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Assessment of the credit risk of Poland based on sovereign credit default swap spreads during the Covid-19 pandemic

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Abstract

Motivation: SCDS contracts, based on treasury bonds, are used to assess credit risk. Observation of changes in these instruments provides information on the current economic situation of individual countries. By correlating them with the economic assessment of individual countries, SCDS indicate the risk level of bankruptcy of a given country and thus play an informative role on the global financial market.

Aim: The objective of the study is to investigate the impact of the Covid-19 pandemic on the level of credit risk in Poland. This aim will be achieved by determining the level and the dynamics of changes of SCDS spreads, and by identifying the determinants of changes in the level of SCDS spreads before and after the pandemic. The study hypothesises that as a result of the supply and demand shocks caused by the outbreak of the Covid-19, the level of Polish SCDS spreads increased due to macroeconomic factors.

Results: The results of the study confirmed that due to the panic, Poland's credit risk increased dynamically in the first stage of the Covid-19. However, over time, the level of credit risk in Poland decreased. Nevertheless, the reduction in Poland's credit risk is accompanied by an increase in public debt, with a simultaneous deterioration in macroeconomic indicators. This evidence suggests that SCDS spreads are not capable of reflecting the foundations of the economy during uncertainty. The results of this study indicate that the fundamental determinants of credit risk changes occurred before and during the pandemic. However, the results showed that the magnitude of their impact on credit risk is different. Multiple linear regression analysis also showed that during the Covid-19,

macroeconomic factors showed a significantly higher degree of correlation with credit risk compared to non-economic factors directly related to the effects of the pandemic.

Keywords: credit default swap; credit risk; sovereign default; Covid-19 pandemic
JEL: E44; E51; H12

1. Introduction

The outbreak of the Covid-19 pandemic has led to significant changes in the way economies function around the world. As a result of the stoppage of economic processes in strongly related sectors of the economy, there has been a sudden supply and demand shock, which may seriously disrupt the process of development in the country. At present, it is impossible to predict the duration of the pandemic, or its long-term effects related to the disruption of supply chains or the closure of individual economic sectors. The necessity of introducing drastic restrictions in the real economy has made it impossible to generate income in many industries, which has directly reduced the state's tax revenues. At the same time, state expenditures related to mitigating the effects of the pandemic are increasing (e.g., increase in expenditure on healthcare, a rescue package for the economy, and a vaccination campaign among the population). The development of the Covid-19 has negatively affected economic and social development, and consequently has increased the level of the country's credit risk.

The level of a country's credit risk is assessed internationally, in which sovereign credit default swap spreads (SCDS) play an important role. There is ample evidence supported by research results, that the SCDS spread reflects all information and events affecting the ability of a given country to settle liabilities and/or the possibility of bankruptcy, for example Ait-Sahalia et al. (2014), Czech (2019), Grodzicki (2012), Kocsis (2015).

In the assessment of credit risk based on SCDS spreads, the observational method is used. It consists of observing the level of SCDS spreads. A decrease in the level of SCDS spreads is evidence of a decrease in the level of a country's credit risk, while an increase in the level of SCDS spreads indicates an increase in the country's credit risk. As the Covid-19 is an unprecedented event that has created uncertainty in every economic and social field, it is therefore important to check whether the SCDS spread still reflects sovereign credit risk during the pandemic.

The main objective of the study is to investigate the impact of the Covid-19 on the credit risk level in Poland. This aim will be achieved by:

- determining the level of CDS spreads based on 5-year treasury bonds in the pre-pandemic period and during the Covid-19 pandemic;
- determining the dynamics of changes in the level of CDS spreads based on 5-year treasury bonds in the pre-pandemic period and during the Covid-19 pandemic;

– identifying the determinants of changes in the level of SCDS spreads based on 5-year treasury bonds in the pre-pandemic period and during the Covid-19 pandemic.

The study hypothesises that because of the supply and demand shocks caused by the outbreak of the Covid-19 pandemic, the size of CDS spreads based on Polish treasury bonds increased, and that this increase is determined by macroeconomic factors.

