Contagion of credit risk: Comparative analysis before and after the pandemic of COVID-19

Takayasu Ito

School of Commerce, Meiji University, Chiyoda-ku, Tokyo, Japan

Abstract
The spreads of credit default swaps (CDS) in Germany, Japan, United Kingdom, and United States move together before the COVID-19 pandemic with few mutual causalities. However, they do not move together after the pandemic and have more mutual causalities. The credit risk of four major countries—Germany, Japan, United Kingdom, and United States are connected due to their relative stability before the pandemic. However, they are not connected in terms of the differences in public spending between the countries during COVID-19. This makes the CDS market more sensitive to credit risk in each nation, resulting in the independent move of credit risk among the four countries.

KEYWORDS
Cointegration, contagion of credit risk, covid-19, credit default swap

JEL CLASSIFICATION
C32, E44, G15

1 | INTRODUCTION

The outbreak of the COVID-19 pandemic began in China at the end of January 2020 and was identified in northern Italy at the end of February 2020, from where it quickly spread to the rest of Europe and to Asian and American countries. As the pandemic intensified, world financial markets tumbled. For example, stock prices declined and the yields of sovereign bonds climbed. The spreads of credit default swaps (CDS) increased sharply because financial market practitioners were concerned that sovereign credit risk would deteriorate. Many countries decided to issue more sovereign bonds to support stagnant economies caused by the COVID-19 pandemic.

Tokic (2020) concludes that “the COVID-19 pandemic is likely to accelerate the trends of de-globalization and de-dollarization and to create an opportunity for building more sustainable globalization.” It is expected that there will be structural change in the financial market following the COVID-19 pandemic. This paper focuses on the contagion of credit risk among four major countries—Germany, Japan, United Kingdom, and United States, by analyzing the market of CDS. The study divides the sample period into two at the beginning of worldwide pandemic to make a comparative analysis.

CDS refers to a financial swap agreement whereby the seller compensates the buyer if there is a credit event. As mentioned in Ito (2020), “the buyer of the CDS makes a series of payments to the seller and, in exchange, receives a compensation payoff if there is a default, whereupon the seller retakes possession of the defaulting bond or loan.” When the credit risk increases in a country, the CDS premium increases. As Ito (2020) states, “it is therefore appropriate to use the CDS spreads to measure credit risk in the financial system.”

To date there have been not so many literatures written on the impact of the COVID-19 pandemic on the CDS market because the first outbreak of coronavirus pandemic was confirmed in China at the end of January 2020. There is no literature analyzing the CDS market of Germany, Japan,
United Kingdom, and United States to investigate the contagion of credit risk. Therefore, this paper distinguishes itself from other related literatures in its originality.

Andries et al. (2021) indicate that “an increased debt-to-GDP ratio significantly boosts the cumulative abnormal change of CDS spreads, which indicates that investors are concerned about countries that are too indebted and thus have a limited capacity to intervene and provide fiscal stimuli and emergency fiscal packages to businesses and households.” Carnazza and Liberati (2021) state that “the pandemic crisis can be interpreted as a symmetric shock” and that they found “important asymmetric consequences both in the sovereign bond market and the credit default swap market.”

Daehler et al. (2021) suggest that “the epidemiological deterioration can lower confidence in the sovereign credit markets due to the prospects of prolonged lockdowns and a slower GDP growth recovery.” “Their results Iso hold for a single regression of daily spread changes during 2014–2020 by investigating the factors driving CDS spreads of emerging market sovereigns around the outbreak of COVID-19.”

Haddad et al. (2021) conclude that “investment-grade corporate bonds traded at a discount to CDS; exchange-traded funds traded at a discount to net asset value, more so for safer bonds by documenting extreme disruption in debt markets during the COVID-19 crisis: a severe price crash accompanied by significant dislocations at the safer end of the credit spectrum.”

Ito (2020) indicates that “CDS spreads were priced independently in five eurozone countries (Germany, France, Italy, Portugal, and Spain) before the pandemic COVID-19 pandemic, not incorporating the sovereign risk of the eurozone as a whole. However, during the period of pandemic crisis, the credit risk was connected in five countries.”

