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Financial contagion of the Russian stock market from the Chinese stock market during the Covid-19 pandemic

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Abstract

The paper explores the financial contagion of the Russian stock market from the Chinese stock market during the global COVID-19 pandemic. Its objectives are to confirm or refute the contagion of these markets during the acute phase of the pandemic and establish the direction, intensity and types of contagion. The study employed average daily values of the *RTSI* (Moscow exchange) and *HSI* (Hong Kong stock exchange) indices. To distinguish between the period of exposure of the two countries' assets to an external shock and the period of relatively calm markets, we calculated the moving normalized coefficients of variation. To test for the presence of contagion, we constructed vector autoregression (*VAR*) models for the logarithmic returns *RTSI* with an exogenous variable of the logarithmic returns *HSI* in the pre-crisis, crisis and post-crisis periods, estimated the coefficients for *HSI* and established their significance. The intensity of contagion was determined by the change in the contribution of the tested variable (*HSI*) to the variance of the dependent variable (*RTSI*) during the crisis period compared to the pre-crisis and post-crisis periods. The Granger causality test allowed us to establish the direction of contagion; the types of contagion were identified using the method of co-moments of return distribution. The study confirmed the existence of contagion from Chinese to Russian stock market during the acute phase of the pandemic and proved its directionality (*HSI*→*RTSI*), and the decomposition of the coefficient of determination established the intensity of the contagion. In the post-crisis period, market interdependence was observed, caused by incompleteness of the pandemic crisis and changes in contagion foci. Contagion during the crisis occurred in the

form of an increase in the lower co-moments of distribution (the impact of HSI returns on RTSI returns, volatility and asymmetry) compared to the pre-crisis period, and manifested itself in the upper co-moments of distribution and market anomalies compared to the post-crisis period. The research results may assist in formulating policies aimed at maintaining financial stability; they will also be useful for investment portfolio optimization.

Keywords
Chinese stock market, Russian stock market, market returns, financial contagion, COVID-19 pandemic, VAR model.

Аннотация
В статье тестируется заражение российского фондового рынка от китайского фондового рынка во время глобальной пандемии COVID-19. Целью исследования является подтверждение/опровержение заражения в период острой фазы пандемии, установление его направленности, масштабов и типов. В исследовании участвовали среднедневные значения индексов RTSI (Московской биржи) и HSI (Гонконгской фондовой биржи). Для разграничения периода воздействия внешнего шока на активы двух стран и периода относительно спокойного рынка использовался скользящий нормированный коэффициент вариации. Тестирование заражения проводилось на основе построения авторегрессионных (VAR) зависимостей логарифмической доходности RTSI от логарифмической доходности HSI в докризисном, кризисном и посткризисном периодах, оценок коэффициентов при HSI и установлении их значимости. Масштабы заражения определялись на основе изменения вклада тестируемой переменной (HSI) в вариацию зависимой переменной (RTSI) в кризисном периоде по сравнению с докризисным и посткризисным периодами, направленность заражения — на основе теста Грейнджера на причинность, а типы заражения — на основе метода моментов совместного распределения доходности. В результате исследования было подтверждено как наличие заражения российского фондового рынка от китайского рынка в период острой фазы пандемии, так и его направленность HSI→RTSI; с помощью декомпозиции коэффициента детерминации установлены масштабы заражения. В посткризисном периоде наблюдалась взаимозависимость рынков, что объясняется незавершенностью пандемического кризиса и изменением очагов заражения. Заражение в кризисном периоде по сравнению с докризисным происходило по линии более низких моментов распределения (влияния доходности HSI на доходность, волатильность и асимметрию RTSI), а по сравнению с посткризисным — по линии более высоких моментов распределения и рыночных аномалий. Исследование представляет интерес для международных инвесторов при оптимизации инвестиционных портфелей, а также для государств при проведении политики финансовой стабилизации в условиях кризиса.

Ключевые слова
Китайский фондовый рынок, российский фондовый рынок, рыночная доходность, финансовое заражение, пандемия COVID-19, VAR-модель.

JEL: G01, F37.

Introduction

The phenomenon of financial contagion has become a subject of increased research interest over the past three decades. This period has witnessed several economic crises that have been directly or indirectly related to the accelerated globalization and financial integration of countries. The term *financial contagion* is used to describe a notable amplification or alteration in the relationship between the asset prices of different issuers during periods of exposure to an external shock, in comparison to periods of relative stability (Forbes & Rigobon, 2002). The concept of financial contagion emphasizes two key terms. The first is «*spillover*», which describes financial contagion as a situation where asset price volatility in one market spreads to another market. The second is *co-movement*, which refers to a significant increase in the joint dynamics of markets following an exogenous shock that cannot be explained by the impact of fundamental economic factors (Dornbusch et al., 2000).

