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The Impact of Covid-19 Dynamics on SCDS Spreads in Selected CEE Countries

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Abstract:

Purpose: *The paper fits into the current of research of the use of SCDS spreads as a country credit risk assessment tool. The main objective of the study is to investigate the impact of the Covid-19 pandemic on the level of credit risk, measured by SCDS spreads in selected CEE countries. The study hypothesized that Covid-19 dynamics in Hungary, Poland, Russia and Slovakia moderately contributed to the assessment of country credit risk, measured by SCDS spreads.*
Design/Methodology/Approach: *The study uses source literature analysis and quantitative research: time series analysis and multiple linear regression analysis. The time series analysis made it possible to study the dynamics and directions of changes in SCDS spreads and Covid-19. Linear regression analysis was used to investigate the correlation between SCDS spreads and the Covid-19 pandemic.*
Findings: *The results of the research confirmed the hypothesis. Studies have shown that the strength of the correlation between SCDS spreads and Covid-19 factors (such as cases, deaths, tests or Covid-19 vaccinations) is weak.*
Practical Implications: *The article will define the determinants of the impact of the pandemic on the credit risk assessment of selected CEE countries. These determinants include the number of Covid-19 cases, test, deaths, and Covid-19 vaccination, as well as the rate of Covid-19 spread and the level of restrictions. This study will contribute to a better understanding of the credit risk assessments of selected CEE countries in health crisis context*
Originality/Value: *Based on the analysis of the literature, a research gap was identified in terms of the impact of Covid-19 pandemic on the assessment of credit risk of selected CEE countries. This study will contribute to the knowledge on the correlation between SCDS spreads of these countries and pandemic indicator. The study also contributes to the discussion on the use of SCDS spreads to assessment credit risk during crises.*

Keywords: *SCDS, credit risk, CEE countries, Covid-19, pandemic.*

JEL Classification: *E50, G00, G01, G10, H50, H69.*

Paper Type: *Research Paper*

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1. Introduction

The sudden supply and demand shock caused by the outbreak of the Covid-19 pandemic has had a negative impact on economic processes in all regions of the world. The first case of the new Covid-19 strain was reported in Wuhan, China, on November 17, 2019 (Ma, 2020). The disease then spread very rapidly around the world, and in March 11, 2020, the World Health Organization (WHO) declared Covid-19 to be a pandemic (WHO, 2020). The increase in Covid-19 cases around the world, combined with restrictions on movement, has disrupted supply chains and, in extreme cases, even shut down individual economic sectors, depriving people of the opportunity to earn a living. This shows that the Covid-19 pandemic has not only affected the behaviour of the general population and businesses, but also government decisions. Governments are obliged to provide their citizens with healthcare (e.g., purchase of medical equipment) and financial security (implementation of assistance systems aimed at protecting the economy and preventing unemployment). As a result, public debt has been increasing while at the same time GDP has been decreasing. This situation may increase a country's credit risk.

Sovereign credit default swaps (SCDS spreads) are an important instrument for measuring a country's credit risk. The increase in credit risk resulting in the threat of a country's bankruptcy is reflected in rising SCDS spreads, and vice-versa. Thus, the analysis of the impact of the Covid-19 pandemic on SCDS spreads is motivated by the effectiveness of these instruments in assessing state debt.

Undertaking research on the impact of Covid-19 dynamics on SCDS spreads is also justified by the existence of a research gap in the determination of Covid-19 factors affecting the market of these instruments in selected CEE countries (Hungary, Poland, Russia and Slovakia). This gap is addressed with the use of multiple linear correlation analysis. The paper also uses time series analysis, which contributes to the investigation of the dynamics and directions of changes in indicators reflecting Covid-19 dynamics and SCDS spreads. Due to the fact that in individual CEE countries the date of the Covid-19 outbreak varied, the beginning of the research was assumed to be March 1, 2020. The end of the research was on September 30, 2021.

The main objective of the study is to examine the impact of Covid-19 dynamics on credit risk measured by the SCDS spreads of the following countries: Hungary, Poland, Russia and Slovakia. This goal will be achieved by:

- Determining the credit default swaps spreads based on 5-year treasury bonds (SCDS),
- Studying the dynamics of changes in SCDS spreads,
- Determining the dynamics of Covid-19 indicators,
- Identifying the determinants of changes in SCDS spreads.

The study hypothesizes that Covid-19 dynamics in Hungary, Poland, Russia and Slovakia moderately contributed to the assessment of country credit risk, measured by SCDS spreads. This paper contributes to the literature on the credit risk of selected CEE countries as measured by the SCDS of this country during Covid-19.

2. Literature Review

Analysis of the source literature was based on two aspects, the study of SCDS spreads as country credit risk pricing tools, and of Covid-19 implications. Many authors have paid attention to the possibility of reflecting economic fundamentals in SCDS spreads (Eichengreen, *et al.,* 2012; Dieckmann and Plank, 2012; Piotrowski and Piotrowska, 2013; Czech and Pyka, 2018). For this reason, much of the literature mainly focuses on correlation analysis of SCDS spreads with various indicators. Pongsiri (2015) analysed the relationship with public debt, Aizenman, *et al.* (2013) and Czech (2019) investigated the impact of inflation on SCDS, Ericsson *et al.* (2016), and Fontana and Scheicher (2016) analysed SCDS with regard to risk-free interest rates.

