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THE RISKINESS AND VULNERABILITY OF THE BANKING SECTOR: THE IMPACT OF THE COVID-19 PANDEMIC

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Abstract. *In recent years, several exogenous shocks, such as the COVID-19 pandemic, have significantly affected the risk profile and overall vulnerability of the banking sector. Therefore, the main objective of this study is to examine how the outbreak of the COVID-19 pandemic affected the riskiness of banking institutions and the banking sector as a whole. Using daily closing stock prices of 77 of the world's largest banks from November 2015 to December 2025, a risk indicator is constructed. To assess the effect of the pandemic, the sample period is divided into two sub-periods, pre-COVID and post-COVID, and changes in risk indicators across banks are analysed. Based on the analysis of the average risk indicator for each bank, the Canadian bank RBC and the Chinese bank BOC can be considered the least risky institutions. In contrast, the European banks Commerzbank and Deutsche Bank are identified as the riskiest institutions. Paradoxically, the results show the largest changes in risk indicators among Canadian banks, while only marginal changes are observed among Chinese banks, which may benefit from explicit state support. The analysis of the overall risk indicator over time highlights a significant increase in the riskiness and vulnerability of the banking sector following the outbreak of the pandemic.*

Keywords: *banking sector, COVID-19 pandemic, financial vulnerability, risk indicator.*

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Introduction

The banking sector plays a key role as the primary source of financing for households and businesses. The financial health of banking institutions is therefore a crucial for maintaining overall financial stability. Financial stability refers to a condition in which the financial system as a whole is able to perform its core functions even in the event of large and unexpected financial and non-financial shocks, whether arising from domestic or external economic and financial environments (Bláhová, 2018). In recent years, the banking sector has been exposed to several negative shocks. These events have contributed to an increase in riskier assets within banks' portfolios, thereby raising their vulnerability and the risk of failure. Given the high degree of interconnectedness among banks, the failure of one banking institution can spread to other institutions, which may negatively affect the stability of the banking and financial system (Rodríguez-Moreno and Peña, 2013; Silva et al., 2018).

Among the mentioned shocks, the outbreak of the COVID-19 pandemic represents an unexpected non-financial shock with a global impact on the financial sector. The pandemic triggered a global wave of financial uncertainty, economic recession, and heightened volatility in financial markets. For banking institutions, the pandemic is associated with increased credit risk, a higher likelihood of loan losses, and a deterioration in asset quality (Foglia et al., 2022; Batten et al., 2023). At the same time, global markets experienced sharp declines, which may have negatively affected banks' trading portfolios and funding conditions. Therefore, the main objective of this

study is to examine the impact of the COVID-19 pandemic on the riskiness and vulnerability of banking institutions and the banking sector as a whole. To achieve this objective, the following research questions are formulated:

1. Which banking institutions exhibit the highest levels of risk within the banking sector?
2. How did the outbreak of the COVID-19 pandemic affect the riskiness and vulnerability of the banking sector?
3. Which banking institutions recorded the largest increase in risk following the outbreak of the COVID-19 pandemic?

Literature Review

Economic subjects are constantly exposed to various financial and non-financial risks. Risk, in general, can be defined as a degree of uncertainty associated with future developments (Mejstřík et al., 2015). According to the European Central Bank, the main risk factors affecting the banking sector and increasing its systemic vulnerability include increasing liquidity risk arising from the economic slowdown and reduced access to capital markets, loss of bank revenues due to regulatory and political responses, and growing interconnectedness among banks (ECB, 2021). In addition to these factors, more recent developments highlight further sources of systemic vulnerability, including geopolitical tensions, macroeconomic uncertainty, increased sensitivity of borrowers to adverse shocks, and new challenges for banks, such as the implementation of climate-related measures and the introduction of the digital euro (ECB, 2024). All of the aforementioned risk may increase the vulnerability of the banking sector and the risk of failure banking institutions. Due to the high degree of interconnectedness among banks, the failure of one institution can spread to others, which may negatively affect the stability of the banking and financial system. This mechanism of risk transmission across financial institutions represents a key source of systemic risk (Rodríguez-Moreno a Peña, 2013; Silva et al., 2018; Baumöhl et al., 2020).