Ivanov et al. (2020) show that “the continuous development and investment in central clearing over the last 10 years greatly contributed to the financial stability of the CDS markets during the Covid-19 crisis, providing increased market transparency, capital efficiency and robust risk management services in the presence of record daily volumes, open interest levels and mark-to-market payments.”

Jinjarak et al. (2021) indicate that “March 2020 divergence is well accounted for by COVID-specific risks and associated policies, mortality outcomes, and policy announcements, rather than traditional determinants. Daily CDS widening ceased almost immediately after the European Central Bank announced the Pandemic Emergency Purchase Programme, but the divergence between actual and model-implied changes persisted.”

Liu et al. (2021) find that “the COVID-19 shock significantly increased the CDS spread and decreased the shareholder value for firms facing higher debt rollover risk. The effect is stronger for non-financial firms, for firms that are financially constrained, and for firms that are highly volatile.” Wei and Han (2021) suggest that “during our sample period following the outbreak of pandemic, neither conventional nor unconventional monetary policies have significant effects on government bond, stock, exchange rate and credit default swap markets.”

The remainder of this paper is structured as follows: Section 2 describes the data and provides summary statistics. Section 3 discusses methodology. Section 4 presents the results. Section 5 concludes.

2 | DATA

Daily CDS spreads (Germany, Japan, United Kingdom, and United States) are used as an indicator of credit risk. The maturity is five years because CDS of five years is liquid compared with other maturities in the market. These data are provided by Datastream. The entire sample period is divided into two parts, before and after the pandemic spread northern Italy. The first period (Sample A) runs from December 6, 2020 to February 21, 2020. The second period (Sample B) runs from February 24, 2020 to January 24, 2022. The movement of CDS spreads is shown in Figure 1. The descriptive statistics of the dataset are shown in Table 1.

3 | METHODOLOGY

3.1 | Unit root test

The Augmented Dickey-Fuller (ADF) test and the Kwiatowski-Phillips-Schmidt-Shin (KPSS) test are used.

| Variable | Average | SD | Min | Max | Median |
|----------|---------|----|-----|-----|--------|
| Sample A |         |    |     |     |        |
| Japan    | 14.91   | 1.99| 11.81|18.47|15.13   |
| US       | 13.21   | 1.24| 9.31 |16.20|13.40   |
| Germany  | 5.84    | 6.6 | 5.00 | 8.17 | 5.71   |
| UK       | 20.59   | 4.92| 11.84|30.29|21.35   |

| Sample B |         |    |     |     |        |
| Japan    | 11.30   | 4.51| 5.53 |22.76|10.39   |
| US       | 12.10   | 3.96| 8.96 |29.41|10.59   |
| Germany  | 6.25    | 2.08| 4.78 |13.78|5.52    |
| UK       | 12.04   | 7.05| 5.04 |37.11|10.78   |

Notes: Sample A is from December 6, 2020 to February 21, 2020. Sample B is from February 24, 2020 to January 24, 2022.
According to Dickey and Fuller (1979, 1981) “the ADF defines the null hypothesis as unit roots exist and the alternative hypothesis as unit roots do not exist.” Fuller (1976) provided a table for the ADF test. Kwiatkowski et al. (1992) indicates that “the KPSS test defines the null hypothesis as unit roots do not exist and the alternative hypothesis as unit roots exist.” As shown in Ito (2020) “the original data are checked to verify whether they contain unit roots.” Following this, “the data with first difference are analyzed to determine whether they have unit roots to confirm that they are I (1) process.”

### 3.2 Cointegration test

The cointegration test proposed by Johansen (1988) is applied as described below to investigate the co-movement of the CDS premium after it is confirmed that the data are non-stationary I (1) variables, as described in Ito (2000). Johansen suggests “starting an analysis with the k order Vector AutoRegression (VAR) model” as in Equation (1).

\[
X_t = \Pi_1 X_{t-1} + \cdots + \Pi_k X_{t-k} + u_t \tag{1}
\]

The CDS in the four countries are analyzed by the Johansen cointegration test. Maximal eigenvalue and trace tests are conducted to investigate the cointegration relationship. As Ito (2000) points out, “when a cointegration relationship is found, it can be concluded that the CDS markets in the four countries move in a long-run equilibrium. In other words, the credit risk in the financial systems of the four countries is connected.”