On the other hand, Yuan *et al.* (2017) and Liu and Morley (2012) studied the effect of exchange rates on SCDS, Longstaff *et al.* (2011) investigated the correlation of stock market indices and SCDS, while Camba-Méndeza and Serwa (2016), Alper *et al.* (2013) and Heinz and Sun (2016) checked the impact of the VIX index on SCDS. Meanwhile, Kliber (2019) analysed the correlation between SCDS and bonds, currencies and the stock market, and examined the strength of the correlation during the financial crisis. They found a varying correlation between SCDS and other domestic financial markets depending on the liquidity and maturity of the markets analysed.

Recent studies have very often highlighted the varying impact of macroeconomic and global factors on SCDS. Kotsis (2014), for example, analysed national, regional and global financial market indicators, and showed that SCDS are susceptible to global factors. Similar results were obtained by Chi *et al.* (2021), who examined emerging market SCDS spreads under the influence of good and bad news from the US. Their results show that US good news contributes to a decrease in SCDS spreads, while bad news increases SCDS spreads.

The dependence of emerging market SCDS spreads on global, regional, national and local factors was also investigated by Ma *et al.* (2018). They found that global variables, such as the US stock index return, have a stronger impact on SCDS during periods of economic downturn. In contrast, during periods of stability, other variables such as the change in the exchange rate, the return on a local stock index, or the change in a country's credit rating, have a stronger impact on SCDS.

Surveys such as that conducted by Czech (2019) have shown the impact of macroeconomic and global factors on SCDS spreads in twenty countries from

around the world. The results showed that SCDS spreads in almost all countries are susceptible to both macroeconomic and global factors. The exception were China's SCDS spreads, which were uncorrelated with macroeconomic factors but correlated with global factors. In addition, Czech (2019) also showed that there are interrelationships between SCDS spreads.

Much of the current literature on the present health crisis pays particular attention to the implications of the Covid-19 pandemic. Dineri and Çütçü (2020) studied the impact of new cases and new deaths from Covid-19 on the exchange rate in Turkey. They showed a correlation between these variables.

The impact of the Covid-19 pandemic on exchange rates was also studied by Villarreal-Samaniego (2020) and Iqbal *et al.* (2020). Villarreal-Samaniego (2020) demonstrated that in several cases, there was a relationship between the exchange rate and the dynamics of Covid-19 variables, e.g., there was correlation between Covid-19 and both the Brazilian Real (BRL/USD) and the South African Rand (ZAR/USD), but there was no correlation between Covid-19 and the Russian Rouble (RUB/USD).

Other studies have considered the relationship between credit default swap (CDS) spreads and Covid-19. For example, Agca *et al.* (2021) examined the impact of credit risk as measured by CDS in the supply chain during different phases of the COVID-19 pandemic. They found that supply chain credit risk increases for firms with high inventory turnover, while it decreases for those with higher inventory buffers, longer operating cycles and longer lead times.

Andrieș *et al.* (2020) analysed the impact of general Covid-19 lockdown measures in Italy on the CDS of European banks. They verified that Covid-19 did not increase banks' credit risk, as measured by SCDS.

Other studies, such as that conducted by Andrieș *et al.* (2021), have shown that the increase in SCDS of European countries is due to increased investor uncertainty in European Treasury bonds. In line with these studies, this uncertainty is due to increased numbers of cases and deaths from Covid-19.

From the point of view of this paper, the most important factor is the impact of the Covid-19 pandemic on sovereign credit default swap spreads (SCDS spreads). Factors thought to influence CDS spreads during Covid-19 have been explored in several studies. Jinjarak et al. (2021) examined the correlation between Covid-19 events and related policy responses on sovereign debt valuations in the Euro Area. They investigated the following Covid-19 variables, stringency indices and daily mobility and policy interventions. They found that during the Covid-19 pandemic, SCDS spreads may have been significantly affected by mortality outcomes and fiscal responses in individual countries. They also demonstrated a lack of correlation between the Eurozone SCDS and the Stringency Index and mobility measures.

Similar results were obtained by Daehler *et al.* (2021), who studied SCDS spreads in emerging markets. Their research also showed that cumulative Covid-19 mortality rate growth is positively related to the SCDS spreads of emerging markets. Work on SCDS and the Covid-19 relationship was also undertaken by Kartal (2020). Kartal analysed the behaviour of SCDS in Turkey during the Covid-19 pandemic, and concluded that SCDS in Turkey fluctuate with changes in numbers of new deaths and new cases of Covid-19. He also found that cumulative cases, cumulative deaths and restrictions had no effect on Turkey's CDS spreads.