Systemic risk has become an important topic in academic research for several reasons. One of the most significant, according to its definition, is its potential to destabilize the entire banking and financial system. The Global Financial Stability Report (2009) and the European Central Bank (ECB, 2010) define systemic risk as the risk of financial instability caused by the failure of all or part of the financial system, which has a negative effect on the real economy. Systemic risk can also be defined as the risk associated with the failure of a firm, an industry, a financial institution, or the entire economy (CFI, 2020). This definition emphasizes that systemic risk is not necessarily limited to the failure of financial institutions but may also arise from other components of the financial system, such as disruptions within the payment system or various exogenous shocks (Harun and Gunadi, 2022).

In recent years, the banking sector has been exposed to major exogenous shock. These events have heightened global uncertainty and underscored the need for a more strategic approach to maintaining financial stability in a rapidly changing international environment. The revised order should be: (Barro et al., 2020; Barua, 2020; Eichenbaum et al., 2020; Rizwan et al., 2020; Chen et al., 2021; McKibbin & Fernando, 2021) and (Zhang et al., 2020; Borri & Giorgio, 2021; Duan et al., 2021). The COVID-19 pandemic could increase the credit risk of intermediaries, including firms and households, impacting their ability to repay debt and potentially leading to non-performing loans (NPLs) and instability in the banking sector (Foglia et al., 2022). Batten et al. (2023) highlight that the increase in household and corporate defaults during the pandemic has directly affected bank asset quality and raised concerns about financial system stability. Moreover, severe declines in intermediation activities may weaken the ability of financial institutions to finance their operations and cover funding costs, while these risks may propagate through interconnected financial institutions (Rizwan et al., 2020). In this context, the COVID-19 pandemic has underscored the importance of effective monitoring of systemic risk within the banking and financial system.

Systemic risk is difficult to capture within a single and unified framework. Therefore, a wide range of indicators has been proposed in the academic literature with the aim of identifying and

capturing the main characteristics of systemic risk (Hansen, 2013). Systemic risk can be measured based on the probability of default of the financial institution or the financial system as a whole (Option-iPoD, JPoD, BSI, DiDe, and PCE), the level of expected losses (CoVaR, SES, SRISK, DIP, and Systemic CCA), financial contagion (CoRisk, PCA, Granger causality, and network analysis), and financial stress (SWARCH, CISS, and RAMSI) (Kleinow and Moreira, 2016). Most systemic risk indicators rely on market-based data, including stock prices, returns, volatility, and credit default swap spreads, due to their high availability and frequency. Stock prices, in particular, are widely used as a proxy for the financial health of institutions and thus represent key inputs in systemic risk models. Their importance is further supported by empirical research showing a positive relationship between stock price volatility and bank risk (Jizi and Dixon, 2017; Garel et al., 2020).

Methods

To analyse the effect of the COVID-19 pandemic on the overall riskiness and vulnerability of the banking sector, a risk indicator is calculated for each banking institution in the sample, and its changes following the outbreak of the pandemic are examined. Based on the literature, the key input in the risk indicator is stock prices, which represent the financial health of institutions (Brownlees & Engle, 2012; Diebold & Yilmaz, 2012; Adrian & Brunnermeier, 2016; Wang et al., 2023; Zhao et al., 2024). Stock prices are also used in the context of the assumption that, in an informationally efficient market, they reflect all publicly available information and thus serve as a reliable proxy for the market's perception of each bank's risk.

In the first step of constructing the risk indicator, logarithmic returns $r_{i,t}$ are calculated from the daily closing stock prices of individual banks, defined as:

$$r_{i,t} = \ln(P_{i,t}) - \ln(P_{i,t-1}) \tag{1}$$

where $P_{i,t}$ denotes the closing price of bank i at time t. As a proxy for each bank's risk level, the standard deviation of logarithmic returns within a 28-day rolling window, with a step size of 20 days, is used. The risk indicator for each bank is therefore defined as:

$$\sigma_{i,t'} = \sqrt{\frac{1}{T}\sum_{t'}^{t'+T}(r_{i,t} - \bar{r}_i)^2} \tag{2}$$

where T represents the window size, t' denotes the starting point of the rolling windows, and $\bar{r}_i$ is the mean of logarithmic returns of bank i calculated within the given rolling window. By applying this process, a time series of rolling standard deviations is obtained for each bank, representing the evolution of risk over time. The parameters of the standard deviation are set based on the approach proposed by Wang et al. (2023). As a robustness check, the indicator was calculated using alternative parameter settings, however, the ranking of banks remained almost unchanged, suggesting that the parameter settings do not bias the analysis.