Quantitative methods were used in the research. Based on analysis of the dynamics, changes in SCDS spreads during the pre-pandemic period and during the pandemic were examined. Then, using multiple linear regression analysis, the impact of selected macroeconomic factors on the level of SCDS spreads were examined.

2. Literature review

The literature study included research into sovereign credit default swap spreads as a country credit risk pricing tool. Much of the current literature pays particular attention to the ability of SCDS spreads to reflect economic fundamentals and other relevant global market factors (Czech, 2019; Dieckmann & Plank, 2012; Eichengreen et al., 2012; Piotrowski & Piotrowska, 2013).

There is a large volume of published studies describing the correlation between SCDS spreads and different indicators. For example, Aizenman et al. (2013) explore the effects of inflation on SCDS, Yuan & Pongsiri (2015) analyse the relationship of SCDS and government debt to GDP, Czech (2019), Liu & Morley (2012) and Qian et al. (2017) and investigate the impact of exchange rates in terms of SCDS volatility, Longstaff et al. (2011) examine stock market indices, while Alper et al. (2013), Camba-Méndeza & Serwa (2016) and Heinz & Sun (2014) verify the impact of the VIX index on the level of SCDS spreads, and Ericsson et al. (2016) analyse changes in SCDS taking into account the risk-free interest rate. Fontana & Scheicher (2016) also compared the market pricing of euro area government bonds and the corresponding Credit Default Swaps and found no correlation between the risk-free interest rate and the level of SCDS spreads.

Recent research very often highlights the diverse impact of macroeconomic factors and global factors on SCDS spreads. For example, Ma et al. (2018) investigated the dependency of emerging market SCDS spreads on a nation's country-specific fundamental factors, local factors and regional factors, as well as global factors. They find that local, regional and fundamental variables, such as the local stock index returns, changes in the exchange rate and changes in a country's credit rating have a stronger influence on SCDS spreads in periods of stability. In contrast, global variables, such as US stock index returns, have a stronger effect on SCDS spreads during the periods of bad economic conditions.

Kocsis (2015), analysed global, regional and country-specific financial market indicators and showed that SCDS spread are correlated with global factors. Similar results were obtained by Yin et al. (2021), who used the EGARCH model in emerging markets to explore the variability of SCDS spreads due to the inflow of good and bad US macroeconomic news announcements. Their findings reveal that good US macroeconomic news announcements contribute to a decline in SCDS spreads, while bad news increases the level of SCDS spreads in emerging markets.

On the other hand, Czech (2019) examined the impact of macroeconomic as well as global factors on the level of SCDS spreads in twenty countries. The results showed that Chinese SCDS spreads do not correlate with macroeconomic factors, but are related to global factors. On the other hand, SCDS spreads in other countries are susceptible to both macroeconomic and global factors, with the influence varying across countries. Czech (2019) also analysed the interrelationship of SCDS spreads and suggests that there are global linkages between SCDS spreads.

Kliber (2019) analysed the interrelation between SCDS and bonds, foreign exchange and the stock market, and investigated the strength of the correlations during the financial crisis. They found that the diverse correlation between SCDS and other domestic financial markets depended on the liquidity and maturity of the analysed markets.

The results of the literature research indicate that the source literature does not address issues related to the evaluation of credit risk during the Covid-19. Therefore, a research gap is demonstrated which will be filled by examining the level of credit risk during the pandemic, and studying the impact of selected macroeconomic factors on the market valuation of this risk.

3. Methods

The implementation of the objectives of the study was based on a critical analysis of the source literature and on quantitative research. The literature review made it possible to explain the essence and application of SCDS spreads and to indicate their relationship to changes in the level of credit risk. Two research methods were used in the quantitative research: dynamics analysis and multiple linear regression analysis. Both methods were applied over the 24-month study period: from March 2019 to February 2021, which adopted a weekly interval. This period was divided into two sub-periods: the pre-pandemic period (March 2019-February 2020) and the pandemic period (March 2020-February 2021). The purpose of the division of the research period was to identify changes in the level of SCDS spreads and factors influencing these changes during the pandemic period relative to the period immediately preceding the Covid-19.