A study into the impact of Covid-19 on SCDS spreads was also carried out by Pan et al. (2021). They analysed SCDS and Covid-19 cases and the influence of policies adopted in response to Covid-19 by governments from 78 developed and developing countries. They found that SCDS increased during periods when the Covid-19 pandemic became more severe. In addition, they investigated whether the impact of the Covid-19 pandemic on SCDS spreads is stronger in developing countries and countries with worse healthcare infrastructure. Also, Cevik and Öztürkkal (2021) investigated the impact of infectious diseases, included Covid-19, on the SCDS of 77 countries, in the period 2004-2020. They found that especially in the initial phase of the outbreak, Covid-19 had a significant impact on SCDS in all countries.

However, in contrast to previous studies, their analysis showed that the impact is more intense in developed economies. The results of the literature survey indicate that the source literature does not address issues related to the study of the impact of the pandemic on SCDS spreads in CEE countries. Therefore, a research gap has been demonstrated to exist.

3. Research Methodology

In the study, time series analysis, comparative analysis and multiple linear regression analysis were used. In the time series analysis, the dynamics and directions of Covid-19 indicators and SCDS spreads were examined. For this purpose, a multiplicative linear time series model was built, and then the main trend was determined using the analytical method, which was described by the following formula:

$$\hat{Y} = b_1 * t + b_0 \quad (1)$$

Where: $\hat{Y}$ – trend; b_0 and b_1 – model parameters; t – time

The trend function determines the changes in SCDS spreads with respect to the time variable. The trend model parameters (b0 and b1) were estimated using the least squares method (LSM):

$$b_1 = \frac{n\sum_t^n yt*t - \sum_t^n yt*\sum_t^n t}{n\sum_t^n t^2 - (\sum_t^n t)^2} \quad (2)$$

$$b_0 = \bar{y} - b_1\bar{t} \quad (3)$$

Where: yt - SCDS spreads in period t; t - number of consecutive units of time; $\bar{y}$ - average SCDS spreads in period t; $\bar{t}$ - average value of time units.

The main analysis applies a multiple linear regression analysis method to investigate the correlation of SCDS spreads based on five-year treasury bonds in Hungary, Poland, Russia and Slovakia against that of Covid-19 dynamics. In the analysis process, four multiple linear regression models were built, one for each of the selected countries. The dependent variables ($\hat{Y}$) were:

1. Hungary SCDS spreads
2. Poland SCDS spreads
3. Russia SCDS spreads
4. Slovakia SCDS spreads

Meanwhile, the independent variables (X) that characterize Covid-19 pandemic dynamics in these countries include:

1. New Covid-19 cases (X1)
2. Total Covid-19 cases (X2)
3. Total Covid-19 deaths (X3)
4. New Covid-19 deaths (X4)
5. ICU Covid-19 patients (X5)
6. Patients hospitalized with Covid-19 (X6)
7. New Covid-19 tests (X7)
8. Total Covid-19 tests (X8)
9. People vaccinated with at least one dose against Covid-19 (X9)
10. People fully vaccinated against Covid-19 (X10)
11. Reproduction rate (R number) (X11) – which measures the ability of the coronavirus to spread. R is the average number of people infected by one infected person, e.g. the number R-10 means that on average one person transmits the coronavirus to 10 other people
12. Stringency index (X12) – the index is calculated on any given day as the mean score of the nine following metrics: school closures; workplace closures; cancellation of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls.

The analysis was conducted on a sample of 2,320 observations of SCDS spreads (580 observations for each country), and more than 30,000 observations of selected indicators characterising the development of the Covid-19 pandemic (580 observations for each indicator).

In the linear regression analysis, the progressive stepwise regression method was used. In building the model, all the above-mentioned indicators were considered, but only those that were statistically significant were entered into the model. Statistical significance was assessed using the t-test, assuming a maximum 5% probability of error in the conclusions. Thus, those variables whose value was higher than the critical value resulting from the Student's t-distribution at the alpha level < 0.05 were considered statistically significant. Then, after all statistically significant variables had been included in the model, the linear significance for the entire constructed model was tested using the F test statistic.

The estimated linear regression model was described by the equation:

$$\hat{Y} = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + \ldots + b_{12}x_{12} + \zeta \quad (4)$$

where: b_i - partial regression factors, model parameters representing independent variables affecting SCDS spreads based on 5-year treasury bonds.

The application of the multiple linear regression model provided an answer to the question of whether the pandemic affected the country credit risk, in selected CEE countries, measured by the SCDS spreads. Comparative analysis was applied to confront the obtained research results in the four CEE countries and to find an answer to the question whether the pandemic has significantly affected the increase in credit risk in the countries studied.