To assess the riskiness and vulnerability of the overall banking sector, a sample of 77 of the world's largest banking institutions headquartered in America, Europe, and Asia is analysed. The sample is constructed based on an international ranking published by the analytical platform TABInsights, which annually identifies the world's largest banks according to their total assets. Within this ranking, the focus is on the top 100 banks; however, the final sample is limited by the availability of market data required for the construction of the risk indicator. Consequently, only those banks whose shares are publicly traded and for which sufficiently long and continuous time series of market data are available are included. The list of selected institutions, together with their total assets, country of headquarters, region, and ticker symbols, is presented in Appendix A (Table A1).

Daily closing prices for these banking institutions were obtained from the publicly available Yahoo Finance database. For each bank, the primary listing on the domestic market (the most liquid

share class) is used, and share prices are retained in local currencies. No currency conversion is applied, as logarithmic returns are not directly affected by the currency denomination. Moreover, converting prices into a common currency might bias the analysis due to exchange rate fluctuations. The potential bias could also be caused by the different trading hours and trading days across exchanges. To avoid non-synchronous trading hours, daily logarithmic returns and a 28-day rolling standard deviation are computed, sampled every 20 trading days (Eq. 2). In the case of non-synchronous trading days across exchanges, the last available closing price is used for banks that were not traded on a given day. This approach could mitigate the potential bias caused by missing observations.

The analysis is conducted on a sample of 77 of the world's largest banking institutions over the period from 16 November 2016 to 30 December 2025. To assess the effects of the COVID-19 pandemic, the sample period is divided into two sub-periods (pre-COVID and post-COVID), each consisting of 300 trading days, based on structural break analysis. Based on a formal Bai-Perron structural break test (Appendix B – Table B1), two statistically significant breakpoints are identified, namely 17 January 2020 and 7 May 2021. Both breakpoints are associated with the COVID-19 pandemic. The first breakpoint can be interpreted as the onset of the pandemic, while the second reflects the stabilization of the banking sector after the pandemic. Given the focus of the analysis, the sample period is divided into sub-periods using 17 January 2020 as the reference breakpoint. The first sub-period (pre-COVID) spans from 23 November 2018 to 16 January 2020 and represents the period preceding the pandemic outbreak, i.e., before the identified structural break. The second sub-period (post-COVID), in contrast, captures the period following the onset of the pandemic, covering 17 January 2020 to 11 March 2021.

Results

To analyse the effect of the COVID-19 pandemic on the overall riskiness and vulnerability of the banking sector, a risk indicator is calculated for each bank in the pre-COVID and post-COVID periods, and its changes following the outbreak of the pandemic are examined. Prior to this analysis, the average risk indicator is calculated for each bank over the entire period, and their risk positions within the banking sector are analysed. The results are shown in Table 1, where the banking institutions are ranked from the least risky to the riskiest.

Table 1. The average risk indicator per bank

	Bank	Risk Indicator		Bank	Risk Indicator
1	RBC	0,00893	**40**	Lloyds Banking Group	0,01627
2	BOC	0,00938	**41**	Shinhan Financial Group	0,01630
3	Bank of Beijing	0,00946	**42**	Danske Bank	0,01632
4	Scotiabank	0,00962	**43**	PNC	0,01652
5	ABC	0,00970	**44**	U.S. Bancorp	0,01654
6	OCBC	0,00972	**45**	Goldman Sachs	0,01661
7	BoCom	0,00974	**46**	Itau Unibanco	0,01662
8	NBC	0,00992	**47**	KBC Bank	0,01682
9	China Minsheng Bank	0,01000	**48**	Ping An Bank	0,01682
10	ICBC	0,01011	**49**	Bank of America	0,01703
11	CIBC	0,01013	**50**	BNP Paribas	0,01728
12	UOB	0,01017	**51**	Resona Holdings	0,01733
13	TD Bank	0,01029	**52**	ING Group	0,01733
14	Hua Xia Bank	0,01068	**53**	Morgan Stanley	0,01743
15	BMO	0,01080	**54**	Citigroup	0,01768
16	Bank of Shanghai	0,01106	**55**	SBI	0,01785
17	DBS	0,01119	**56**	Erste Group Bank	0,01789
18	SPD Bank	0,01143	**57**	Wells Fargo	0,01810
19	CCB	0,01159	**58**	State Street	0,01825