### 3.3 Granger causality test

Granger causality tests are applied to investigate the causalities among CDS prices in the five stated countries and hence to identify the transmission of contagion. Following Toda and Yamamoto (1995), “the original data are usually transformed into the change ratio to avoid the problem of spurious regression, but using these data is considered to cause an error.” They developed the Granger causality test in which non-stationary data are used directly.

According to their method, “the null hypothesis is tested by adding trend term t and p + 1 (original lag plus one) for
the estimation of the four equations mentioned below.” As outlined below, these four equations are used to test the CDS spreads in four countries: for example, Equation (2) shows whether the CDS spreads of Japan, UK, US, and Germany Granger-cause the CDS spreads of Germany. The akaike information criterion (AIC) standard is used for the original number of lags.

\[
\text{Germany} = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i \text{Japan}_{t-1} + \sum_{i=1}^{p+1} \beta_i \text{UK}_{t-1} \\
+ \sum_{i=1}^{p+1} \chi_i \text{US}_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i \text{Germany}_{t-1} + u_t \tag{2}
\]

\[
\text{Japan} = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i \text{Germany}_{t-1} + \sum_{i=1}^{p+1} \beta_i \text{UK}_{t-1} \\
+ \sum_{i=1}^{p+1} \chi_i \text{US}_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i \text{Japan}_{t-1} + u_t \tag{3}
\]

\[
\text{UK} = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i \text{Japan}_{t-1} + \sum_{i=1}^{p+1} \beta_i \text{Germany}_{t-1} \\
+ \sum_{i=1}^{p+1} \chi_i \text{US}_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i \text{UK}_{t-1} + u_t \tag{4}
\]

\[
\text{US} = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i \text{Japan}_{t-1} + \sum_{i=1}^{p+1} \beta_i \text{UK}_{t-1} \\
+ \sum_{i=1}^{p+1} \chi_i \text{Germany}_{t-1} + \sum_{i=1}^{p+1} \varepsilon_i \text{US}_{t-1} + u_t \tag{5}
\]

4 | RESULT

4.1 | Unit root test

The results of ADF and KPSS tests on the original data show that all original data used for analyses are non-stationary. The results are shown in Tables 2 and 3.

The results of ADF and KPSS tests on the first differenced data indicate that all first differenced data are stationary. It can be concluded that all data used for analyses are non-stationary I (1). Therefore, it is correct to use a non-stationary time series model. The results are shown in Tables 4 and 5.

4.2 | Cointegration test

The results of Johansen cointegration test (both maximal eigen value and trace tests) show that there is one coin-
integration relationship in Sample A. But no cointegration relationship is found in Sample B. It is concluded that the CDS spreads in Germany, Japan, United Kingdom, and United States moved together before the pandemic of COVID-19. The results are shown in Table 6.

### 4.3 | Granger causality test

The results of the Granger causality test show that causalities from Germany to Japan, US, and UK, and from US to UK are confirmed in Sample A. On the other hand, there are causalities from Germany to Japan and UK; from UK to Japan, US, and Germany; and from Japan to Germany and UK. The results are shown in Table 7.

### CONCLUSION

This paper focuses on the contagion of credit risk among four major countries: Germany, Japan, United Kingdom, and United States by making comparative analyses of CDS market before and after the COVID-19 pandemic.

CDS spreads increased sharply after the pandemic was found in northern Italy at the end of February, 2020. CDS spreads in Germany, Japan, United Kingdom, and United States move together before the pandemic of COVID-19 with fewer mutual causalities. But they do not move together after the pandemic, and have more mutual causalities.