4. Results

4.1 Dynamics Analysis Results

First, the dynamics of the Covid-19 pandemic were examined as well as the direction, and then the dynamics of SCDS spreads. The data was collected from CBONDS, World Government Bonds, Asset Macro and Our World in Data. We use the daily data of the following indicators to characterize the dynamics of the Covid-19 pandemic:

1. Total Covid-19 cases,
2. Total Covid-19 deaths,
3. People fully vaccinated against Covid-19.

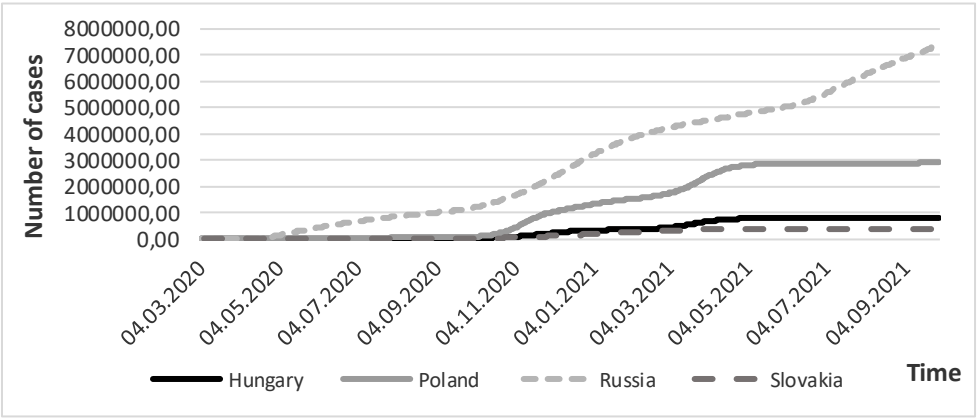
Figures 1 and 2 show a steadily increasing trend in the number of cases and the number of deaths from Covid-19 in all the countries studied. In the initial period of the pandemic, both the number of cases and the number of deaths remained at a similar, relatively constant level. In contrast, an marked increase in these rates was observed in the subsequent period. Figure 1 shows that the number of Covid-19 cases in individual countries increased unevenly, and the increase was spread over time.

The earliest dynamic increase in the number of Covid-19 cases was observed in Russia - in May 2020, and in Poland - in October 2020. In Russia, the upward trend in the number of Covid-19 cases continued until the end of September 2021 (an increase of more than 2,100% from May 21, 2020 to September 30, 2021).

In contrast, in Poland, the trend was upward, but from May 2021, the Covid-19 incidence curve reduced and remained at a relatively constant level until the end of the research period (September 30, 2021). During this period, from October 1, 2020 to September 30, 2021, the number of Covid-19 cases in Poland increased by over 665%.

In other countries (Hungary and Slovakia), a greater increase in the number of Covid-19 cases was not recorded until March 2021, but it was not as intense as in Russia and Poland. From March 1, 2021 to September 30, 2021, the number of Covid-19 cases in Hungary increased by 90%, while in Slovakia it increased by only 33.53% (Figure 1).

Figure 1. *Total Covid-19 cases*

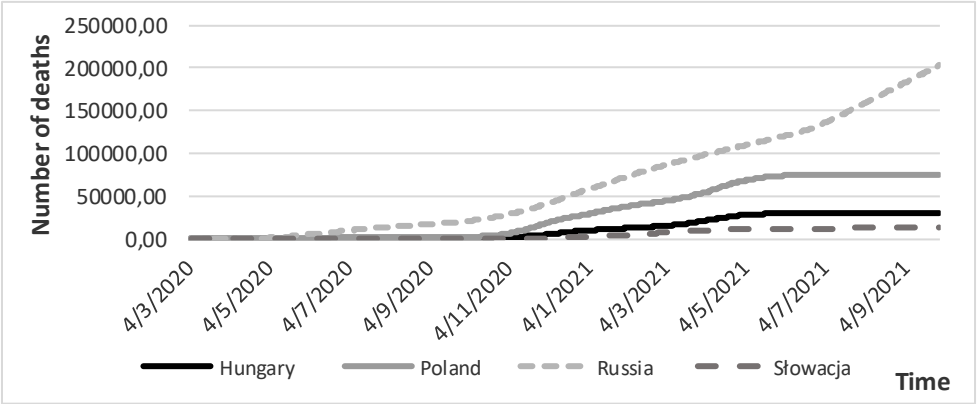


Source: *Own calculations, based on Our World in Data.*

A similar situation was observed in the number of deaths from Covid-19. This variable also shows that the intense increase in the number of Covid-19 deaths in individual countries was staggered over time. At the beginning of the pandemic, the number of deaths from Covid-19 remained relatively constant, while an intense increase in deaths was recorded in the period from the second wave of the pandemic - from November 2020.

Since then, until the end of the research period (September 30, 2021), the dynamics of the number of deaths from Covid-19 increased the most in Slovakia - over 2,600% and in Hungary - over 980%. On the other hand, the lowest dynamics of deaths from Covid-19 was observed in Poland (733%) and Russia (541%) (Figure 2).