	Bank	Risk Indicator		Bank	Risk Indicator
20	China Everbright Bank	0,01186	**59**	Bank of Ningbo	0,01834
21	Japan Post Bank	0,01251	**60**	Truist Financial Corp.	0,01849
22	HDFC Bank	0,01257	**61**	NatWest Group	0,01857
23	Bank of Jiangsu	0,01302	**62**	Standard Chartered	0,01860
24	BOCHK	0,01326	**63**	Banco Santander	0,01863
25	China CITIC Bank	0,01338	**64**	Barclays	0,01880
26	Industrial Bank	0,01369	**65**	KB Financial Group	0,01890
27	Mizuho	0,01373	**66**	ABN AMRO Bank	0,01895
28	SMFG	0,01415	**67**	BBVA	0,01896
29	Bank of Nanjing	0,01422	**68**	CaixaBank	0,01906
30	HSBC Holdings	0,01422	**69**	Banco Bradesco	0,01912
31	SEB	0,01432	**70**	Hana Financial Group	0,01919
32	JPMorgan Chase	0,01480	**71**	Banco do Brasil	0,01929
33	Nordea Bank	0,01493	**72**	Capital One Financial Corp.	0,02014
34	BNY Mellon	0,01506	**73**	Societe Generale	0,02021
35	MUFG	0,01532	**74**	Raiffeisen Gruppe	0,02072
36	Credit Agricole Group	0,01602	**75**	UniCredit	0,02182
37	China Merchants Bank	0,01611	**76**	Deutsche Bank	0,02243
38	Intesa Sanpaolo	0,01623	**77**	Commerzbank	0,02405
39	UBS Group	0,01625			

Source: own elaboration

The Canadian bank RBC can be considered the least risky bank, with an average risk indicator of 0.00893. Chinese banks BOC and Bank of Beijing follow in second and third place, with risk indicators of 0.00938 and 0.00946, respectively. The fourth and fifth positions are held by the Canadian bank Scotiabank and the Chinese bank ABC. Banks such as OCBC (Singapore), NBC (Canada), as well as ICBC, BoCom, and China Minsheng Bank (China), can also be classified as low-risk institutions. Conversely, the European banks Commerzbank and Deutsche Bank, both headquartered in Germany, represent the riskiest banking institutions, with indicator values of 0.02405 and 0.02243, respectively. The third, fourth, and fifth positions are held by the Italian banking group UniCredit, the Austrian banking group Raiffeisen Gruppe, and the French banking group Societe Generale. In addition to European banks, the Asian bank Hana Financial Group, the American bank Capital One Financial Corp., and the Brazilian banks Banco do Brasil and Banco Bradesco are also among the higher-risk institutions.

The observed differences between banking institutions can be primarily attributed to the structural characteristics of individual banking sectors. The Canadian banking sector is considered one of the most stable in the world, owing to strong regulation, strict supervision, and a relatively high level of market concentration. Banking institutions operating in China and Singapore also benefit from a stable regulatory environment and more conservative business models, typically characterized by a higher share of traditional lending activities and lower exposure to financial instruments. In the case of Chinese banks, where the largest institutions are typically state-owned, explicit state intervention may play an important role in their relatively low risk levels. In contrast, the higher risk levels observed in European banking institutions can be attributed to several factors, including the effects of the financial and sovereign debt crises, a higher share of non-performing loans, and the prolonged low-interest-rate environment. Due to low and, in some cases, negative interest rates, European banks have experienced a decline in interest margins, which has led them to seek more profitable, but also riskier, sources of income. European banking institutions are also characterized by more complex business models and a higher degree of international interconnectedness, which may contribute to their relatively higher risk positions within the banking system.

To assess the overall riskiness of the banking system, the average risk indicator is calculated over the analysed period. The development of the overall average risk indicator over the entire period and across the sub-periods is illustrated in Figure 1.