One of the most recent crises to give rise to financial contagion was the 2020 pandemic caused by the novel coronavirus (COVID-19), which led to significant disruptions in global financial markets. Prior to the pandemic, several studies have demonstrated that markets exhibited a high degree of cointegration, with mixed transmission of external shocks between them (Tabash et al., 2022; Gajurel & Dungey, 2023; Tang & Aruga, 2021; Davidescu et al., 2023; Zehri et al., 2024). However, the pandemic, due to the specificity of external causes and response methods, altered the processes of financial contagion (Matos et al., 2021; Naeem et al., 2022; Uddin et al., 2022).

The problem of contagion was acute in Asia, especially in China, which became a focal point for the dissemination of the COVID-19 infection (Sohrabi et al., 2020). In early 2020, the outbreak of coronavirus infection was perceived as a localized phenomenon within China and was not given due consideration outside the region. However, the rapid spread of the coronavirus led the World Health Organization to recognize the situation as an emergency of international concern (30 January 2020) and subsequently declare a pandemic (11 March 2020). These processes and the accompanying news background resulted in market turbulence not only in China but also in the markets of other countries (Ganie et al., 2022). The implementation of enforced quarantine measures in China resulted in the disruption of production chains, with ramifications extending beyond the economic sector of the country to impact economic partners both in the Asian region and worldwide (Ramelli & Wagner, 2020; Ain Shahrier, 2022; Zhang et al., 2022; Muharam & Pratama, 2020; Bagchi et al., 2023; Guru & Yadav, 2023).

In the era of globalization and complex interdependence of national economies, the effect of financial contagion can be viewed from different perspectives. The co-movement of individual economic variables including the dynamics of national currency exchange rates and stock indices is a common characteristic of emerging markets in general and the BRICS countries in particular. This study focuses on the impact of the Chinese market on the Russian market. China and Russia have historically maintained close economic relations. Asian financial markets frequently exert an influence on the

Russian financial markets (Minakir, 2020); during the pandemic, the Russian stock market was particularly susceptible to external shocks from China, Japan, Singapore, and Taiwan (Dzyuba et al., 2023). Previous economic crises have shown that regions with closer economic ties tend to experience more pronounced contagion effects. Close spatial, macroeconomic or institutional proximity and significant bilateral trade render economies of different countries highly dependent on each other. The pandemic crisis was no exception.

Financial shocks can propagate between financial markets through a variety of channels such as information, liquidity, trade, financial, macroeconomic and political channels (Loukianova & Smirnova, 2015; Guidolin & Pedio, 2017; Grillini et al., 2022). Below is a detailed explanation of what these channels are and how they might work in the interaction between China and Russia.

The information channel operates through the transmission of information about asset prices. An information imbalance between the parties to a transaction can have significant implications for the work of international markets. The lack of complete and accurate information about the situation in other countries forces investors to rely on the actions of foreign participants. This can lead to confusion when investors analyze asset price changes caused by shocks specific to other countries that lead to volatility spillovers and overreactions in domestic prices (Boshkoska et al., 2024). The distinctive response of stock markets to the global pandemic of 2020 was not solely attributable to the transmission of asset price information. There was also a significant correlation between the dissemination of data regarding the number of confirmed cases of the COVID-19 and fluctuations in asset prices (Ashraf, 2020). The rapid transformation of the disease from a local outbreak to a global pandemic shifted the epicentre of financial markets' response to the disease threat, with markets stabilising in China and declining in other countries (Ali, 2020). However, reports of economic measures to deal with the pandemic also had a significant impact on changes in market volatility (Zaremba et al., 2020). Researchers have identified the presence of information asymmetry in both investors' general awareness of the pandemic and its future development, as well as among investors in different regions, contingent on the movement of the pandemic epicenter (Szczygielski, 2022).

The liquidity channel is associated with a decline in the creditworthiness of borrowers and scarcity of general liquidity in the economy. As posited by Kyle and Xiong (2001), the behaviour of financial intermediaries exerts a considerable influence bringing about diminution of liquidity, decline in asset prices and intensification of market volatility. Consequently, a crisis in the domestic market may result in liquidity issues for a significant number of investors, compelling them to divest foreign assets from their portfolios. This, in turn, precipitates a decline in the prices of foreign securities and a reduction in the capitalization of foreign markets. Furthermore, investor behavior is shaped by the extent of risk aversion. Investors often use analogy to assess the risks associated with securities from other countries that are part of the same region or exhibit comparable macroeconomic and political characteristics. This may lead to the simultaneous dumping of securities from countries with similar profiles during a crisis.

Accordingly, significant asset sales can destabilize individual country markets without any underlying fundamental rationale (Zhuang & Dowling, 2003).