The study period was determined by the duration of the pandemic and the availability of statistical data. The pre-pandemic study period was assumed to be the 52 weeks immediately preceding the pandemic outbreak,

i.e., from March, 2019 to February, 2020. The length of this period corresponds to the length of the research period during the pandemic. The outbreak of the Covid-19 in Poland dates to March 2020, when the first case of Covid-19 was confirmed. However, the end date of the pandemic is not yet known, as the Sars-Cov-2 virus responsible for Covid-19 is constantly mutating. In addition, the Polish population has not yet achieved herd immunity, which is conducive to an increase in morbidity. Such a situation causes difficulties in defining the upper limit of research due to the disproportion in the frequency of publishing individual statistical data. During the research period, the most complete current statistical data ended in February 2021, therefore the research period covering the period of the pandemic was defined in the range from March 2020 to February 2021 (52 weeks).

3.1. Dynamics analysis

In the quantitative research, analysis of the dynamics was used first. On its basis, the direction of changes in the level of SCDS spreads and the dynamics of the changes were examined. For this purpose, a linear multiplicative time series model was built. The main trend was identified by an analytical method, which is described by Formula 1.

$$\hat{Y} = b_1 t + b_0, \tag{1}$$

where:

$\hat{Y}$ — trend;

b_0 and b_1 — model parameters;

t — time;

The trend model parameters (b_0 and b_1) were estimated using the least squares method (LSM) (Formula 2; Formula 3).

$$b_1 = \frac{n\sum_t^n y_t t - \sum_t^n y_t \sum_t^n t}{n\sum_t^n t^2 - \left(\sum_t^n t\right)^2}, \tag{2}$$

$$b_0 = \overline{y} - b_1 t^{-}, \tag{3}$$

where:

y_t — level of SCDS spreads in period t;

t — number of consecutive time units;

$\overline{y}$ — average SCDS spread level in period t;

t^{-} — average value of time units.

The trend of changes taking place on the SCDS market was estimated in relation to the time variable and allowed the direction of changes in SCDS spreads in the pre-pandemic period and during the pandemic to be determined.

On the other hand, the dynamics of changes in SCDS spreads was tested using the average rate of change and was determined using Formula 4.

$$\sqrt[n-1]{\frac{y_n}{y_1}} - 1, \tag{4}$$

where:

y_1 — the level of SCDS spreads in period 1;
y_n — the level of SCDS spreads in period n;
n–1 — the number of observations reduced by 1 (which results from the construction of chain indexes).

Based on the dynamics analysis, the rate of changes in the level of SCDS spreads in the pre-pandemic period and during the pandemic was determined.

3.2. Multiple linear regression analysis

The multiple linear regression analysis was used to analyse the correlation between the SCDS spreads and the selected macroeconomic indicators during the pre-pandemic period and the Covid-19 pandemic.

The analysis was conducted on a sample of:

– 624 observations of SCDS spreads (312 observations for each study period);
– 3238 observations of selected macroeconomic indicators (1618 observations in the pre-pandemic period and 1620 observations during the pandemic);
– 1560 observations of selected non-economic indicators (520 observations in the pre-pandemic period and 1040 observations during the pandemic).

The dependent variable is the SCDS spread, while the independent variables are the following indicators:

1. macroeconomic indicators:
– debt of the public finance sector;
– bond yields;
– level of budget deficit;
– level of GDP;
– inflation rate;
– the level of interest rates;
– unemployment rate;
– level of money supply M3;
– average employment in the enterprise sector;
– USD/PLN exchange rate;
– EUR/PLN exchange rate;
– CHF/PLN exchange rate;
– GBP/PLN exchange rate;
– WIG20 level;

2. non-economic indicators:
– number of new confirmed Covid-19 cases;
– total number of deaths;
– number of Covid-19 deaths;
– number of deaths excluding Covid-19.

