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CONTAGION CHANNELS IN THE BİST STOCK MARKET

Osman Emre ARLI*

* Muğla Sıtkı Koçman Üniversitesi, Muğla Meslek Yüksekokulu

e-posta: emrearli@mu.edu.tr,

ORCID 0000-0002-7756-9372

Berkan ATAŞ**

** İstanbul Üniversitesi, İşletme Fakültesi.

e-posta: atasberkan@gmail.com

ORCID 0000-0003-3049-3195

ABSTRACT

The contagion effect refers to the transfer of price fluctuations from one market to others. In periods of turmoil, the relationship between various asset markets can result in substantial risks of contagion that go further the typical risks connected with changes in volatility and correlation. This can occur through various channels, such as the spread of shocks caused by transformations in the statistical relationships on asset returns, including changes in the relationship between average yields and volatility across different markets. This paper analyses the contagion of the BİST stock market on the volatility of gold, foreign exchange, and crude oil markets during the Covid-19 period. The correlation, coskewness, cocurtosis, covolatility test applied to measure the volatility contagion. The result shows contagions among the mentioned markets through higher moments. Our results are essential for asset management and developing preventive measures for financial stability.

Keywords: Contagion Effect, Coskewness, Covid-19

Jel Codes: G10, G21

BİST HİSSE SENETLERİ PİYASASINDA BULAŞMA KANALLARI

ÖZ

Bulaşma etkisi (contagion effect) bir piyasada meydana gelen fiyat hareketliliğinin yayılarak başka bir piyasaya sirayetini ifade etmektedir. Varlık piyasası dalgalanma geçişkenliği, finansal kriz dönemlerinde, volatilite ve korelasyonlardaki değişikliklerle ilişkili risklerin ötesinde önemli bulaşma risklerine yol açabilir. Bu kanallar, varlık getirilerinin yüksek dereceli anlamsız değişikliklerinde meydana gelen şokların iletimini içerir ve varlık piyasaları arasındaki volatilite ve ortalama getiriler arasındaki etkileşimdeki değişikliklerden kaynaklanan eşçarpıklıklarda oynamalar meydana getirmektedir. Bu çalışmada Covid-19 pandemisi döneminde BİST hisse senetleri piyasası ve altın, döviz, ham petrol volatilitesi üzerindeki bulaşma etkisi araştırılmıştır. Çalışmada volatilite bulaşma etkisini ölçmek için korelasyon, eşçarpıklık, eşbasıklık ve eşvolatilite testleri uygulanmıştır. Çalışmanın sonuçları bahsi geçen piyasalar arasında yüksek momentler üzerinden bulaşma etkisi olduğunu göstermektedir. Sonuçlarımız, varlık yönetimi, bulaşma olaylarının daha iyi anlaşılması ve finansal istikrar gözetimi için ihtiyati önlem araçların geliştirilmesi açısından önem arz etmektedir.

Anahtar Kelimeler: Bulaşma Etkisi, Eşçarpıklık, Covid-19

Jel Kodları: G10, G21.

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INTRODUCTION

Global financial crises create disturbances in international markets that are transmitted to various sectors of the economy, causing a worldwide ripple effect. These market fluctuations not only pose challenges to portfolio diversification but also have implications for policymakers' decision-making processes. This study explores the impact of the contagion channel, as portrayed by Forbes and Rigobon (2002), regarding the financial markets amidst the Covid-19 pandemic. The interdependencies between normal periods and crisis periods manifest in diverse ways. Even in non-crisis periods, there are significant connections among financial markets. Contagion refers to the spread of shocks across one or more markets (Hui, Chan, 2021). During the pandemic, there was a notable increase in the interdependencies among financial assets. Dependencies can occur due to current market connections, like trade links, financial transactions, and shared vulnerability to unexpected events. The contagion effect signifies that the unpredictable volatility disrupts the usual interconnections between markets in cross-market relationships (Apergis et al., 2019). This definition provides a practical approach for analyzing if the links betwixt two markets become stronger in a crisis in contrast to the term before the upheaval. It also delivers a comprehensive understanding of spread structures, enabling the exploration of both linear and nonlinear transmission channels.