The trade channel can be defined as a mechanism through which the mutual influence of international markets is facilitated by the supply and demand for resources, goods and services. China is an important trading partner of Russia. International trade plays a significant role in economic relations between these countries. In the year preceding the advent of the pandemic, the trade turnover between Russia and China reached a value of 110.76 billion USD (Trade Representation of Russia in China, 2024). In response to the outbreak of the COVID-19, China rapidly reduced its manufacturing and consumer activity. Prior to the pandemic, China accounted for 20% of global trade in intermediate products. The 2% decline in exports of such products from China had a serious impact on the production capacity of many countries. As reported by UNCTAD, the European Union suffered the greatest losses, amounting to 11 billion USD, because of the reduction in supplies from China. The United States and Japan also suffered, with losses reaching 5.8 billion USD and 5.2 billion USD, respectively. It is estimated that Russia incurred losses amounting to approximately 149 million USD (UNCTAD, 2020). Overall, the reduction in trade turnover between China and Russia during the pandemic is estimated at approximately 3 billion USD. In the post-pandemic period, however, the trade turnover between Russia and China increased from 107.76 billion USD in 2020 to 218.76 billion USD in 2022 (RIA Novosti, 2023).

The financial channel is a path for the impact of shocks to reach stock market returns and capital flows between countries. The export of goods from Asian countries is accompanied by a substantial inflow of foreign direct investment (FDI) into the importing countries. As indicated in the ASEAN Annual Investment Reports, the total value of direct investment flows from China in 2019 amounted to 9 billion USD while those from Hong Kong it reached 12.9 billion USD (ASEAN, 2021). In the post-pandemic period, the volume of such investments from China has more than doubled: from 7 billion USD in 2020 to 15 billion USD in 2022. At the same time, investments from Hong Kong increased from 8 billion USD in 2020 to 13 billion USD in 2022 (ASEAN, 2023); these are extremely important because they provide insight into the true scale of investment from China. Some investment flows, constrained by China's "containment policy" and subjected to heightened scrutiny by other countries, find their way through offshore structures in Hong Kong or the British Virgin Islands (McCalman et al., 2022; Wache, 2024). According to Sahiner (2024), a higher degree of financial stress is transmitted between Asian countries through the Hong Kong stock market. Moreover, an analysis of the relationships between the returns of companies listed on the Hong Kong Stock Exchange revealed that their "co-movement" had increased during the pandemic, accompanied by an escalation of systemic risk – a phenomenon not seen in previous financial crises (So et al., 2021).

In 2022, the European Bank for Reconstruction and Development recorded foreign direct investment from China to the post-Soviet countries in the amount of 67.5 billion USD, of which 12.5 billion USD went to Russia. In contrast, the Bank of Russia reported

a relatively low level of direct investment from Asian countries to Russia. Similar to investments from China into ASEAN, it is important to consider the significant proportion of investments into Russia from offshore jurisdictions. The countries in question are the Bahamas, Bermuda, the British Virgin Islands, Jersey, Cyprus, the Netherlands and Luxembourg. The data reported by the Bank of Russia reflect cross-border investments from the investor country although in fact they are made through intermediate transit or conduit jurisdictions, so the statistics on investment flows into Russia give a distorted picture (Casella, 2019; Kluge, 2024).

The macroeconomic channel transmits the responses of different markets to macroeconomic changes. These changes may include depreciation of the national currency, a rise in the budget deficit, or an increase in the debt burden. It is therefore assumed that crises can spread between countries with similar macroeconomic conditions, and that intensified domestic borrowing and exchange rate depreciation significantly increase the probability of financial contagion and the power of crises (Jiang et al., 2022). Some researchers argue that alterations in macroeconomic variables in response to crisis shocks occur over a longer period of time than adjustments in asset prices (Yarovaya et al., 2022). This allows them to conclude that the analysis of the reaction of macroeconomic fundamentals (variables) should be carried out in conjunction with the main contagion channels even though the intensity of financial contagion depends on the level of international economic relations and macroeconomic variables are conventional channels in contagion studies.

The political channel is described as a mechanism through which changes in economic policy are made in response to macroeconomic and financial instability. A case in point would be a shift in the key rate set by the central bank. In the event of an economic shock, countries with comparable institutional and political structures typically apply unidirectional measures to contain the crisis. These measures are usually in the interests of open economies but they may result in financial contagion between them (Hausken & Plumper, 2002; Dasgupta et al., 2011). The level of corruption, respect for law and order, and the quality of government regulation in the economy can also influence the extent of financial contagion (Kaufman et al., 2009).

It is a widely held view among researchers that markets are connected through financial and trade channels, with the information channel playing a significant role in the transmission of financial contagion. However, the similarity of macroeconomic policies in the two countries during the pandemic may also lead to contagion through macroeconomic and political channels (Ahmed et al., 2021).

In the analysis of financial contagion, the development and justification of appropriate statistical and econometric tools for the analysis of market interconnectivity play a pivotal role. These tools facilitate a comprehensive assessment of the direction and magnitude of systemic risk. Researchers have developed a variety of analytical tools, including the method of co-moments of return distribution, method of building VAR and GARCH models of various specifications, method of spatial autoregressions, the construction of quantile regressions, the copula method, wavelet analysis, and others (Lu et al., 2023; Tan et al., 2022; Youssef et al., 2021).