The values of individual indicators were taken from five databases belonging to the following institutions: the Central Statistical Office (GUS), the European Statistical Office (Eurostat), the National Bank of Poland (NBP), the World Health Organization (WHO) and Markit Financial Information Services. Due to the different frequency of providing statistical data (daily, monthly, quarterly and annual data), for the needs of the model, these were unified and the impact of selected indicators on the level of SCDS spreads was examined by weekly interval. For this purpose, the daily data of the examined indicators was aggregated. The arithmetic mean was applied such that 104 weekly mean values of the examined indicators were obtained. For monthly, quarterly and annual data, an assumption was made that in subsequent weeks of a given month, quarter or year the observed values are the same as in the whole month, quarter or year.

In the multiple linear regression analysis, the method of progressive stepwise regression was used. All the above-mentioned indicators were taken into account in the construction of the model, but only those that were statistically significant were introduced into the model. The statistical significance was assessed by means of the t-test, assuming a maximum 5% chance of making an error in conclusion. Therefore, those variables whose value was higher than the critical value resulting from the Student's t-distributions at the alpha<0.05 level were considered statistically significant. Then, after including all statistically significant variables in the model, the linear significance for the whole model was examined with the use of F test statistics.

The estimated model of linear multiple regression is described by Formula 5.

$$\hat{Y} = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + K + b_{18}x_{18} \pm \zeta, \qquad (5)$$

where:

b_i — regression partial factors.

The application of the multiple linear regression model answered the question whether the credit risk of Poland measured by the level of SCDS spreads changes because of changes caused by the outbreak of the Covid-19 pandemic.

Comparative analysis was applied to confront the results obtained in the pre-pandemic period and during the Covid-19, and to answer the question whether the pandemic significantly affected the increase in credit risk in Poland.

4. Results

4.1. Dynamics analysis

Based on Polish SCDS spreads, the level of Poland's credit risk was measured in the pre-pandemic period and during the pandemic. In Chart 1 there is a clear decreasing trend in the level of SCDS spreads in the period preceding the outbreak of the Covid-19 pandemic.

Between March 1, 2019 and February 29, 2020, there was a compression of SCDS spreads from 70 bp to 46.9 bp. In dynamic terms, the level of SCDS spreads decreased on average by –0.49 bp from week to week. However, the trend analysis showed that the level of SCDS spreads decreased by –0.2982 bp only due to the main causes. The reduction in SCDS spreads during this period was the result of Poland's economic prosperity, expressed by the high level of GDP (4% in 2019), increased corporate tax revenues, the tightening of the tax system and the reduction of the shadow economy. Moreover, as Chart 2 shows, the level of public debt remained at a very stable, low level during this period. The value of public debt in this period ranged from PLN 984,313.50 million to PLN 1,001,190.90 million, and was characterised by a moderate downward trend. The trend analysis showed that in the pre-pandemic period, public debt decreased by PLN 362.18 million from period to period, as a result of main causes. This situation was conducive to reducing the country's credit risk.

However, the boom was interrupted by the outbreak of the Covid-19. From March 2020, SCDS spreads based on Polish treasury bonds increased at a high rate (by 0.98% on average from week to week), quickly reaching a level similar to that in March 2019 (64 bp). This was mainly caused by the panic resulting from uncertainty, as well as ignorance of the nature and parameters of the Covid-19 pathogen, especially during the first stage of the pandemic (Norman et al., 2020). The increase in the level of SCDS spreads immediately after the outbreak of the pandemic was also due to a sharp increase in public finance sector debt. The increase in debt was the result of measures taken by the government to reduce the impact of the pandemic. After the outbreak of the Covid-19 pandemic, there was a need to introduce extraordinary measures aimed at extinguishing pandemic outbreaks, such as restrictions on personal contact, limitations on the mobility of citizens, and restrictions on running a business. The introduction of drastic restrictions resulted in a strong need for state borrowing to finance relief efforts.