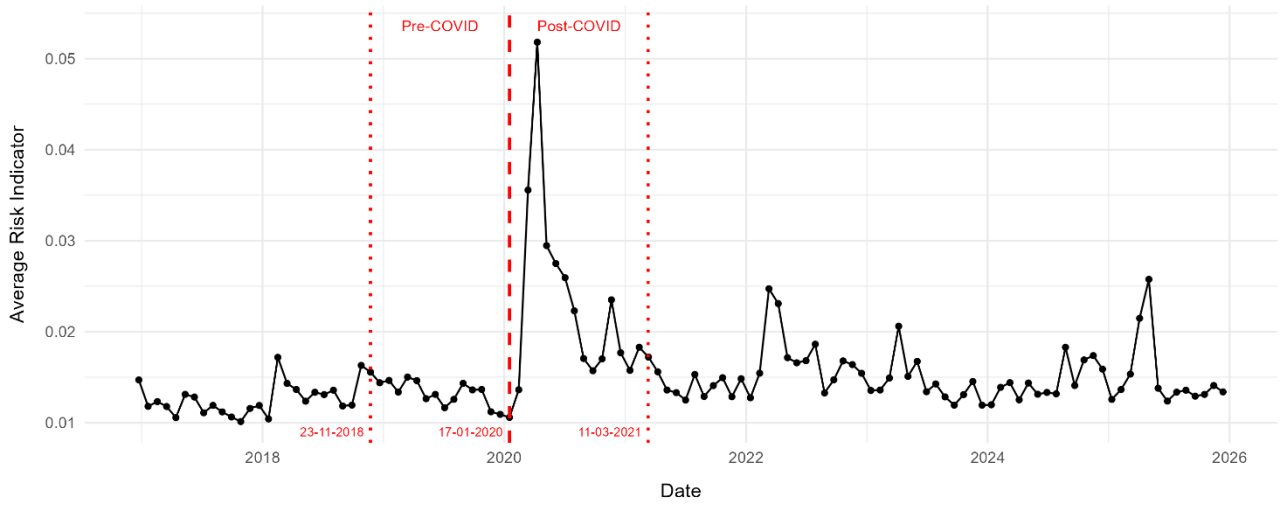

Figure 1. Development of the average risk indicator

Source: own elaboration

At the beginning of the period, approximately between 2017 and 2019, the development of the level of risk in the banking sector was relatively stable, without significant fluctuations. The first significant increase in the average risk indicator can be observed at the beginning of 2020, when the level of risk reached its peak over the entire analysed period. Additional increases can be observed in early 2022 and 2025, also indicating disruptions in the stability of the banking sector, but to a lesser extent compared to 2020. These changes in the average risk indicator could be associated with major exogenous shocks that affected not only the banking sector but also the financial system as a whole. However, the most significant increase in the riskiness and vulnerability of banking sector is observed after the outbreak of the pandemic. Therefore, the subsequent analysis focuses on the distribution of risk across individual banks. To assess the effect of the pandemic on risk indicators, the average risk indicators for the pre-COVID and post-COVID periods are calculated, and their changes are analysed (Table 2).

Table 2. Changes in average risk indicators due to the COVID-19 pandemic

	Bank	Pre-COVID	Post-COVID	Change (%)
1	NBC	0.00555	0.02139	285 %
2	BMO	0.00759	0.02259	198 %
3	U.S. Bancorp	0.01075	0.03178	195 %
4	Scotiabank	0.00664	0.01920	189 %
5	RBC	0.00648	0.01756	171 %
6	TD Bank	0.00727	0.01959	169 %
7	Truist Financial Corp.	0.01325	0.03557	168 %
8	Wells Fargo	0.01313	0.03451	163 %
9	Capital One Financial Corp.	0.01550	0.03967	156 %
10	ABN AMRO Bank	0.01531	0.03625	137 %
11	Citigroup	0.01551	0.03659	136 %
12	PNC	0.01298	0.03037	134 %
13	JPMorgan Chase	0.01234	0.02864	132 %
14	CIBC	0.00776	0.01793	131 %
15	HSBC Holdings	0.01082	0.02487	130 %
16	Barclays	0.01483	0.03393	129 %
17	Mizuho	0.00786	0.01794	128 %
18	BBVA	0.01487	0.03357	126 %