The process of globalization and the growing interdependence of markets necessitate research on international contagion. Understanding the propensity of certain markets and countries to exhibit higher levels of contagion is crucial for investment and risk management. Governments and regulatory institutions need to comprehend the fluctuations in global financial market volatility, their dissemination, and their impact on financial stability. Therefore, accurately measuring contagion becomes a critical issue that demands attention (Tabak et al., 2015).

Global financial crises underscore the transmission of shocks from one sector of the economy to others, with global implications. These market movements can have a negative impact on investors' diversification strategies and influence policymakers' decision-making. This study primarily focuses on examining the contagion channels between the Turkish stock market and interconnected markets, such as foreign exchange, gold, and crude oil. Previous papers by Apergis et al. (2019) and Tabak et al. (2015) have provided evidence suggesting the presence of coskewness and cokurtosis in these transmission channels, indicating the influence of contagion. In addition to investigating low-moment linkage channels, such as correlation tests suggested by Forbes and Rigobon (2002), this study will also explore the effects of high-moment transmission channels, as examined by Fry-McKibbin et al. (2010) and Fry-McKibbin and Hsaio (2018), and compare the findings. Therefore, this study places significant emphasis on investigating both linkages and the moments of transmission between markets.

The main question and motivation of this study is to uncover the relationship and direction of risk transmission between stock markets and other major markets. Furthermore, the validity of the contagion concept, initially proposed by Forbes and Rigobon (2002) and later expanded upon by Fry-McKibbin et al. (2010) and Fry-McKibbin and Hsaio (2018), will be tested in the context of the Turkish stock market. Modern portfolio theory has primarily focused on the relationship between low-level moments such as returns and variance. However, some studies, such as those by Brunnermeier and Pedersen (2009) and Kostakis et al. (2012), suggest that higher moments such as skewness and kurtosis may also be associated with risk transmission. Therefore, detecting transmission through higher moments in the Turkish stock markets could yield valuable insights for investment and portfolio management. Hence, testing the existence, degree, and direction of correlation, coskewness, cokurtosis, and covolatility contagion channels would provide beneficial findings for the literature.

1. Literature Review

Given the recent financial crises, financial stability has become a crucial topic of interest for central banks and regulatory authorities. Consequently, there has been a surge in research examining market interrelationships and contagion during times of crisis. Several methodologies, such as the contagion method created by Forbes and Rigobon (2002), Fry-McKibbin et al. (2010), and Fry-McKibbin and Hsaio (2018), have been employed to define and investigate these concepts.

During a financial crisis, it is common to see a decline in yields and an expansion in volatility. This aligns with the notion that risk-averse investors tend to take on higher risks during a crisis in order to achieve higher returns (Sharpe, 1964; Lintner, 1965; Black, 1972). Initial contagion tests, like those conducted by King and Wadhwani (1990), concentrated on changes in cross-market correlation on yields of various markets before and throughout of a turmoil. Building on this approach, the correlation analysis concept of Forbes and Rigobon (2002) addresses the limitations associated with heteroskedasticity in previous correlation tests.

However, it has been demonstrated that the first two moments are not sufficient to fully describe the distribution of yields (Kraus & Litzenberger, 1976; Harvey & Siddique, 2000). Factors such as coskewness and cokurtosis have been identified as important dimensions of risk (Harvey & Siddique, 2000; Smith, 2007; Poti & Wang, 2010). Researchers, including Kostakis et al. (2012), have found that stocks with (-) skewness and (+) kurtosis, indicating right-skewed returns compared to the market portfolio, provide extraordinary returns. Asset returns also exhibit a transition from left skewness to right skewness following a shock, attributed to investors' preference for right-skewed returns (Fry et al., 2010). Additionally, the kurtosis of yields tends to increase during crisis periods, reflecting a shift towards negative returns and negative skewness (Brunnermeier and Pedersen, 2009). Higher moments have been linked to the risk characteristics of utility functions in testing higher-level moments (Fry-McKibbin and Hsaio, 2018). Hasler and Ornthanalai (2018) argue that transmission occurs when traders give more concentration to news with high volatility.

Various methodologies have been employed to conduct contagion tests in finance. For instance, Liu and Ouyang (2014) used the SCC (structural conditional correlation) test to explore transmission among markets, distinguishing between infiltration effects and coherent movements. Cayon and Thorp (2014) employed a multivariate GARCH model to test contagion on financial asset returns and evaluate the effect of regulations on Colombian pension funds. You et al. (2014) applied other contagion methods to explore the relationship between economic integration and financial contagion, specifically focusing on China's integration into the global market.