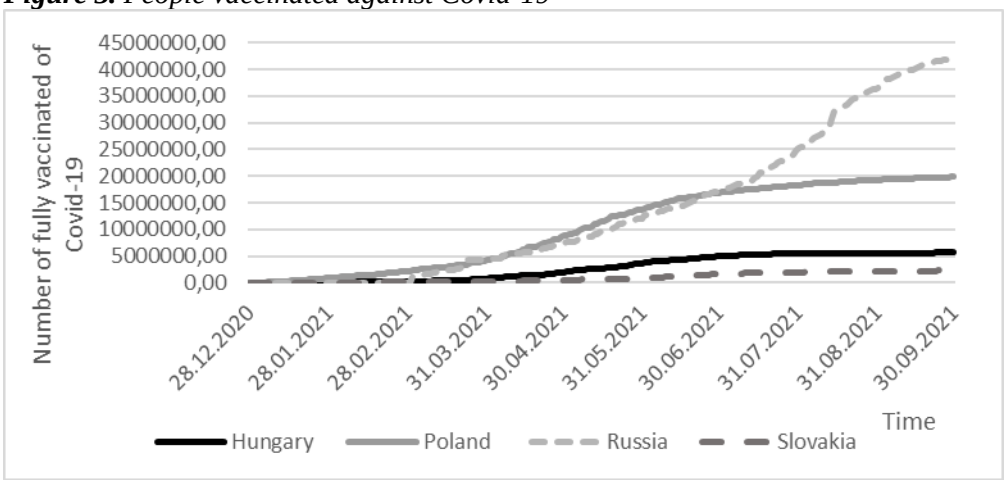
Figure 2. *Total Covid-19 deaths*



Source: *Own calculations, based on Our World in Data.*

Figure 3 compares the number of people vaccinated in the countries studied. The results obtained from the analysis indicate that as of September 30, 2021, the highest number of vaccinated people was in Russia and Poland. Covid-19 vaccinations started at the turn of the year 2020 and 2021. According to the data collected in Our World in Data, the earliest vaccinations started in Poland (December 28, 2020), then in Slovakia (January 4, 2021) and Hungary (January 01, 2021), and the latest in Russia (March 2, 2021). Due to the low supply of vaccines, the number of vaccinated people remained stable until the end of March 2021, but then increased rapidly. In Russia, the upward trend continued until the end of the research period, but in the other countries the curve of the number of vaccinated persons slowed down at the turn of June and July and then remained constant (Figure 3).

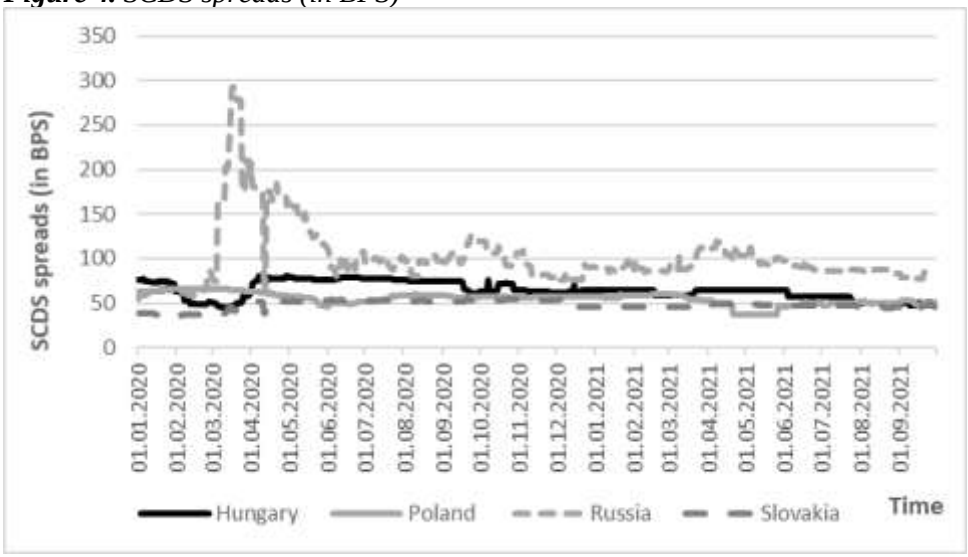
Figure 3. *People vaccinated against Covid-19*



Source*: Own calculations, based on Our World in Data*

Next, based on the SCDS spreads of Hungary, Poland, Russia and Slovakia, the credit risk of these countries was measured. The study results show that in individual countries the response of SCDS spreads to the outbreak of the Covid-19 pandemic was not the same. However, as time passed, the trend of the formation of SCDS spreads was convergent. The discrepancies in the studied spreads in the first wave of the pandemic wave are justified by the growing panic resulting from the uncertainty and ignorance of the nature of the Covid-19 pathogen (Norman *et al.*, 2020). In Figure 4, from February 25, 2020 to March 11, 2020, there is a clear trend of increasing SCDS spreads in Russia (212.56%) and Slovakia (31.65 %), and a slight increase in SCDS spreads in Poland (1%), while Hungarian SCDS showed a downward trend over the same period (-9.15%) (Figure 4).