	Bank	Pre-COVID	Post-COVID	Change (%)
19	ING Group	0.01581	0.03537	124 %
20	Banco Santander	0.01536	0.03398	121 %
21	KBC Bank	0.01421	0.03114	119 %
22	Societe Generale	0.01774	0.03790	114 %
23	Hana Financial Group	0.01360	0.02895	113 %
24	Bank of America	0.01496	0.03156	111 %
25	Japan Post Bank	0.00883	0.01835	108 %
26	HDFC Bank	0.01096	0.02272	107 %
27	BNP Paribas	0.01534	0.03169	107 %
28	Lloyds Banking Group	0.01488	0.03057	105 %
29	Shinhan Financial Group	0.01204	0.02461	104 %
30	KB Financial Group	0.01370	0.02702	97 %
31	Morgan Stanley	0.01547	0.03034	96 %
32	Credit Agricole Group	0.01575	0.03042	93 %
33	Banco Bradesco	0.01616	0.03096	92 %
34	Standard Chartered	0.01519	0.02904	91 %
35	SMFG	0.00967	0.01801	86 %
36	BNY Mellon	0.01479	0.02753	86 %
37	Erste Group Bank	0.01575	0.02929	86 %
38	State Street	0.01758	0.03240	84 %
39	Goldman Sachs	0.01525	0.02794	83 %
40	Itau Unibanco	0.01540	0.02730	77 %
41	Banco do Brasil	0.01820	0.03219	77 %
42	DBS	0.00908	0.01605	77 %
43	NatWest Group	0.01804	0.03174	76 %
44	OCBC	0.00803	0.01389	73 %
45	CaixaBank	0.01850	0.03125	69 %
46	Intesa Sanpaolo	0.01415	0.02388	69 %
47	Resona Holdings	0.01188	0.01990	67 %
48	UBS Group	0.01398	0.02321	66 %
49	MUFG	0.01091	0.01799	65 %
50	UOB	0.00899	0.01439	60 %
51	UniCredit	0.02036	0.03205	57 %
52	Nordea Bank	0.01478	0.02301	56 %
53	Commerzbank	0.02402	0.03696	54 %
54	SBI	0.01895	0.02889	52 %
55	Raiffeisen Gruppe	0.01742	0.02586	48 %
56	SEB	0.01476	0.02146	45 %
57	Deutsche Bank	0.02265	0.03143	39 %
58	Bank of Ningbo	0.01710	0.02278	33 %
59	China Everbright Bank	0.01318	0.01722	31 %
60	Industrial Bank	0.01430	0.01840	29 %
61	China Merchants Bank	0.01483	0.01890	27 %
62	BOCHK	0.01270	0.01585	25 %
63	Danske Bank	0.01854	0.02305	24 %
64	CCB	0.01142	0.01373	20 %
65	Bank of Jiangsu	0.01121	0.01340	20 %
66	Ping An Bank	0.01909	0.02266	19 %
67	China Minsheng Bank	0.00907	0.01067	18 %
68	Hua Xia Bank	0.00971	0.01108	14 %

	Bank	Pre-COVID	Post-COVID	Change (%)
69	ICBC	0.00930	0.01060	14 %
70	Bank of Nanjing	0.01425	0.01600	12 %
71	ABC	0.00816	0.00908	11 %
72	SPD Bank	0.01225	0.01321	8 %
73	BOC	0.00802	0.00847	6 %
74	Bank of Beijing	0.00987	0.01039	5 %
75	China CITIC Bank	0.01216	0.01237	2 %
76	Bank of Shanghai	0.01138	0.01147	1 %
77	BoCom	0.00969	0.00910	-6 %

