pandemic onset, the largest increases in the correlation coefficient were seen for the number of unemployed and the unemployment rate. The correlation coefficient significance test's results further allowed the population's correlation to be considered significantly different from zero. These results imply that as the COVID-19 pandemic expressed by the number of deaths progressed, the number of unemployed and the unemployment rate increased. It is important to emphasise that the authors' assumption was to highlight the difference between the two periods, and not necessarily an accurate interpretation saying that in the pre-pandemic period, as the number of deaths increased, unemployment decreased, while it increased post-pandemic onset. Such conclusions would require deep and detailed analysis, which may be an extension of this study, but was not its primary purpose.

In order to set a forecast of how the labour market situation might evolve if the current trend of increasing pandemic deaths continues (currently, there is an increase in infections resulting from the spread of the SARS-CoV-2 variant called Omicron), a linear regression model was determined for the number of unemployed and the unemployment rate. The results for each model are presented in Table 3.

Table 3. Linear regression model parameters for the number of unemployed and unemployment rate

Number of unemployed model	Coefficients	p-value	Adjusted R-squared
Intercept	884.36	$8.33 \cdot 10^{-13}$	0.1472
Number of deaths	0.003	0.044	
Unemployment rate model	Coefficients	p-value	Adjusted R-squared
Intercept	5.32	$2.73 \cdot 10^{-13}$	0.1531
Number of deaths	0.00002	0.041	

The model has a low R-square coefficient of determination, which is obvious since the variables under study are also influenced by other factors not included in the model.

As part of the model verification, the distribution of residuals was analysed. The goodness of fit of the empirical distribution and the homoscedasticity of the variance and stationarity were tested. Shapiro-Wilk normality test and Lilliefors (Kolmogorov-Smirnov) normality test were used to test the normality of the distribution. Breusch-Godfrey test was used to test autocorrelation. The KPSS test was used to test the stationarity.

The results obtained for the number of the unemployed model did not allow us to reject the null hypothesis that the model's residuals come from a population with a normal distribution. The Shapiro-Wilk test statistic was $W = 0.9423$ and $p\text{-value} = 0.2207$ while the Lilliefors test was $D = 0.1171$ and $p\text{-value} = 0.6$. Also satisfactory are the results of the Breusch-Godfrey test, indicating a lack of autocorrelation of the model residuals (LM test

= 17.195, p-value = 0.1424). The results of the KPSS test did not provide a basis to reject the null hypothesis of stationarity of the series under study. The test statistic was 0.29442, while p-value = 0.1.

Satisfactory results were also obtained for the unemployment rate model. The distribution of residuals was found to follow a normal distribution (Shapiro-Wilk test statistic was $W = 0.9398$, p-value = 0.1962, and Lilliefors test statistic was $D = 0.1462$, p-value = 0.2551). Independence of residuals was confirmed by Breusch-Godfrey test (LM test = 16.227, p-value = 0.1811), while stationarity by the KPSS test (KPSS Statistic= 0.25437, p-value = 0.1). Thus, although the coefficient of determination is low, the model can be considered valid, especially since the authors intended to show the significant impact of the Covid-19 pandemic as expressed by the number of deaths on the number of unemployed and the unemployment rate. An increase in the number of deaths causes an increase in the values of the studied variables (Fig. 4), but this impact is not considerable, as shown by the coefficients of the regression model in Table 3. Therefore, it can be concluded that the measures taken by the state have been effective, and the policies to protect companies and workers have had the desired effect. Thus, it can be concluded that the COVID pandemic, expressed in this case by the number of deaths, has significantly, although slightly, translated into an increase in unemployment.

The analysis presented is obviously at a high level of generalisation, but this is what the authors intended. The article aimed to show that the number of deaths can be used