Figure 4. *SCDS spreads (in BPS)*



Source: *Own calculations, based on CBONDS, World Government Bonds, Asset Macro*.

Figure 4 shows that after the initial shock of the pandemic, SCDS spreads started to return to a relative equilibrium. Throughout the pandemic (1.03.2020 - 30.09.2021), there is a clear decreasing trend. The decrease in SCDS spreads is also confirmed by the mathematical trend analysis, on the basis of which the main trend of SCDS spreads in the individual countries was determined:

$$Y_{Hungary} = - 0.0359x + 1648.6$$
$$Y_{Poland} = - 0.0225x + 1048.1$$
$$Y_{Russia} = - 0.1214x + 5470.8$$
$$Y_{Slovakia} = - 0.0108x + 527.44$$

The trend analysis confirmed that SCDS spreads in all the studied countries showed a declining trend throughout the research period. The largest decline was in Russia, where SCDS spreads fell from period-to-period by 0.12 bps on average. In contrast,

the smallest decline was in Slovakia, where SCDS spreads fell from period-to-period by 0.01 bp on average. The research results indicate that despite the negative effects of the Covid-19 pandemic, the credit risk of Hungary, Poland, Russia and Slovakia decreased.

4.2 Linear Regression Analysis Results

The size of SCDS spreads reflects the level of a country's debt in relation to its ability to service it. The study raises the question of whether the dynamics of the pandemic have directly resulted in changes in SCDS spreads in Hungary, Poland, Russia and Slovakia, and thus whether they have affected the credit risk assessment of these countries. Research was therefore conducted to determine the impact of factors showing the dynamics of the pandemic on SCDS spreads. Four multiple linear regression models were therefore built, one for each selected CEE country.

The study shows that the Covid-19 dynamics in Hungary, Poland, Russia and Slovakia have had little impact on the SCDS spreads of these countries. A large variety was demonstrated in terms of the impact of individual determinants on SCDS spreads in the countries. The results of the analysis show that the strongest influence on SCDS spreads was exerted by Covid-19 dynamics in Hungary (75% of the analysed indicators), followed by Slovakia (58% of the examined indicators), Poland (42% of the examined indicators) and Russia (33% of the analysed indicators). The results of the study also show that the strength and direction of the impact of the individual determinants in the studied countries is not the same. This is confirmed by the parameters of the independent variables (Table 1).

Table 1. *Linear regression analysis results*

Dependent variables SCDS spreads	Estimates of Regression Coeficients											
	New Covid-19 cases	Total Covid-19 cases	Total Covid-19 deaths	New Covid-19 deaths	ICU Covid-19 patients	Patients hospitalized with Covid-19	New Covid-19 tests	Total Covid-19 tests	People vaccinated with at least one dose against Covid-19	People fully vaccinated against Covid-19	Reproduction rate	Stringency index
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
Hungary	0.01	0.001	0.002	-0.02		0.002		-0.001	-0.001	0.0001	-9.45	
Poland	-0.01			0.01		0.001					19.4	0.14
Russia	-0.001	0.006						-0.001		0.0001		
Slovakia	0.001	-0.001	0.01			0.006	0.0001			0.0001	-2.9	

Source: *Own calculations, based on CBONDS, World Government Bonds, Asset Macro and Our World in Data.*

It can be seen from the data in Table 1 that the strength of the correlation between Covid-19 dynamics and SCDS spreads is weak. Thus, the study supports the thesis

that changes in the dynamics of the pandemic in these countries moderately contribute to the credit risk assessment measured by SCDS spreads. The results reveal that an increase in the number of Covid-19 cases by one person increases the SCDS spreads in Hungary by 0.01 bp. An even lower impact of this indicator on SCDS spreads was demonstrated in Slovakia (0.001 bps).

As can be seen from Table 1, in Poland and Russia a negative correlation was found between new cases of Covid-19 and SCDS spreads, and at the same time it was confirmed that the strength of this correlation is equally weak (0.01 bps in Poland and 0.001 bps in Russia) (Table 1). Similar results were obtained for the total Covid-19 cases variable. The results, as shown in Table 1, indicate that the total number of Covid-19 cases has an equally limited impact on SCDS spreads in Hungary, Russia and Slovakia, while in Poland the correlation of these two variables is not present at all.

Table 1 illustrates the result of the correlation between SCDS spreads and the total Covid-19 deaths and new Covid-19 deaths. These results suggest that the impact of both variables on SCDS spreads is insignificant. This is evidenced by both the extent of the impact of the variables, as well as by the parameters of these variables. Comparing the two results, it can be seen that the range of impact of both variables is the same 50% of the countries. Total Covid-19 deaths show a positive correlation with Hungary SCDS spreads and Slovakia SCDS spreads.