Source: own elaboration

As a result of the COVID-19 pandemic, nearly all banks in the sample recorded an increase in their risk indicators, reflecting a widespread rise in financial vulnerability. Although an increase in risk indicators was observed across almost all institutions, with the exception of BoCom, the analysis highlights significant heterogeneity in the magnitude of this increase. While some banks experienced only marginal increases, for many institutions the rise in the risk indicator exceeded 100 %. An extreme case is the Canadian bank NBC, where the increase reached as much as 285 %, followed by banks such as BMO (198 %), U.S. Bancorp (195 %), Scotiabank (189 %), RBC (171 %), TD Bank (169 %), Truist Financial Corp. (168 %), and Wells Fargo (163 %). In contrast, for other institutions, such as the Chinese Bank of Shanghai, the increase was almost negligible, at approximately 1 %. A marginal increase can also be observed in banks such as China CITIC Bank (2 %), Bank of Beijing (5 %), BOC (6 %), SPD Bank (8 %), Bank of Nanjing (12 %), and ICBC (14 %), all of which are headquartered in China. Paradoxically, Canadian banks, which were identified as the least risky institutions, recorded the most significant increase in their risk indicators following the COVID-19 pandemic. These results may be explained by the relatively low pre-pandemic risk levels of Canadian banks, which amplify relative percentage changes, as well as their primarily exposure to mortgage loans and household lending, which were affected by income losses. Moreover, as the risk indicator is based on market data, the observed increase likely reflects a reassessment of the market's perception of risk of individual banks in response to heightened uncertainty during the pandemic.

Discussion

This paper analyses the riskiness and vulnerability of the banking sector in the context of a significant exogenous shock, namely the COVID-19 pandemic. To assess the effect of this systemic shock, a risk indicator is constructed based on daily closing stock prices of 77 of the world's largest banking institutions over the period from November 2016 to December 2025. The findings, consistent with the existing literature (Rodríguez-Moreno and Peña, 2013; Silva et al., 2018; Foglia et al., 2022; Batten et al., 2023), confirm the negative impact of the COVID-19 pandemic on the stability of the banking and financial system.

Following the outbreak of the pandemic, a significant increase in the average risk indicator is observed, indicating a rise in the overall vulnerability of the banking sector. Although this increase is evident across almost all institutions, the results reveal substantial heterogeneity in its magnitude. Paradoxically, the largest increases are observed among Canadian Banks, which are generally considered the least risky institutions due to the stability of the Canadian banking sector. In contrast, Chinese banks recorded only marginal increases in risk indicators, with may be attributed to their stable regulatory environment, conservative business model, and the crucial role of the state support. European banks, particularly German banks, recorded the highest levels of risk indicators over the entire period and can therefore be considered the riskiest institutions within the sample. The higher risk level observed in European banking institutions can be attributed to several factors, including the effects of the financial and sovereign debt crises, a higher share of non-performing loans, the prolonged low-interest-rate environment, more complex business models, and a higher degree of international interconnectedness.

Overall, the observed differences in risk positions across banks can be primarily associated with the structural characteristics of national banking sector as well as bank-level characteristics. Future research could further explore these bank-level characteristics and their role in explaining the heterogeneous responses of banking institutions to systemic shocks such as the COVID-19 pandemic.

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Appendix A

Table A1. List of analysed banks

Bank	Total assets (USD mil.)	Country	Region	Ticker
ICBC	6 688 735	China	Asia	601398.SS
ABC	5 923 763	China	Asia	601288.SS
CCB	5 558 377	China	Asia	601939.SS
BOC	4 803 510	China	Asia	601988.SS
JPMorgan Chase	4 002 814	USA	America	JPM
Bank of America	3 261 519	USA	America	BAC
HSBC Holdings	3 017 048	UK	Europe	HSBA.L
BNP Paribas	2 800 402	France	Europe	BNP.PA
MUFG	2 758 725	Japan	Asia	8306.T
Credit Agricole Group	2 693 578	France	Europe	ACA.PA
Citigroup	2 352 945	USA	America	C
SMFG	2 045 316	Japan	Asia	8316.T
BoCom	2 041 446	China	Asia	601328.SS
Wells Fargo	1 929 845	USA	America	WFC
Banco Santander	1 901 935	Spain	Europe	SAN.MC
Barclays	1 900 675	UK	Europe	BARC.L
Mizuho	1 891 981	Japan	Asia	8411.T
Goldman Sachs	1 675 972	USA	America	GS
China Merchants Bank	1 664 868	China	Asia	600036.SS
Societe Generale	1 629 097	France	Europe	GLE.PA
UBS Group	1 565 028	Switzerland	Europe	UBSG.SW
Japan Post Bank	1 559 964	Japan	Asia	7182.T
RBC	1 558 365	Canada	America	RY.TO
TD Bank	1 479 549	Canada	America	TD.TO
Industrial Bank	1 439 616	China	Asia	601166.SS
Deutsche Bank	1 436 150	Germany	Europe	DBK.DE
China CITIC Bank	1 306 013	China	Asia	601998.SS