What is interesting in this data is that over time, public sector debt has been steadily increasing while the level of SCDS spreads has been declining. As Chart 1 shows, there is no significant difference between the level of SCDS spreads before the outbreak of the pandemic and after the outbreak. After the initial shock of the pandemic outbreak, the level of SCDS spreads returned to a continuation of its downward trend. This shows that the SCDS spreads do not reflect the eco-

nomic fundamentals in the period of the pandemic. As a result of main causes, the level of the SCDS spreads in the period from March 1, 2020 to February 28, 2021 decreased by –0.0973 bp from week to week and closed in the range between 64 bp (March 2020) and 49.4 bp (February 2021).

The average rate of decline in the level of SCDS spreads during the pandemic was –0.12% from week to week. The results obtained indicate a reduction in Poland's credit risk both before and after the outbreak of the Covid-19 pandemic.

4.2. Multiple linear regression analysis

The size of CDS spreads based on treasury bonds reflects the level of government debt in relation to the ability to service it. However, there is reason to conclude that not only debt, but also other factors cause changes in the level of SCDS spreads. Therefore, a study was conducted to determine the factors affecting the level of SCDS spreads before and after the outbreak of the Covid-19. Hence, two multiple linear regression models were built: the first for the period from March 1, 2019 to February 29, 2020, and the second for the period from March 2020 to February 28, 2021.

Based on the results, the following variables were found to have an impact on SCDS spreads in the pre-pandemic period: inflation rate, unemployment rate, Level of Money Supply M3, EUR/PLN exchange rate, debt of the public finance sector and bond yields. It should be noted that the unemployment rate, EUR/PLN exchange rate and bond yields were on the verge of statistical significance, but in order to better adjust the model parameters, these variables were included in the model.

The multiple linear regression equation for the period from March 1, 2019 to February 29, 2020 is as follows:

$$\begin{aligned} &SCDS\ spread = -87.2699 - 5.2596 * inflation\ rate - 1.3143 * \\ &unemployment\ rate - 0.0001 * level\ of\ money\ supply\ M3 + \\ &+13.3822 * EUR/PLN\ exchange\ rate + 0.0002 * \\ &debt\ of\ the\ public\ finance\ sector - 3.4055 * bond\ yields \pm 1.5442. \end{aligned} \tag{6}$$

The constructed regression model is linear and statistically significant, which is confirmed by the statistical values F = 122.13 and p <0.0000. The multiple correlation coefficient of R = 0.9706 is significantly different from zero, which means that there is a very strong linear relationship between the dependent variable and the independent variables. The coefficient of determination is equal to 0.94, which means that the model explains 94% of the changes in the level of SCDS spreads. The standard error of the evaluation of the free expression relative to its value is low at 1.5442.

The results are consistent with those of previous studies, and confirm that SCDS spreads respond to changes in fundamental economic variables during periods of market equilibrium.

The results of the correlational analysis in the pre-pandemic period can be compared to those in the period of the Covid-19 pandemic. The research results show that during the Covid-19 pandemic, changes in SCDS spreads depend on the following variables: the GBP/PLN exchange rate, the number of deaths from Covid-19, the debt of the public finance sector, the number of confirmed Covid-19 cases, WIG20, the level of inflation, bond yields, the number of deaths excluding Covid-19 deaths, the CHF/PLN exchange rate and the level of interest rates. It should be noted that the level of inflation, the number of deaths excluding deaths from Covid-19, the CHF/PLN exchange rate and the level of interest rates were on the verge of statistical significance, but in order to better adjust the model parameters, these variables were included in the model.

The multiple linear regression equation for the period from March 1, 2020 to February 28, 2021 is as follows:

$$\begin{aligned} &SCDS\ spread = -114.0806 + 30.5069 * GBP/PLN\ rate - 0.0057 * \\ &number\ of\ deaths\ from\ Covid\text{-}19 + 0.0001 * debt\ of\ the\ public\ finance \\ &sector + 0.0001 * number\ of\ confirmed\ Covid\text{-}19\ cases + 0.0193 * \\ &WIG20 + 3.4313 * inflation\ level + 11.1839 * bond\ yields - 0.0020 * \\ &number\ of\ deaths\ excluding\ Covid\text{-}19\ deaths - 17.1099 * CHF/PLN \\ &exchange\ rate - 3.8375 * level\ of\ interest\ rates \pm 2.0863. \end{aligned} \tag{7}$$

The constructed regression model is linear and statistically significant, which is confirmed by the statistical values F = 4.2025 and p <0.0009. The multiple correlation coefficient of R = 0.7534 is significantly different from zero, which means that there is a very strong linear relationship between the dependent variable and the independent variables. The coefficient of determination is equal to 0.43, which means that the model explains 43% of the changes in the level of SCDS spreads. The standard error of the evaluation of the free expression relative to its value is low at 2.0863.