This paper aims to confirm and assess the financial contagion of the Russian stock market from the Chinese stock market during the acute phase of the pandemic. To this end, we construct vector autoregressive models and use the method of decomposing the coefficient of determination. The method of co-moments of return distribution is further applied to elucidate the types of contagion (in terms of returns, volatility, skewness, and so forth). The methodology employed in this study has been previously applied in the study by Malkina and Rogachev (2024) to examine the influence of the European stock market (*STOXX-50 index*) on the Russian stock market (*RTSI*) during the global COVID-19 pandemic. In this paper, contagion was identified based on the significance and change in the estimated coefficient for the tested variable (the supposed source of contagion) during the crisis period compared to the pre-crisis and post-crisis periods. The degree of market contagion was assessed by changing the contribution of the tested variable (*STOXX-50* returns) to the variance of the dependent variable (*RTSI* returns) during the crisis period compared to two other periods. Our new study develops these methods to analyze the impact of the Chinese stock market on the Russian stock market.

Exploring the interconnectedness of financial assets in the new economic context will provide investors with information needed to adjust portfolio diversification and risk hedging strategies to overcome losses caused by major shocks, such as the COVID-19 pandemic. It will also provide a basis for regulators to design robust macroprudential measures that could mitigate their spillover effects in the financial sector.

Research Hypothesis

The study aims to confirm or refute the presence of a spatial financial contagion effect from the Chinese stock market on the fundamental (market) returns in the Russian stock market during the COVID-19 pandemic, and then evaluate it and determine its types.

The study hypothesis: the relationship between the asset returns of the Russian and Chinese stock markets will manifest itself or become significantly stronger only during the period of impact of the pandemic shock, making it possible to identify the signs of financial contagion. In the pre-shock and post-shock periods, the Russian stock market returns should demonstrate reduced sensitivity to changes in the Chinese stock market. In the absence of substantial alterations in their interconnection at various stages of the crisis, their co-movement would indicate interconnectedness but not contagion.

Data and Methodology

The *RTSI* (Russian Trading System Index) is an indicator of the current state of the Russian stock market, reflecting the dynamics of share prices of the largest Russian companies traded on Moscow Exchange, measured in the US dollars. The *HSI*, Hang

Seng Index of the Hong Kong Stock Exchange (HKEX) is one of the most significant indicators of the Chinese market. For the purposes of our study, we converted *HSI* from Hong Kong dollars (HKD) into the US dollars (USD). During the period under review, both stock exchanges were home to international investors trading around the world, so we used the US dollar as a benchmark.

Traditionally, the RTS index has a negative correlation with the US dollar to ruble exchange rate, and this relationship becomes more pronounced during crises. According to the time frame defined below, in the pre-pandemic period the linear correlation coefficient of the *RTS* index logarithmic returns and the US dollar to ruble exchange rate was –0.63; during the pandemic it was –0.82; in the post-pandemic period –0.71. At the same time, the *HSI*, estimated in US dollars, shows only weak sensitivity to the US dollar to Hong Kong dollar exchange rate (–0.19, –0.16 and –0.19, respectively, in three periods). No relationship has been found between the dynamics of the exchange rates of the two currencies: the Russian ruble and the Hong Kong dollar against the US dollar. This allows us to conclude that the dynamics of the exchange rates does not affect the relationship between the two indices and, therefore, the assessment of financial contagion. In other words, the use of two indices in US dollars does not distort the estimates.

China has other stock market indices, such as the Shanghai Composite (SSEC) and SZSE Component, but we chose the *HSI* because, historically, Hong Kong has been better integrated into the global economic system and more exposed to globalization processes than mainland China. The *HSI* is constructed based on the capitalization of 82 companies, including both local companies and mainland Chinese companies listed in *HKEX* and denominated in Hong Kong dollars. The construction of the index entails the incorporation of three distinct categories of stocks: *the H-share* category comprises stocks of companies listed in mainland China; t*he red-chip* category includes stocks of companies listed outside mainland China, often in Hong Kong, but controlled by the mainland Chinese enterprises; t*he P-chip* category represents the shares of private mainland Chinese companies listed outside mainland China, in Hong Kong. The *HKEX* is more open to international investors than the mainland China exchanges, that is why its index was chosen to analyze cross-country processes of financial contagion.

It is important to note that the Chinese yuan (CNY) is not a fully convertible currency and foreigners' access to China's domestic stock, such as the *A-shares* of mainland Chinese companies listed on the Shanghai Stock Exchange (SSE) or Shenzhen Stock Exchange (SZSE), remains restricted via programs like the Stock Connect. The complexities of the CNY, however, can be sidestepped by using the Hong Kong dollars.