Some other studies have explored the interconnections between markets and the spread of volatility. Fernandez (2005) observed normal dependence between stock yields via examining yield contagion at various duration spans. Al-Deehani and Moosa (2006) analyzed stock market interdependence in three GCC[1] countries and identified volatility spillovers. Olbrys (2013) used a adjusted version of the EGARCH method to analyze the dependence of price volatility, considering transaction frictions. Lestano and Kuper (2015) examined the connection among stock and currency markets before and after the 1997 Asian crises, utilizing dynamic conditional correlation and multivariate GARCH models to analyze correlations during those specific periods.

Upon examining studies related to the Turkish stock market, it can be observed that Kara et al. (2021) investigated the two-way contagion channels between sectors in the BİST during crisis periods and found that sectors with less international integration are more sensitive to the banking sector during crises. Doğan et al. (2022) observed that the Covid-19 pandemic created speculative price movements on an international scale and led to contagion effects among global stocks. Bayraktar (2020) stated that announcements during the pandemic period led to increased volatility and contagion at the international level. Gökbulut (2017) investigated the volatility spillover between Turkey and five different developed and emerging market countries

[1] GCC stands for Gulf Cooperation Council.

and observed bidirectional solid volatility spillover between BİST and DAX. Özden and Ural (2020) studied contagion and herding behavior between BİST and S&P 500 during the 2008 crisis period, concluding that contagion was valid during the pre-crisis, crisis, and post-crisis periods while herding behavior was only significant in the post-crisis.

A review of the literature reveals that the contagion channels proposed by Forbes and Rigobon (2002), Fry-McKibbin et al. (2010), and Fry-McKibbin and Hsaio (2018) have not been tested for validity in Turkish stock markets. This study is designed to fill this gap in the literature. Additionally, testing the crisis contagion effect between the Turkish stock market and other major investment alternatives during the Covid-19 period is believed to yield valuable insights for the literature.

2. The Data

The study investigates the contagion between the Turkish stock market and other major markets, including foreign exchange, gold, and crude oil, during Covid-19. The BİST30 return (XU030) is utilized as a proxy for the stock market, COWTI (American-type crude oil returns in US dollars) for crude oil, USD/TRY (US dollar returns in Turkish lira) for foreign exchange, and GONS (gold returns in US dollars per ounce) for gold. The data confines the interval from Jan. 2, 2018, to Mar. 17, 2023. The pre-crisis period spans from Jan. 2, 2018, to Mar. 11, 2020. Mar. 11, 2020, is designated as the onset of the pandemic, coinciding with the World Health Organization's (WHO) declaration of an international outbreak. The subsequent observation period is referred to as the pre-crisis and crisis spans. The total amount of observations is 549 for the pre-Covid-19 and 754 for the Covid-19. Following table 1, 2 indicate descriptives for the respective time series.

Table 1. Pre-crisis Period Data Descriptive Statistics

	XU030	GONS	COWTI	USD/TRY
Mean	-0,0002	0,0004	-0,0009	0,0010
Median	-0,0004	0,0003	0,0007	0,0004
Standard Deviation	0,0145	0,0075	0,0238	0,0131
Kurtosis	1,2686	4,4763	23,9604	45,7812
Skewness	-0,2329	-0,0784	-1,8368	3,7255
Maximum	-0,0586	-0,0461	-0,2459	-0,0627
Minimum	0,0466	0,0357	0,1468	0,1584
Observations	549	549	549	549

Tablo 2: Crisis Period Data Descriptive Statistics

	XU030	GONS	COWTI	USD/TRY
Mean	0,0022	0,0003	-0,0032	0,0016
Median	0,0030	0,0004	0,0030	0,0004
Standard Deviation	0,0193	0,0111	0,1270	0,0145
Kurtosis	5,1841	3,6924	459,7890	135,7364
Skewness	-0,6702	-0,0695	-19,8120	-6,5939
Maximum	-0,0995	-0,0499	-3,0597	-0,2547
Minimum	0,0997	0,0595	0,3766	0,0881
Observations	754	754	754	754