The multiple linear regression results show that the sudden economic disruptions caused by Covid-19 changed the determinants that formed the level of SCDS spreads. During the pandemic, the GBP/PLN and CHF/PLN exchange rates have the largest impact on the level of the examined spreads. This situation should be associated with the GBP exposure of Polish citizens related to employment in Great Britain, as well as the high debt of the Polish population denominated in Swiss francs. Furthermore, the results indicate a high level of negative correlation of SCDS spreads with the level of interest rates. Their decrease encourages indebtedness, which is negatively assessed by the market, while an increase in interest rates inhibits debt issuance and improves the level of SCDS spreads. These results suggest that the health indicators directly related to Covid-19, such as the number of confirmed cases of Covid-19 or the number of deaths from Covid-19, also correlate with the level of SCDS spreads, but the strength of this correlation is very weak.

The comparison of the two results reveals that public finance sector debt, inflation rates and bond yields affected the SCDS spreads, both in the pre-pandemic period and the pandemic period, but that the impact is varied. During the pandemic, bond yields had a significantly larger impact on SCDS spreads compared to the pre-pandemic period, while inflation and public finance sector debt had less impact. This once more shows that the SCDS spreads do not reflect the economic fundamentals in the period of the pandemic. These results were confirmed by the results of the dynamic analysis.

5. Conclusion

The study was designed to determine the effect of the Covid-19 pandemic on the level of credit risk in Poland. The measurement of the credit risk was made using the level of CDS spreads based on five-year Polish treasury bonds. The achievement of the set objective was conditioned by the study of the level and dynamics of changes in SCDS spreads and the study of the determinants of these changes before and after the outbreak of the coronavirus pandemic. The study hypothesized that, as a result of demand and supply shocks caused by the outbreak of the Covid-19 pandemic, the size of SCDS spreads increased, and that this increase is determined by macroeconomic factors. Undoubtedly, the pandemic had a negative impact on the macroeconomic environment in Poland, but the results obtained only partially confirmed the hypothesis.

The results of the dynamics analysis confirmed that due to the panic caused by lack of knowledge on the parameters of the Covid-19 pathogen, Poland's credit risk increased dynamically in the first stage of the Covid-19 pandemic. However, over time, the level of credit risk in Poland decreased. From the point of view of debt servicing costs, this is a favourable situation for the state. The most striking result to emerge from the analysis conducted during the coronavirus pandemic is that the reduction of Poland's credit risk is accompanied by an increase in public debt (with a simultaneous deterioration in macroeconomic indicators). In the pre-pandemic period, the situation was the opposite, as the low level of the credit risk was determined by the low level of public debt and good economic conditions. This study confirms previous findings and provides additional evidence to suggest that SCDS spreads reflect the level of credit risk during periods of economic equilibrium, but are less useful during economic turmoil.

Returning to the hypothesis posed at the beginning of this study, it can now be stated that the fundamental factors affecting changes in the level of credit risk are unchanged and occurred both in the pre-pandemic period and the period of the Covid-19 pandemic. These factors include public finance sector debt, the level of inflation and bond yields. However, the results of the study show that the extent of their impact on the credit risk in the pre-pandemic period and during the pandemic varies. Multiple linear regression analysis also revealed that during the Covid-19 pandemic, macroeconomic factors showed a significantly

higher degree of correlation with credit risk compared to non-economic factors. The evidence from this study suggests that factors directly related to Covid-19, such as the number of new confirmed Covid-19 cases or the total number of deaths or Covid 19 deaths, have little impact on sovereign credit risk. It must be emphasized that this study has demonstrated, for the first time, the correlation between the number of deaths and Poland's credit risk. In the pre-pandemic period, the credit risk was not sensitive in any way to the number of deaths, whereas the pandemic revealed a link between these indicators.