Bank	Total assets (USD mil.)	Country	Region	Ticker
SPD Bank	1 296 308	China	Asia	600000.SS
Morgan Stanley	1 215 071	USA	America	MS
Lloyds Banking Group	1 135 116	UK	Europe	LLOY.L
China Minsheng Bank	1 070 676	China	Asia	600016.SS
ING Group	1 056 574	Netherlands	Europe	INGA.AS
Scotiabank	1 013 295	Canada	America	BNS.TO
BMO	1 011 587	Canada	America	BMO.TO
Intesa Sanpaolo	966 234	Italy	Europe	ISP.MI
China Everbright Bank	953 408	China	Asia	601818.SS
NatWest Group	886 344	UK	Europe	NWG.L
SBI	855 994	India	Asia	SBIN.NS
Standard Chartered	849 668	UK	Europe	STAN.L
UniCredit	811 682	Italy	Europe	UCG.MI
BBVA	799 671	Spain	Europe	BBVA.MC
Ping An Bank	790 408	China	Asia	000001.SZ
CIBC	747 747	Canada	America	CM.TO
U.S. Bancorp	678 318	USA	America	USB
CaixaBank	653 280	Spain	Europe	CABK.MC
Nordea Bank	645 362	Finland	Europe	NDA-FI.HE
DBS	606 132	Singapore	Asia	D05.SI
Hua Xia Bank	599 593	China	Asia	600015.SS
Bank of Beijing	578 365	China	Asia	601169.SS
Commerzbank	574 227	Germany	Europe	CBK.DE
PNC	560 038	USA	America	PNC
Bank of Jiangsu	541 442	China	Asia	600919.SS
Truist Financial Corp.	531 176	USA	America	TFC
Resona Holdings	516 673	Japan	Asia	8308.T
BOCHK	516 422	Hong Kong	Asia	2388.HK
Danske Bank	515 869	Denmark	Europe	DANSKE.CO
HDFC Bank	514 053	India	Asia	HDFCBANK.NS
KB Financial Group	513 011	South Korea	Asia	105560.KS
Shinhan Financial Group	500 771	South Korea	Asia	055550.KS
Capital One Financial Corp.	490 144	USA	America	COF
Itau Unibanco	461 523	Brazil	America	ITUB4.SA
OCBC	457 996	Singapore	Asia	O39.SI
Bank of Shanghai	442 062	China	Asia	601229.SS
Hana Financial Group	431 780	South Korea	Asia	086790.KS
Bank of Ningbo	428 167	China	Asia	002142.SZ
BNY Mellon	416 064	USA	America	BK
ABN AMRO Bank	398 641	Netherlands	Europe	ABN.AS
UOB	393 965	Singapore	Asia	U11.SI
Banco do Brasil	387 835	Brazil	America	BBAS3.SA
Erste Group Bank	366 224	Austria	Európa	EBS.VI
Bank of Nanjing	355 030	China	Asia	601009.SS
State Street	353 240	USA	America	STT
KBC Bank	347 478	Belgium	Europe	KBC.BR
SEB	339 590	Sweden	Europe	SEB-A.ST
Raiffeisen Gruppe	337 252	Switzerland	Europe	RBI.VI
Banco Bradesco	334 603	Brazil	America	BBDC4.SA
NBC	331 701	Canada	America	NA.TO

Source: own elaboration based on TABInsights (2025)

Appendix B

Table B1. Bai–Perron structural break analysis

Breaks	Corresponding dates	RSS	BIC
1	14-02-2020	0,002846896	-900,6486030
2	**17-01-2020; 07-05-2021**	**0,002177818**	**-922,7201574**
3	14-02-2020; 04-06-2021; 02-06-2023	0,002149704	-914,7119914
4	14-02-2020; 04-06-2021; 07-04-2023; 26-07-2024	0,002123052	-906,6427399
5	16-03-2018; 14-02-2020; 04-06-2021; 07-04-2023; 26-07-2024	0,002111629	-897,7379314

Source: own elaboration

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