On the other hand, new Covid-19 deaths correlate with Hungary SCDS spreads and Poland SCDS spreads, but in this case the direction of the correlation is different. It is also apparent from the table that no significant differences were found between the strength of the relationship between SCDS spreads and Covid-19 variables. This is confirmed by the parameters of these variables: an increase in total Covid-19 deaths by one unit increases the SCDS spreads in Hungary by 0.002 bp, and in Slovakia by 0.02 bp, while an increase in new Covid-19 deaths by one unit causes a decrease in SCDS spreads in Hungary by 0.01 bps and an increase in SCDS spreads in Poland by 0.01 bps (Table 1).

The research also showed a negative correlation of SCDS spreads with total Covid-19 tests. This situation can be explained in that increasing the number of tests performed reduces the number of people suffering from Covid-19. It should be emphasized, however, that such a correlation was found in Hungary and Russia. Table 1 also reflects the mutual positive correlation of SCDS spreads in Slovakia and new Covid-19 tests. The results obtained from analysis of the correlation indicate that the strength of this correlation is negligible (0.0001 pb).

At the same time, the results of the correlational analysis show that the introduction of further restrictions to prevent the spread of Covid-19 have no significant impact on SCDS spreads. The stringency index was found to have a positive impact only on Poland SCDS spreads (0.14 bp). This is quite a surprising discovery, because the

threat of temporary exclusion from professional and social life causes a decrease in demand and supply of goods and services, and as a result, generates the need for government debt with a simultaneous drop in GDP.

Most surprising are the correlation results between SCDS spreads, the number of people fully vaccinated against Covid-19 and those vaccinated with at least one dose against Covid-19. There was a slight correlation between these variables, although the direction of these correlations is different. An increase in the number of people vaccinated against Covid-19 should be a factor that prevents the transmission of Sars-Cov-2 virus, thus avoiding the temporary exclusion of vaccinated people from economic and social life.

The strongest correlation was found between the reproduction rate and SCDS spreads. The research has shown that the direction of the impact of this indicator on SCDS spreads varies. In the case of Hungary and Slovakia there is a negative correlation. This means that an increase (decrease) in the reproduction rate by one unit will cause a decrease (increase) in SCDS spreads by 9.5 bps (Hungary) and 2.9 bps (Slovakia). Interestingly, in the case of Poland, the situation is different and there is a relatively strong positive correlation: an increase in the reproduction rate by one unit will cause an increase in SCDS spreads by over 19.4 bp. It should be emphasized that according to the generally accepted scale for assessing the strength of the correlation, | 0.0 - 0.2 | this is very weak (Pułaska-Turyna, 2008).

The research results confirm that all the constructed multiple linear regression models are statistically significant. This is indicated by the results of the assessment of the significance of the model parameters (Table 2).

Table 2. *Evaluation results of the significance of the parameters of the multiple linear regression model*

Dependent variables. SCDS spreads	Model adjustment parameters				
	Determination coefficient R^2	Estimation error	F-test statistic value	Test probability level ($p<0,05$)	T-test statistic value (intercept term)
Hungary	0.8646	1.96	135.1	0.0000	120.59
Poland	0.5272	6.67	45.83	0.0000	20.74
Russia	0.6511	6.10	51.38	0.0000	823.54
Slovakia	0.8141	1.36	138.37	0.0000	120.24

Source: *Own calculations, based on CBONDS, World Government Bonds, Asset Macro and Our World in Data.*

The coefficient of determination R^2 indicates what percentage of the variation in SCDS spreads (dependent variables) was explained by the variability of the independent characteristics. The estimation error reveals the average difference between the observed values of the dependent variable and the theoretical values. The value of the F statistic shows the significance of the model components if F = 0,

then the model components are irrelevant, and if $F \neq 0$, the components are significant. The value of the t statistic (intercept term) underlines the significance of the model. If the intercept is significantly different from zero, the model is statistically significant.

Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε. shows that all four regression models are statistically significant. This is confirmed by the values of the F statistic of the individual models (ranging from 45.83 – 138.37) and $p < 0.05$. The level of the coefficients of determination in all four models are diverse.

The lowest R^2 applies to Poland (0.5272), while the highest is for Hungary (0.8646), which means that the models explain more than 52% (in the case of Poland) and more than 86% (in the case of Hungary) of the changes in SCDS spreads. The other two models explain 65.11% (in the case of Russia) and 81.41% (in the case of Slovakia) of the changes in SCDS spreads. Moreover, the standard errors of evaluating intercept terms in relation to their values in individual models differ significantly from zero, which confirms that the models are statistically significant.

5. Discussion

The research is part of the discussion on the impact of the Covid-19 pandemic on the credit risk of selected CEE countries, measured by SCDS in Hungary, Poland, Russia and Slovakia. The study uses both literature analysis and quantitative research. Based on the literature analysis, it has been shown that SCDS are used to measure a country's credit risk. It has been demonstrated that SCDS spreads are influenced not only by macroeconomic factors, such as public debt (Pyka and Czech, 2018; Pongsiri, 2015), inflation (Aizenman *et al.*, 2013) or a risk-free interest rate (Ericsson *et al.*, 2016), but also factors related to the development of the Covid-19 pandemic (Jinjarak *et al.*, 2021; Daehler *et al.*, 2021; Pan *et al.*, 2021).