3. Methodology

Let a and b represent the returns of two different assets, and the observations indicate the co-movement in response to a specific shock, where $a, b = 1,2, \dots N, a \neq b$, period of x and y define the pre and after crisis, respectively. The total number of observations for each period is denoted as T_x, T_y. Accordingly, the standard deviation $(\hat{\sigma}_{a,x}, \hat{\sigma}_{b,x}, \hat{\sigma}_{a,y}, \hat{\sigma}_{b,y})$and the mean $(\hat{\mu}_{a,x}, \hat{\mu}_{b,x}, \hat{\mu}_{a,y}, \hat{\mu}_{b,y})$ of the returns $r_{i,t}$ and $r_{j,t}$ are calculated. Forbes and Rigobon (2002) describe contagion based on changes in correlation adjusted for heteroskedasticity. $\delta = \frac{\sigma_{y,a}^2 - \sigma_{x,a}^2}{\sigma_{x,a}^2}$ is depicted as $v_y = \frac{\rho y}{\sqrt{1+\delta(1-\rho_y^2)}}$.

The study uses variance-covariance estimates obtained from a vector autoregressive (VAR) system to estimate the correlation coefficients among the source and the recipient market in a shock. It is also assumed there is no endogeneity or skipped variables. T-tests are employed to examine whether a substantial boost in any correlation coefficient exists during the shock. Accordingly, the zero hypothesis is defined as $H_0: v_y = \rho_y$while the alternative hypothesis is defined as $H_1: v_y > \rho_y$. The statistic is:

$$FR(a \to b) = \frac{\frac{1}{2}\ln\left(\frac{1+\hat{v}_y}{1-\hat{v}_y}\right) - \frac{1}{2}\ln\left(\frac{1+\hat{\rho}_x}{1-\hat{\rho}_x}\right)}{\sqrt{\frac{1}{T_y - 3} + \frac{1}{T_x - 3}}}$$

Forbes and Rigobon (2002) FR(a→b) method investigates the linear transmission channel. Mainly, it conducts a transmission test from the return of a and b.

The coskewness statistics developed by Fry et al. (2010) tests substantial differences in dependence estimated by the 3rd-order joint moments of returns of a and b. The CS_{12} statistic tests the increase in market dependency among the yields in a and the variance of yields in b, while the CS_{21}statistic indicates the difference in market dependency among the variance of yields in a and the yields in b. The statistical test for CS_{12} is defined as:

$$CS_{12} = \left[\frac{\hat{\varphi}_y(r_a, r_b^2) - \hat{\varphi}_x(r_a, r_b^2)}{\sqrt{\frac{4\theta_y x_a + 2}{T_y} + \frac{4\rho_x^2 + 2}{T_x}}}\right]^2$$

$\hat{\varphi}_y(r_a, r_b^2)$ and $\hat{\varphi}_x(r_a, r_b^2)$ represent the coskewness in the x and y period. In other words:

$$\hat{\varphi}_x(r_a, r_b^2) = \frac{1}{T_x}\sum_{t=1}^{T_x}\left(\frac{r_{a,t} - \hat{\mu}_{a,x}}{\hat{\sigma}_{a,x}}\right)\left(\frac{r_{b,t} - \hat{\mu}_{b,x}}{\hat{\sigma}_{b,x}}\right)^2$$

and

$$\hat{\varphi}_y(r_a,r_b^2) = \frac{1}{T_y}\sum_{i=1}^{T_y}\left(\frac{r_{a,t}-\hat{\mu}_{b,y}}{\hat{\sigma}_{a,y}}\right)\left(\frac{r_{b,t}-\hat{\mu}_{b,y}}{\hat{\sigma}_{b,y}}\right)^2$$

$\hat{\varphi}_y(r_a,r_b^2)$ and $\hat{\varphi}_x(r_a,r_b^2)$ are swapped for the CS_{21} test statistic.