The first step in diagnosing contagion is distinguishing between periods of external shocks, which manifest themselves in increased market volatility, and periods of relative market stability. To achieve this goal, we calculated moving coefficients of variation (CV_X) of Russian (*RTSI*) and Hong Kong (*HSI*) stock market indices. These coefficients were calculated sequentially for each point in time based on 10 index values before a given date, the index value on that date, and 10 index values after that date. The choice of 21 values was made to align with the average number of trading sessions in a month.

$$CV_X = \frac{s_X}{m_X}, \quad (1)$$

where μ_X is the intertemporal mean of the considered index X in each sub-period, and σ_X is standard deviation of X in the same period.

To enhance visualization of the coefficients of variation, the data were normalized on a linear scale (0;1).

$$ICV_X = \frac{CV_X - minCV_X}{maxCV_X - minCV_x}, \quad (2)$$

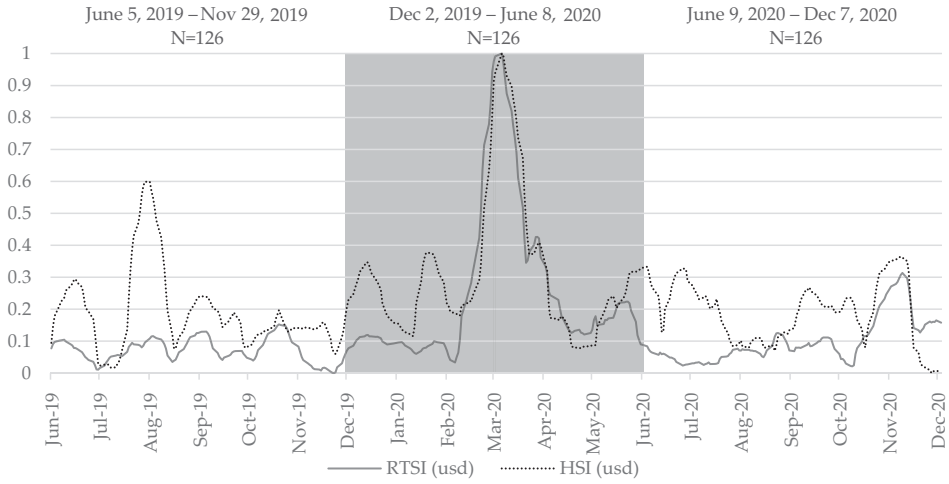

Figure 1. Moving normalized coefficients of variation of the logarithm of index values. *Note*. The area corresponding to the highlighted crisis period is greyed out. *Source*: Compiled by the authors based on their own calculations

The duration of the economic crisis was defined in accordance with the sustained surplus of the moving coefficient of variation relative to its mean value over the course of the study period (2016-2021)[1]. The observation exhibiting the greatest degree of variation was identified as the midpoint of the crisis period. The number of observations within this period (N = 126) corresponds to six months, with each month comprising an average of 21 trading sessions. Equal length periods preceding and following the crisis period were designated as the pre-crisis and post-crisis phases, respectively. Figure 1 demonstrates the dynamics of the moving normalized coefficient of variation calculated for the logarithm of the values of the studied indices.

[1] This study presents the time interval corresponding to the examined period of the COVID-19 pandemic. We did not find any other effects of financial contagion transmission from the Chinese stock market to the Russian stock market in the periods 2016-2019 and later than 2021.

Figure 1 shows that the period of greatest market volatility occurred between December 2, 2019 and June 8, 2020, which generally coincides with the acute phase of the pandemic. The pre-crisis period (June 5, 2019 – November 29, 2019) and post-crisis period (June 9, 2020 – December 7, 2020) are defined respectively, each of which includes 126 observations.

To test the hypothesis that there may have been a contagion of the *RTSI* from the *HSI* during the pandemic, we constructed a vector autoregression (VAR) model using *HSI* returns as an exogenous variable. We employed robust estimates of standard errors to address heteroscedasticity. Vector autoregressive models were developed separately for the periods preceding, during and following the crisis period.

This model has the following form:

$$Y_t = c + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{j=1}^{k} b_j X_{t-j} + \varepsilon_t, \quad (3)$$

where: Y_t — vector $p \cdot 1$ of endogenous variables at time t; c — constant; X_t — vector $k \cdot 1$ of exogenous variables at time t; a_i — matrix $p \cdot p$ of coefficients of endogenous variables with lag up to order p; b_j — matrix $p \cdot k$ of coefficients of exogenous variables with lag up to *order k*; ε_t — vector of model residuals at time t.

The estimation of VAR model parameters is contingent on the assumption of stationarity of time series. Therefore, in the modeling we used the difference in the logarithms of the index values (i.e. their logarithmic returns). The stationarity of the obtained time series of variables was confirmed by the augmented Dickey-Fuller test.

The maximum lag size in the models was determined by a comprehensive analysis of the Akaike, Schwartz, and Hennan-Quinn information criteria. This analysis yielded clear results, with most criteria pointing to an optimal lag of 1. Furthermore, the constant term was excluded from the constructed models, given that estimates of this parameter were close to zero and exhibited no statistically significant effect.