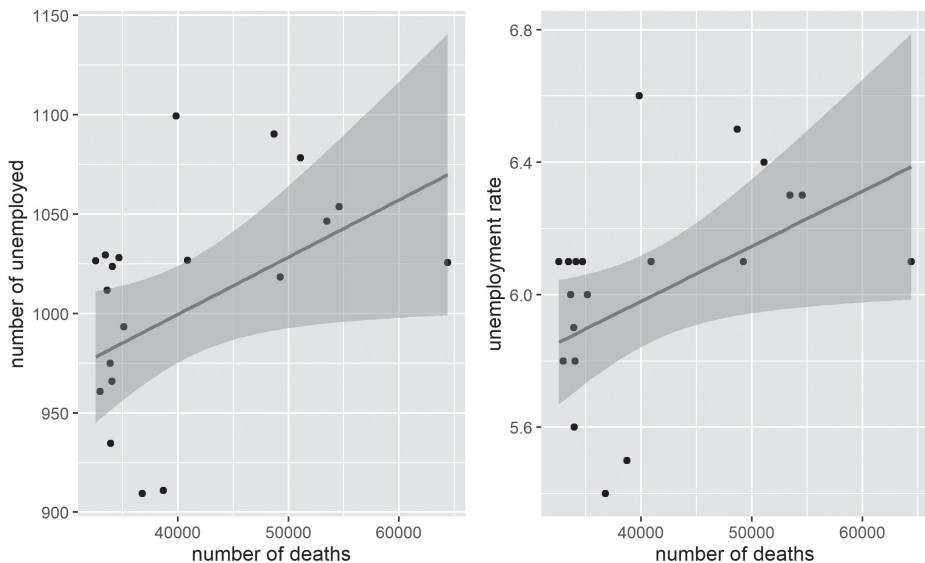


Figure 4. Comparison of two linear regression models

in research as a factor reflecting the dynamics of the pandemic and that, on its basis, it is possible to assess the correlation between the pandemic and the labour market condition. Further detailed research on the number of unemployed and the unemployment rate in the pandemic era will be done in future research papers.

4. Discussion

The analysis showed that the number of deaths is a variable that is significantly different between before and after the pandemic onset and can be used in analyses of the assessment of COVID-19 impact on selected factors. It resolved the first research question. Thus, it is possible to extend the analysis to studies covering a longer time horizon or to make comparisons constituting an alternative to the majority of studies presented in the literature that concern only the pandemic period. This conclusion enabled the authors to perform a correlation analysis between the number of deaths and selected unemployment rates and answer the second research question. Special attention has been given to the number of unemployed and unemployment rate variables. The analysis, divided into two periods, showed that in the pre-pandemic period, the correlation coefficient was not significantly different from zero, while in the pandemic period, its value, although small, proved to be statistically significant. These results imply that as the COVID-19 pandemic progressed, the number of unemployed and the unemployment rate increased. The regression model presented, showing a low but significant value of the estimated parameters, serves as a measure of this growth and an answer to the third research question. The research hypothesis was confirmed, and the stated objectives were met.

The results were mainly to serve as a general assessment of the situation and, above all, to show how the relationship between factors describing unemployment changed after the onset of the pandemic. In the pre-pandemic period, the correlation coefficient was very low and, in most cases, statistically insignificant, while during post-pandemic onset, this relationship was larger and statistically significant, especially for the number of unemployed and unemployment rate variables.

The study confirmed the literature trend toward increased unemployment due to the emergence of the SARS-CoV-2 virus. Additionally, it showed a difference between the pre-pandemic relationships (statistically insignificant) and post-pandemic onset relationships (statistically significant results). It highlights the importance of comparisons, as they also provide interesting findings and are overlooked in many studies.

5. Conclusions

Since 2020, the global socio-economic situation has been shaped by the COVID-19 pandemic. Introduced border restrictions and other closures of various industries, closed schools and universities, cancelled mass events, restrictions on movement, use of public transport, closure

of offices, and many other restrictions have brought significant consequences for human life and human functioning in society. Not surprisingly, it is the subject of intense analysis and investigation by scholars. This paper also fits into this trend by presenting a correlation analysis between the COVID-19 pandemic and selected unemployment indicators. The number of deaths was chosen as the variable determining the impact of the pandemic by proving beforehand that these values differ significantly when comparing the period before and during the pandemic. In the course of the study, it turned out that statistically significant values of the correlation coefficient were obtained only for the number of unemployed variable and unemployment rate variable. The positive result showed that the value of these coefficients increased with the number of deaths. The regression models developed helped to present that this increase is not considerable.

To summarise the study, it is necessary to conclude that the assumed objectives have been achieved. The authors' main intention was to show that the number of deaths is a variable that is significantly different between before and after the onset of the pandemic and that it can be used in analyses of the impact of COVID-19 on selected indicators, in this case, the labour market related ones. In this study, it was used in correlation analysis. It allowed us to show significant differences in the relationships between the variables in the two study periods. Such comparative analysis is less common in the literature, as studies often date from the pandemic onset. Meanwhile, providing context is also valuable and provides interesting conclusions.

The research hypothesis was confirmed. The analysis can also be used with other spheres of society – social, economic and other, also in other states.

As an additional conclusion from the study, it can be assumed that the programmes introduced by the Polish government to help employees and companies survive in the labour market proved to be successful in many areas, and the changes in the Polish market are not as drastic as in other countries presented in the literature review. In Poland, the government introduced the so-called anti-crisis industry shield in response to the situation. It is a package of solutions aimed at protecting the Polish state and its citizens from the crisis caused by the coronavirus pandemic. It consisted of five pillars within which actions were taken. These were: protecting jobs and employees' safety, financing entrepreneurs, health care, strengthening the financial system, and public investments. These pillars included measures such as subsidising salaries and social security contributions from the state budget, cash grants for companies, stoppage allowances for entrepreneurs who cannot operate due to the state of the epidemic, reduced working hours or implementing remote work.

The virus is constantly spreading and mutating, causing increased deaths, changing society's life and functioning in almost every area. Analyses similar to the one presented in the paper explore the knowledge of its impact on selected economic sectors and support inference in this regard. They also provide a basis for further reflections on this subject.

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