More recent attention by researchers has also focused on the impact of the pandemic on economic variables, including SCDS spreads. Most studies have examined the impact of Covid-19 cases, Covid-19 deaths, or the restrictions on economic indicators such as exchange rates or the credit risk of businesses. Most of these studies indicate that the pandemic affects economic indicators (Agca *et al.*, 2021; Dineriand& Çütçü, 2020; Iqbal *et al.*, 2020), while some studies do not confirm this, or confirm it partially (Andrieș *et al.*, 2020; Villarreal-Samaniego, 2020).

Prior studies that noted the importance of Covid-19 mortality rates (Jinjarak *et al.*, 2021; Daehler *et al.*, 2021) were not confirmed in this study. On the other hand, the results of the study published by Kartal (2020) were partially confirmed. These proved that SCDS spreads in Turkey are affected by changes in the number of new deaths, but that the number of cumulative deaths does not affect the spreads studied. In this study, regression analysis showed that total Covid-19 deaths and new Covid-19 deaths contribute negligibly to changes in SCDS spreads. A change in total

Covid-19 deaths contributes 0.002 bps to changes in SCDS spreads in Hungary and 0.01 bps in Slovakia. In contrast, new Covid-19 deaths contribute to a change in SCDS spreads in Hungary by -0.02 bps and in Poland by 0.01 bps The results of the study also indicate a medium range (50%) of these two variables in CEE countries.

In contrast to earlier findings (Kartal, 2020), however, no evidence of a correlation between SCDS spreads and new Covid-19 cases was detected. The current study found that a change in the number of new Covid-19 cases by one unit results in a very small change in SCDS spreads in all the countries, in Hungary by 0.01bps, in Slovakia by 0.001 bps, in Poland by -0.01 bps, and in Russia by -0.001 bps (Table 1). Similar results were obtained for the total Covid-19 cases variable. The results, as shown in Table 1, indicate that total Covid-19 cases have a small effect on SCDS spreads in Hungary, Russia and Slovakia, but in Poland the correlation between these two variables does not occur at all. These results match those observed in earlier studies (Kartal, 2020).

The results obtained in this study also correspond with the results of Jinjarak *et al.* (2021) in terms of the correlation of SCDS spreads and the Stringency Index. Both studies showed no correlation between these variables. Moreover, prior studies have noted that in the initial phase of the pandemic, Covid-19 dynamics had a significant impact on CDS spreads for all countries, which is confirmed by our results.

Contrary to expectations, this study found no significant correlation between SCDS spreads and Covid-19 dynamics. It is somewhat surprising that although the Covid-19 pandemic has negatively affected countries' economic processes, remedial measures such as the restrictions introduced or the number of people vaccinated against Covid-19 are not reflected in the assessment of credit risk measured by SCDS spreads. However, the remaining results seem to be partially consistent with other studies that have found a relationship between selected indicators reflecting SCDS spreads and Covid-19 dynamics (Kartal 2020; Jinjarak *et al.*, 2021).

Returning to the hypothesis posed at the beginning of this study, it is now possible to state that it has been verified positively. The hypothesis assumed that the Covid-19 dynamics in Hungary, Poland, Russia and Slovakia moderately contribute to a country's credit risk assessment, measured by SCDS spreads. These results match those observed in previous studies, which showed that the impact of the Covid-19 pandemic on SCDS spreads is characterized by greater strength in countries with poorer healthcare infrastructure (Pan *et al.*, 2021).

6. Conclusions

The following conclusions can be drawn from this study, Covid-19 dynamics do not significantly affect changes in SCDS spreads in the CEE countries studied. Indeed, the results of the study indicated the very weak impact of the studied variables. This is also confirmed by the results of the time series analysis. It was shown that Covid-

19 cases and Covid-19 deaths increased, while SCDS spreads over the same period showed a decreasing trend. This thesis is also confirmed by the correlation analysis results for the Stringency index and SCDS spreads. The correlation between these two variables was shown only in Poland, where an increase in restrictions increased SCDS spreads by 0.14 bps. The results obtained partly confirm the results found in the literature analysis.

This paper has found that the biggest impact on SCDS spreads is the reproduction rate, but that the direction of this impact varies.

One of the more significant conclusions of this study is that sudden Covid-19 shocks do not significantly affect changes in SCDS spreads, and the determinants of the impact on SCDS spreads differ in the direction of the impact. It can be seen from the data in Table 1 that the direction of the correlation studied is not the same for individual variables in all countries.

It should be noted that the results should be interpreted with some caution. This is because the Covid-19 pandemic is still in progress. Therefore, this study is only an introduction to broader research on the economies of CEE countries during the Covid-19 pandemic. Future research focusing on the correlation between Covid-19 dynamics and SCDS spreads over a longer period and in different CEE countries could be of interest. It would also contribute to a better understanding of the SCDS market and thus the factors affecting the pricing of a country's credit risk during crises.

7. Conflicts of Interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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