The coskewness channel may not always be sufficient to capture the full extent of contagion. Supplementary information channels can emerge via excessive dependence. The cokurtosis detects the transmission between expected returns and skewness for a and b. To indicate transmission from source to receiver asset via skewness channel, Fry-McKibbin and Hsiao (2018) propose the below test:

$$(CK_{mn}(a \to b; r_a^m, r_b^n)) = \left(\frac{\hat{\xi}_y\,(r_a^m\,,\,r_b^n) - \hat{\xi}_x\,(r_a^m\,,\,r_b^n)}{\sqrt{\frac{18\hat{v}_y^2+6}{T_y}+\frac{18\hat{\rho}_y^2+6}{T_x}}}\right)^2$$

$(\hat{\xi}_y(r_a^m,r_b^n) = \hat{\psi}_y(r_a^m,r_b^n) - (3\hat{v}_y), \hat{\xi}_x(r_a^m,r_b^n) = \hat{\psi}_x(r_a^m,r_b^n) - (3\hat{\rho}_x))$ are expressed. It models the transmission from the changes in market a's returns to the skewness of b, where m, n = 1, 3. In this case, the null and alternative hypotheses are:

$H_0: \xi_y(r_a^m,r_b^n) = \xi_x(r_a^m,r_b^n), H_1: \xi_y(r_a^m,r_b^n) \neq \xi_x(r_a^m,r_b^n)$

Cokurtosis changes asymptotically follow the distribution: $CK_{13}(a \to b), CK_{31}(a \to b) \xrightarrow{d} X_1^2$.

The change from negative to positive correlation between the volatility of one market to another after a shock gives rise to the volatility smile via the transmission route of covolatility during shock. The CV(2,2) test is presented with the following equation for contagion testing a to b:

$$CV_{22}(a \to b; (r_a^2, r_b^2)) = \left(\frac{\hat{\xi}_y\,(r_a^2\,,\,r_b^2) - \hat{\xi}_x\,(r_a^2\,,\,r_b^2)}{\sqrt{\frac{4\hat{v}_y^4+16\hat{v}_y^2+4}{T_y}+\frac{4\hat{\rho}_x^4+16\hat{\rho}_x^2+4}{T_x}}}\right)^2$$

In the equation, $\hat{\xi}_y(r_a^2,r_b^2)$ is expressed as $\hat{\xi}_y\,(r_a^2\,,\,r_b^2) = \hat{\psi}_y\,(r_a^2\,,\,r_b^2) - (1 + 2\hat{v}_y^2)$, $\hat{\xi}_x\,(r_a^2\,,\,r_b^2) = \hat{\psi}_x\,(r_a^2\,,\,r_b^2) - (3\hat{\rho}_x)$. The following hypotheses can be established to test the significance of covolatility tests:

$H_0: \xi_y\,(r_a^2\,,\,r_b^2) = \xi_x\,(r_a^2\,,\,r_b^2)$, $H_1: \xi_y\,(r_a^2\,,\,r_b^2) \neq \xi_x\,(r_a^2\,,\,r_b^2)$ covolatility test asymptotically follow the distribution of; $CV_{22}(a \to b) \xrightarrow{d} X_1^2$.

4. Results

Table 1 presents the FR(a→b) statistics results. The initial column denotes the source asset (a), whereas the top row signifies the receiver asset (b). The findings reveal no observed transmission effect from stock markets to others, or vice versa, concerning the market returns for gold, crude oil, and currency markets to stock market returns. Hence, the correlation channel is ineffective in propagating transmission within the mentioned markets. In other words, changes in correlations resulting from the crisis demonstrate statistically insignificant effects on shock transmission between markets regarding the distribution of the consequences of the Covid-19. This condition could be explained by the fact that there were no major differences in the correlation of markets returns before or after the shock. The correlation matrices in Appendices 1 and 2 depict the correlations between assets.

Table 3: Forbes, Rigobon (2002) Correlation Test Result

	XU030	GONS	COWTI	USD/TRY
XU030		-0,35	-0,55	0,45
		(0,72)	(0,58)	(0,65)
GONS	-0,42		0,78	-0,52
	(0,68)		(0,44)	(0,60)
COWTI	-0,24	0,36		0,76
	(0,81)	(0,72)		(0,44)
USD/TRY	0,62	-0,76	0,57	
	(0,54)	(0,45)	(0,57)	

Notes: FR(a→b) model quantifies the extent of spread between the expected yields of the asset (a) and (b). The initial column represents the source asset (a) and the top row pertains to the receiver asset (b). The zero hypothesis posits that there is no transmission. The above numbers correspond to the test statistics, while the numbers in parentheses represent the associated p-values. Bold ones signify the denial of the zero hypothesis at a 5%.