The potential limitations of vector autoregression (VAR) models with exogenous variables are threefold. Firstly, they do not account for cross-sectional relationships between included variables that may affect the joint dynamics of markets. Secondly, they are unable to capture changes in the relationships between variables over time. Thirdly, they are sensitive to the choice of variables and time periods (Youssef et al., 2021).

The impact of the Chinese stock market on the Russian stock market during the crisis period was examined in comparison to the pre-crisis and post-crisis periods through the implementation of several analytical techniques:

1) comparing the values of the coefficients for the *HSI* variable; the latter's impact on the Russian stock market during the crisis presumably differed from that in the pre-crisis and post-crisis periods. The statistical significance of these coefficients in models (3) is determined.

2) calculating the contribution of the *HSI* variable to the explained variance of the dependent variable *RTSI* in the crisis period compared to the pre-crisis and post-crisis periods using the following formula:

$$Var\left(X_j / Y\right) = \frac{b_j^2 \times Var\left(X_j\right) + \sum_{i=1}^{p} b_j \times a_i \times CoVar\left(X_j; Y_{t-i}\right)}{Var(Y)}, \quad (5)$$

where: $Var(X_j)$ — variance of the exogenous tested variable x_j, b_j и a_i — coefficient estimates from model (3); $CoVar(X_j; Y_{t-i})$ — covariance of the tested variable with the lagged dependent variable.

3) conducting a Granger causality test to identify the source and recipient of financial contagion;

4) determining the co-moments of *RTSI* and *HSI* returns distribution in the pre-crisis, crisis and post-crisis periods using the methodology developed for additional confirmation of contagion and identification of its forms in the works of Forbes & Rigobon (2002), Fry et al. (2010), Fry-McKibbin & Hsiao (2018).

Research Results and Discussion

Table 1 presents descriptive statistics of the logarithmic returns of *RTSI* and *HSI* in three time periods: pre-crisis, crisis, and post-crisis.

Table 1. Descriptive statistics of logarithmic returns of variables

	RTSI	HSI
	June 2019 — November 2019 (BC)	
Average, %	0.08	–0.01
Standard deviation, %	0.928	1.054
Skewness	–0.626	0.192
Kurtosis	2.738	1.663
	December 2019 — June 2020 (C)	
Average, %	–0.09	–0.04
Standard deviation, %	3.236	1.695
Skewness	–1.242	–0.508
Kurtosis	4.540	1.842
	June 2020 — December 2020 (PC)	
Average, %	0.05	0.05
Standard deviation, %	1.570	1.159
Skewness	0.155	0.126
Kurtosis	1.629	0.663

Note: Hereinafter BC — pre-crisis (before-crisis) period; C — crisis period; PC — post-crisis period.
Source: Compiled by the authors based on their own calculations.

The data in Table 1 show that there was a noticeable decline in asset prices during the acute phase of the pandemic. However, the decline in *RTSI* returns was more pronounced than the decline in *HSI* returns. In the post-crisis period, both indices exhibited a rebound, returning to an upward trend. The growth of the standard deviation during the crisis period indicates increased market volatility. The negative skewness during this period reflects a leftward shift in returns, which corresponds to an increase in the probability of losses. The growth of kurtosis means an increase in the number of extreme cases. Taken together, they indicate a deterioration of the market situation, a change in the sentiment of stock market participants, an increase in uncertainty and risk, and significant price jumps.

Table 2 presents the results of estimating VAR models with an exogenous variable for three periods: pre-crisis (BC), crisis (C) and post-crisis (PC).

Table 2. Estimated coefficients and tests of VAR models*

Y_t (*RTSI*)	Y_{t-1} (*RTSI*)	X_t (*HSI*)	R^2	The Portmanteau test		*ARCH* test *LM* Lag		*DH* test		*F* test	
(BC) June 19 — November 19	0.0281	0.25818***	0.09	30.01	✓	0.246	✓	10.63***		0.1357	
(C) December 19 — June 20	–0.1851*	1.08062***	0.302	31.32	✓	2.373	✓	21.96***		3.2089*	✓
(PC) June20 — December 20	0.0006	0.70149***	0.266	32.01	✓	0.338	✓	4.76	✓	0.0001	

Note: Significance levels * p ≤ 0.05; ** p ≤ 0.01; *** p ≤ 0.001.
R^2 is the coefficient of determination.
Robust estimates of standard errors (adjusted for heteroscedasticity), variant HC1.
For ease of visualisation and presentation of the results obtained for the three periods, the test results are marked:
Portmanteau test (✓) — no autocorrelation;
ARCH test LM Lag (✓) is the first order lag homoscedasticity;
DH test (✓) — the distribution of residuals follows a normal distribution;
F-test (✓) — a subset of variables has a statistically significant effect.
Source: Compiled by the authors based on their own calculations

Table 2 illustrates that the relationship between the variables under examination is weakly significant during the crisis (with the coefficient of determination, R^2, equating to 0.3), and there is a notable negative correlation between the return on the Russian stock market at the current point in time and the return at the previous point in time, which indicates a gradual decline in stock prices. The significant positive coefficient on the *HSI* variable indicates a correlation between the Chinese and Russian stock markets: their stock prices decline in tandem. The lag subset in the models makes a significant contribution to explaining the variance of the dependent variables, as evidenced by the F-test result. Furthermore, the subset of variables Y, X_{t-1} is significant only in the crisis period.