Due to the dynamic epidemiological situation, a major limitation of this study were the difficulties in obtaining up-to-date data, as well as the lack of access to data over the long term. The study did not evaluate the correlation of the credit risk with the number of people vaccinated against Covid-19. Vaccination in Poland has been ongoing since January 2020, so the study period is too short to produce conclusive results. Nevertheless, this observation will contribute to the continuation of research on the level of credit risk during the health crisis. Even so, the study has gone some way towards enhancing our understanding of credit risk assessment in times of volatility caused by non-economic factors, and has provided additional evidence that SCDS spreads have a limited ability to correctly value a country's credit risk during a period of uncertainty.

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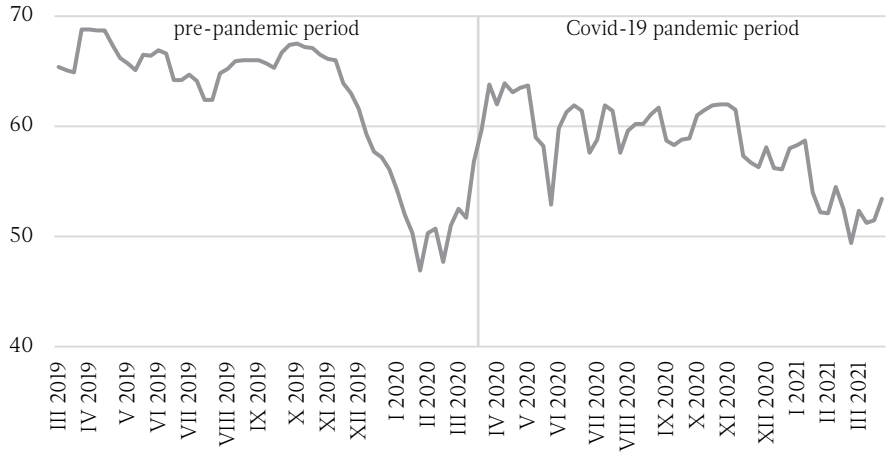
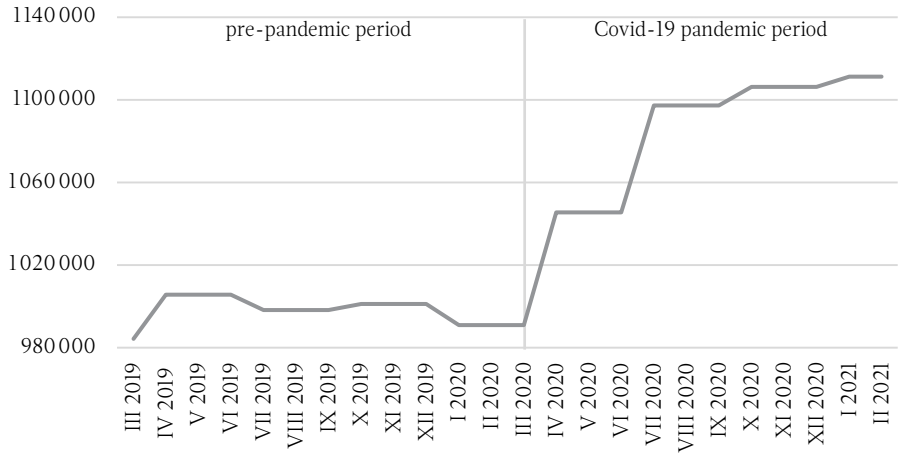
Appendix

Chart 1.
The level of Polish SCDS spreads (in bp)



Source: Own preparation based on AssetMacro (2021).

Chart 2.
Debt of the public finance sector (in mln PLN)



Source: Own preparation based on Ministry of Finance (2021).