Table 4, 5 present the findings of the CS(1,2) estimation statistics. Table 4 displays the tests for the impact of shocks in the average returns of the source asset (a) on the recipient market's (b) volatility, as assessed by the CS (1,2) test. Conversely, Table 5 provides the test statistics for the effect of turmoil in the fluctuation of the source assets on the recipient asset's average returns, measured by the CS (2,1) test. The outcome reveals that the mean returns of gold, oil, and currency markets do not generate contagion effects on the BİST 30 index. In other words, shocks in the returns of these markets do not lead to contagion in the BİST 30 index. However, changes in the volatility of the gold, oil, and currency markets do have an impact on the BİST 30 index. Moreover, the tables suggest that the contagion effect of the currency and oil markets is relatively more significant, while the contagion from the gold is limited.

Tablo 4: Fry Et Al. (2010) Cosekwness CS (1,2) Test Results

	XU030	GONS	COWTI	USD/TRY
XU030		**21,60**	**224,72**	**160,60**
		(0,00)	**(0,00)**	**(0,00)**
GONS	0,03		**271,62**	**33,70**
	(0,86)		**(0,00)**	**(0,00)**
COWTI	0,07	3,44		**24,47**
	(0,80)	(0,06)		**(0,00)**
USD/TRY	0,73	2,83	**40,83**	
	(0,39)	(0,09)	**(0,00)**	

Notes: CS(1,2) model measures the transmission from the required yields of the asset (a) to the mean volatility of asset (b). The initial column represents the source asset (a), the top row represents the receiver asset (b). The zero hypothesis is "no transmission". The numbers above indicate the test statistic estimations and the numbers in parentheses represent the probability. Bold ones reveal the denial of the zero hypothesis at a 5%.

Table 5: CS (2,1) Results

	XU030	GONS	COWTI	USD/TRY
XU030		0,03	0,07	0,73

		(0,86)	(0,80)	(0,39)
GONS	**21,60**		3,44	2,83
	(0,00)		(0,06)	(0,09)
COWTI	**224,81**	**271,84**		**40,83**
	(0,00)	**(0,00)**		**(0,00)**
USD/TRY	**160,47**	**33,67**	**24,47**	
	(0,00)	**(0,00)**	**(0,00)**	

Notes: CS(2,1) model measures the transmission from the mean volatility of the asset (a) to the required yields of asset (b). The initial column represents the source asset (a), the top row represents the receiver asset (b). The zero hypothesis assumes "no transmission". The above numbers correspond to the test statistic values, and the numbers in parentheses indicate the associated p-values. Bold ones signify the denial of the zero hypothesis at a 5%.

Tables 6, 7 present the CK(1,3) estimation results. These tables provide values for measuring the contagion effects through cokurtosis channel, CK (1,3) and CK (3,1), between different assets. The CK (1,3) value captures the contagion effect of shocks in the yields of the source asset (a) on the skewness of the receiver asset (b), on the other hand the CK (3,1) quantifies the statistical significance of the contagion effect of the skewness in the source asset (a) on the mean yields of the receiver asset (b). Analyzing the results in these tables, we observe contagion effects across all markets except for gold and stock. Remarkably, both the crude oil and currency markets exhibit a contagion towards the stock market. Notably, changes in both returns and skewness are influential factors for transmission. Further, Tables 3, 4, 5, and 6 suggest that higher-order moments dominate the contagion channels.

Table 6: Fry-McKibbin, Hsiao (2018) cokurtosis (1,3) test results

	XU030	GONS	COWTI	USD/TRY
XU030		**87,11**	**24627,12**	**18087,26**
		(0,00)	**(0,00)**	**(0,00)**
GONS	0,18		**55483,18**	**905,22**
	(0,67)		**(0,00)**	**(0,00)**
COWTI	**10,97**	**36,17**		**587,60**
	(0,00)	**(0,00)**		**(0,00)**
USD/TRY	**8,20**	**4,49**	**4189,65**	
	(0,00)	**(0,03)**	**(0,00)**	

Notes: CK(1,3) model measures the transmission from the required yields of the asset (a) to the mean skewness of the asset (b). The initial column represents the source asset (a), while the top row represents the receiver asset (b). The zero hypothesis states that there is "no transmission". The numbers above indicate the test statistic estimation and the numbers in parentheses represent the probability. Bold ones indicate the denial of the zero hypothesis at a 5%.