The results confirm our hypothesis that the relationship between variables appears or strengthens precisely during the period of economic shock. This points to the presence of financial contagion and its transmission from the Chinese market to the Russian market. The results of the additional model quality diagnostics (Portmanteau,

Doornik-Hansen and ARCH tests) generally corroborate the appropriateness of the selected model specification. The lack of normality in the residuals distribution in the pre-crisis (BC) and crisis (C) periods may be indicative of the presence of outliers or a non-linear relationship between the dependent variable and its predictors. The low explanatory power of the *HSI* suggests that other factors not included in this model may also participate in the formation of the *RTSI*.

Table 3 presents the results of the Granger causality testing procedure applied to the models. The calculations indicate that during the pandemic crisis, *HSI* returns caused a change in *RTSI* returns. This also confirms the presence of contagion of the Russian stock market from the Chinese stock market during the crisis, given that before the crisis the variables in question had no influence on each other. On the contrary, in the post-crisis period, their co-movement indicates mutual dependence (interconnectedness), which is probably due to the simultaneous fading of crisis phenomena in the period of global economic recovery.

Table 3. Granger causality test

Period	Null hypothesis	F-statistics
(BC) June 19 — November 19	RTSI ↛ HSI	4.123966*
	HSI ↛ RTSI	4.49568*
(C) December 19 — June 20	RTSI ↛ HSI	15.9622***
	HSI ↛ RTSI	1.68908
(PC) June 20 — December 20	RTSI ↛ HSI	1.17771
	HSI ↛ RTSI	0.58442

Note: Significance levels * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$.
Source: Compiled by the authors based on their own calculations

Based on the methodology outlined in Formula (4), we decomposed the contribution of the explanatory variables to the variance of the explained variable. As evident from Table 4, the contribution of the *HSI* return to *RTSI* return variance exhibited a notable growth during the crisis period (from 8.5% to 29.4%). In the post-crisis period, the contribution of the tested variable *HSI* to the variance of *RTSI* decreased slightly (to 26.6%), indicating the lingering impact of the crisis. In general, the obtained data support the hypothesis that the Russian stock market was affected by the Chinese stock market during the acute phase of the pandemic.

Table 4. Contribution of factors to the variance of the RTSI returns, %

Period	RTSI(-1)	HSI	Explained variance
(BC) June 19 — November 19	0.26	8.52	8.79
(C) December 19 — June 20	0.81	29.41	30.22
(PC) June 20 — December 20	0.003	26.56	26.563

Source: Compiled by the authors based on their own calculations

To establish the types of contagion of the Russian *RTSI* from the Hong Kong *HSI*, we also calculated the number of co-moments of return distribution of the two indices in three periods. A significant increase in the value of the co-moment (correlation, coskewness, cokurtosis or covolatility) during the crisis period compared to the pre-crisis and post-crisis periods indicated the possibility of contagion of the respective types, which was ultimately confirmed by testing the equality of the compared co-moments. The null hypothesis states the absence of contagion. The results of the calculation of co-moments and the performed tests are presented in Table 5. Cells shaded in grey indicate confirmation of contagion for the relevant co-moment of the return distribution. For these cases, the test statistic exceeds the critical value at the chosen significance level (p = 0.05).

Table 5. Tests for co-moments of HSI and RTSI returns distribution

Co-moments of return distribution	Co-moments value				Test statistics		p-value	
	BC	C/BC	C/PC	PC	C/BC	C/PC	C/BC	C/PC
Correlation (FR_{11} test)	0.278	0.354	0.369	0.474	2.898	–1.002	0.004	0.316
Coskewness (CS_{12})	–0.161	–0.668	–0.668	0.223	6.740	18.388	0.009	0.000
Coskewness (CS_{21})	0.015	–0.317	–0.317	0.235	2.888	7.051	0.089	0.008
Cokurtosis (CK_{13})	1.316	2.301	2.255	0.818	7.813	14.982	0.005	0.000
Cokurtosis (CK_{31})	1.026	1.164	1.118	0.338	0.152	4.650	0.696	0.031
Covolatility (CV_{22})	0.255	0.847	0.816	–0.160	1.991	2.475	0.158	0.116

Note. * The conditional correlation coefficients were obtained by adjusting the correlation coefficient of the crisis period for the change in the variance of index returns during the crisis period compared to the pre-crisis and post-crisis periods using the method developed in (Forbes & Rigobon, 2002). C/BC — crisis period relative to pre-crisis period, C/PC — crisis period relative to post-crisis period.
Source: Compiled by the authors based on their own calculations

The hypothesis that *RTSI* experienced contagion from *HSI* in the crisis period *compared to the pre-crisis period,* is confirmed by the second co-moment of the return distribution (correlation), the third co-moment (coskewness), and the fourth co-moment (cokurtosis). These confirmations are made in terms of the impact of *HSI* returns on *RTSI* returns, volatility and skewness, respectively. The remaining tests do not corroborate the hypothesis of contagion from *HSI* to *RTSI*.