The results described by Ito (2000) are different from those in this paper. Ito (2020) concludes that “the CDS spreads in five eurozone countries (Germany, France, Italy, Portugal, and Spain) are not connected before the COVID-19 pandemic crisis. CDS spreads are priced independently and did not incorporate the sovereign risk of the eurozone as a whole.” However, “during the pandemic period of crisis, CDS spreads are connected in five countries.”

The credit risk of Germany, Japan, United Kingdom, and United States are connected because they were relatively stable before the pandemic. However, they are not connected because the level of public spending during COVID-19 differed among four countries. This makes the CDS market more sensitive to credit risk in each nation, resulting in the independent move of credit risk among the four countries.

### ENDNOTE

1. The CDS premiums are usually expressed as the CDS spreads in the market.

| TABLE 5 | KPSS test—first differenced series |
| --- | --- |
| Variable | Lag = 0 | Lag = 12 |
| | $\eta_\mu$ | $\eta_\tau$ | $\eta_\mu$ | $\eta_\tau$ |
| Sample A | | | | |
| $\Delta$Japan | 0.042 | 0.016 | 0.095 | 0.036 |
| $\Delta$US | 0.005 | 0.005 | 0.017 | 0.017 |
| $\Delta$Germany | 0.032 | 0.008 | 0.102 | 0.027 |
| $\Delta$UK | 0.352 | 0.032 | 0.473 | 0.048 |
| Sample B | | | | |
| $\Delta$Japan | 0.081 | 0.084 | 0.061 | 0.063 |
| $\Delta$US | 0.046 | 0.084 | 0.092 | 0.086 |
| $\Delta$Germany | 0.084 | 0.082 | 0.084 | 0.086 |
| $\Delta$UK | 0.142 | 0.142 | 0.090 | 0.090 |

Notes: 5% critical values are .463 (level stationary), .146 (trend stationary). $\eta_\mu$ indicates level stationarity. $\eta_\tau$ indicates trend stationarity.

Sample A is from December 6, 2020 to February 21, 2020.

Sample B is from February 24, 2020 to January 24, 2022.

| TABLE 6 | Johansen cointegration test |
| --- | --- |
| Null | Alternative | Test statistics | 5% critical value | Test statistics | 5% critical value |
| Sample A | | Maximal eigenvalue test | Trace test |
| $r = 0$ | $r = 1$ | $40.77^a$ | 28.14 | 64.96 | 53.12 |
| $r \leq 1$ | $r = 2$ | 15.97 | 22.00 | 24.19 | 34.91 |
| $r \leq 2$ | $r = 3$ | 6.63 | 15.67 | 8.22 | 19.96 |
| $r \leq 3$ | $r = 4$ | 1.59 | 9.24 | 1.60 | 9.24 |
| Sample B | | | | |
| $r = 0$ | $r = 1$ | 18.79 | 28.14 | 39.64 | 53.12 |
| $r \leq 1$ | $r = 2$ | 10.88 | 22.00 | 20.85 | 34.91 |
| $r \leq 2$ | $r = 3$ | 7.64 | 15.67 | 9.97 | 19.96 |
| $r \leq 3$ | $r = 4$ | 2.33 | 9.24 | 2.33 | 9.24 |

Notes: Critical values are cited from Osterwald-Lenum (1992).

Sample A is from December 6, 2020 to February 21, 2020.

Sample B is from February 24, 2020 to January 24, 2022.

$^a$ indicates significance at 5% level.
TABLE 7  Granger causality test

| Variables | Test statistics | Variables | Test statistics |
|-----------|----------------|-----------|----------------|
| Japan → US | 0.047 | Japan → US | 1.984 |
| Japan → Germany | 0.631 | Japan → Germany | 7.313*a |
| Japan → UK | 0.952 | Japan → UK | 3.578*a |
| US → Japan | 0.915 | US → Japan | 0.584 |
| US → Germany | 0.961 | US → Germany | 0.867 |
| US → UK | 3.131*a | US → UK | 2.157 |
| Germany → Japan | 4.607*a | Germany → Japan | 7.224*a |
| Germany → US | 2.308*a | Germany → US | 0.890 |
| Germany → UK | 7.350*a | Germany → UK | 4.080*a |
| UK → Japan | 2.079 | UK → Japan | 4.297*a |
| UK → US | 1.727 | UK → US | 5.954*a |
| UK → Germany | .414 | UK → Germany | 9.742*a |

Notes: As for the number of lags, one is added to AIC selection.
Sample A is from December 6, 2020 to February 21, 2020.
Sample B is from February 24, 2020 to January 24, 2022.
a indicates significance at the 5% level.

REFERENCES

Andries, A. M., Ongena, S., & Sprincean, N. (2021). The COVID-19 pandemic and sovereign bond risk. *North American Journal of Economics and Finance, 58*, 101527.

Carnazza, G., & Liberati, P. (2021). The asymmetric impact of the pandemic crisis on interest rates on public debt in the Eurozone. *Journal of Policy Modelling, 43*(3), 521–542.

Daehler, T. B., Aizenman, J., & Jinjarak, Y. (2021). Emerging markets sovereign CDS spreads during COVID-19: Economics versus epidemiology news. *Economic Modelling, 100*, 105504.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74*(366), 427–431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica, 49*(4), 1057–1072.

Fuller, W. A. (1976). *Introduction to statistical time series*. John Wiley & Sons, Inc.

Haddad, V., Moreira, A., & Muir, T. (2021). When selling becomes viral: Disruptions in debt markets in the COVID-19 crisis and the Fed’s response. *Review of Financial Studies, 11*(34), 5309–5351.

Ito, T. (2020). Impact of the coronavirus pandemic crisis on the financial system in the eurozone. *Journal of Corporate Accounting and Finance, 31*(4), 15–20.

Ivanov, S., Jordan, R., & Springe, J. (2020). Credit default swap market retrospective: observations from the 2008–9 financial crisis and the onset of the Covid-19 pandemic. *Journal of Financial Market Structures, 9*(3), 53–72.

Jinjarak, Y., Ahmed, R., Nair-Desai, S., Xin, W. N., & Aizenman, J. (2021). Pandemic shocks and fiscal-monetary policies in the Eurozone: COVID-19 dominance during January-June 2020. *Oxford Economic Papers, 73*(4), 1557–1580.

Johansen, S. (1988). Statistical analysis of cointegrated vectors. *Journal of Economic Dynamics and Control, 12*(2-3), 231–254.

Kartal, M. T. (2020). The behavior of Sovereign Credit Default Swaps (CDS) spread: Evidence from Turkey with the effect of Covid-19 pandemic. *Quantitative Finance and Economics, 4*(3), 489–502.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics, 54*(1-3), 159–178.

Liu, Y., Qiu, B. H., & Wang, T. (2021). Debt rollover risk, credit default swap spread and stock returns: Evidence from the COVID-19 crisis. *Journal of Financial Stability, 53*, 100855.

Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics, 66*(1-2), 225–250.

Tokic, D. (2020). Long-term consequences of the 2020 coronavirus pandemics: Historical global-macro context. *Journal of Corporate Accounting and Finance, 31*(3), 9–14.

Wei, X. Y., & Han, L. Y. (2021). The impact of COVID-19 pandemic on transmission of monetary policy to financial markets. *International Review of Financial Analysis, 74*, 101705.

AUTHOR BIOGRAPHY

Takayasu Ito has been a professor of Monetary and Financial Economics at the School of Commerce, Meiji University since April 2014. He started an academic career as a professor in April 2003 by joining in the Faculty of Economics at Niigata University. Before an academic career, he worked for a major Japanese News Agency. There he covered monetary policy, fixed
income and interest rate derivatives market, and so forth. He holds two PhDs, one in Economics and one in Business Administration. His research interests are central bank, financial market and Islamic finance.

**How to cite this article:** Ito, T. (2022). Contagion of credit risk: Comparative analysis before and after the pandemic of COVID-19. *Journal of Corporate Accounting & Finance*, 1–7. https://doi.org/10.1002/jcaf.22562