The hypothesis that *RTSI* experienced contagion from *HSI* in the crisis period *compared to the post-crisis period* is supported by the third co-moment of distribution (coskewness) both in terms of the impact of *HSI* returns on *RTSI* return volatility and in terms of the impact of *HSI* return volatility on *RTSI* returns. The contagion is also confirmed by the fourth co-moment of distribution (cokurtosis) both in terms of the influence of *HSI* returns on *RTSI* skewness and in terms of *HSI* skewness on *RTSI* returns. However, the other tests do not confirm the presence of *RTSI* contagion from *HSI*.

Taking into account the econometric models and statistical tests used in this research, it can be asserted with a high degree of confidence that contagion from the Chinese stock market to the Russian stock market occurred during the acute phase of the coronavirus pandemic.

Conclusions

The objective of this study was to find out whether financial contagion of the Russian stock market from the Chinese stock market occurred during the global pandemic caused by COVID-19. The term «*financial contagion*» is used to describe a notable strengthening of inter-market interrelationships during the impact of external shock, when the influence of fundamental factors cannot be identified as the primary driver. The majority of researchers agree that China was the origin of the coronavirus and that the Chinese stock market was the most responsive to the economic crisis at the beginning of the pandemic. Therefore, it is reasonable to suggest that the Chinese stock market may have been a source of financial contagion for other markets during the acute phase of the pandemic.

The transmission of financial contagion between countries occurs through a number of channels, including trade, financial, information, macroeconomic and political channels. It is possible that they were involved in the interaction between the Russian and Chinese stock markets during the COVID-19 pandemic. The integration of the Chinese and Russian economies through international trade and investment provides a conduit for contagion through trade and financial channels. The stock market in Hong Kong, a special administrative region of China, has historically been subject to the least regulation by Chinese authorities and has been the most open to foreign investors. Consequently, its prices have been most sensitive to global shocks. In addition, the majority of Chinese companies' shares are traded on the Hong Kong stock exchange. Before the start of Russia's special military operation in Ukraine, the Russian stock market was also relatively accessible to foreign investors. This suggests that the transmission of financial contagion between the Chinese and Russian stock markets may have occurred not only through the trade and financial channels, but also through the information channel. Furthermore, there are notable parallels between Russia and China in terms of their institutional and macroeconomic structures, as well as their responses to economic crises. These similarities may have contributed to the propagation of macroeconomic and political contagion, despite the reservations of some scholars regarding the self-sustainability of these channels.

The distinction between the crisis, pre-crisis and post-crisis periods of the study was made using normalized moving coefficients of variation of *RTS index* of the Moscow Exchange and *HSI* of the Hong Kong stock exchange. The potential contagion of the Russian stock market from the Chinese stock market was tested using vector autoregression (VAR) models. The contagion types were identified

using the method of co-moments of return distribution. The increase in coefficient estimates for the tested variable (*HSI*) and their significance during the crisis period in comparison to the pre-crisis and post-crisis periods (when the model satisfies the majority of quality criteria), as well as the increase in the contribution of the tested variable (*HSI*) to the variance of the explained variable (*RTSI*), serve to confirm the presence of contagion of the Russian stock market from the Chinese stock market during the acute phase of the pandemic. The Granger causality test demonstrated the directionality of contagion from Hong Kong to the Russian stock market during the crisis. Additionally, it indicated the presence of mutual influence of indices after the acute phase of the pandemic. The persistence of residual phenomena of market contagion after the acute phase of the pandemic is evidenced by the high contribution of *HSI* to the explained variance of *RTSI* in the post-crisis period.

The analysis of the co-moments of return distribution revealed the types of contagion of the Russian stock market from the Chinese stock market. A comparison of the crisis period with the pre-crisis period testified that contagion occurred primarily along the line of lower co-moments of distribution, specifically in terms of correlations between *HSI* returns and *RTSI* returns, volatility and skewness. A comparison of the crisis period with the post-crisis period revealed that contagion occurred along the line of higher co-moments of distribution (coskewness and cokurtosis). This suggests a connection not at the level of returns, but rather at the level of extreme values and «heavy tails» of the distribution.

The hypothesis that the Russian stock market experienced contagion from the Chinese market during the pandemic is thus confirmed, and the characteristics of this contagion are revealed. The study may be useful for regulators adjusting financial stabilization policies during periods of exposure to external shocks and for investors managing portfolios in times of crisis.

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