Table 7: CK (3,1) Results

	XU030	GONS	COWTI	USD/TRY
XU030		1,78	**17,84**	**731,86**
		(0,18)	**(0,00)**	**(0,00)**
GONS	2,15		**159,00**	**11,18**
	(0,14)		**(0,00)**	**(0,00)**
COWTI	**23,32**	**181,59**		**59,09**
	(0,00)	**(0,00)**		**(0,00)**
USD/TRY	**710,80**	**8,45**	**53,28**	

	(0,00)	**(0,00)**	**(0,00)**	

Notes: CK (3,1) model measures the transmission from the mean skewness of asset a to the required yields of asset b. The initial column represents the source asset (a), on the other hand the top row represents the recipient asset (b). The zero hypothesis is "no transmission". The numbers above indicate the test statistic estimation and the numbers in parentheses represent the probability. Bold ones state the denial of the zero hypothesis at a 5%.

Table 8 CV(2,2) estimation results. The CV (2,2) statistical value represents the contagion effect of volatility changes in the source asset (a) on the volatility of the receiver assets (b). According to the CV (2,2) test, volatility changes in all markets except for gold have a contagion effect on the BİST30 index. Thus, it can be observed that the results of the CV (2,2) test are similar to those of the CK (3,1) test. Additionally, a significant and strong contagion effect among gold, crude oil, and currency markets is observed. According to Table 8, it can be stated that the contagion effect is primarily transmitted through the covolatility channel, especially during times of crisis.

Tablo 8: Fry-Mckibbin, Hsiao (2018) Covolatility (2,2) Test Results

	XU030	GONS	COWTI	USD/TRY
XU030		1,78	**17,84**	**731,86**
		(0,18)	**(0,00)**	**(0,00)**
GONS	2,15		**159,00**	**11,18**
	(0,14)		**(0,00)**	**(0,00)**
COWTI	**23,32**	**181,59**		**59,09**
	(0,00)	**(0,00)**		**(0,00)**
USD/TRY	**710,80**	**8,45**	**53,28**	
	(0,00)	**(0,00)**	**(0,00)**	

Notes: CV (2,2) model indicates the transmission between the asset a's mean volatility and the market b's mean volatility. The initial column represents the source asset (a), on the other hand the top row represents the recipient asset (b). The zero hypothesis states "no transmission". The numbers above represent the test statistic estimations, and the numbers in parentheses indicate the corresponding probability. Bold ones signify the denial of the zero hypothesis at a 5%.

CONCLUSION

This paper explores the shock transmission between the Turkish stock and other international major financial assets, including gold, foreign exchange, and crude oil, during the Covid-19 period. The Forbes and Rigobon (2002) correlation test, Fry et al. (2010) coskewness tests, Fry-McKibbin and Hsiao (2018) cokurtosis and covolatility tests are applied to measure the contagion. The outcomes state that crude oil and foreign exchange have a remarkable contagion on the BİST30 index, whereas gold exhibited a relatively limited. This can be attributed to the unique nature of the gold market and its lower integration with other assets. Gold remains regarded as a safe haven during crises, as Wen et al. (2022) indicated, suggesting this characteristic partially distinguishes gold in terms of volatility behavior.

However, the contagion effect of oil on the stock market during the crisis period can be attributed primarily to the rising energy market following the alleviation of the pandemic's impact and the energy supply disruption that emerged after the Russia-Ukraine tension. It is believed that this tension in the energy sector has created a significantly high contagion on other assets. On the other hand, the expansive monetary policies during the pandemic have destabilized the already highly volatile foreign exchange market. It is assessed that this destabilizing effect has permeated the stock market extensively.

Moreover, the study suggests that shocks in markets such as crude oil and foreign exchange had a pronounced transmission on the BİST30. While the impact of correlation channel is limited, the transmission occurs through the channels of coskewness, cokurtosis, and covolatility. The changes in higher-order moments during the crisis propagated to other markets. Additionally, it suggests that cokurtosis and covolatility channels exhibited similar effects. Findings have implications for valuation, investment decisions, and portfolio diversifications, potentially enhancing the efficiency of these financial processes.

Undoubtedly, understanding the causes of a crisis provides valuable insights, including their magnitude, severity, and channels through which they propagate. The findings of this research could aid in recognizing and examining the spread of contagion between financial markets, which could help in developing customized stabilization strategies. Recognizing the interconnections among markets carries significant implications for investors, policymakers, and international organizations.

Modern portfolio theory focuses on investment optimization based on low-level moments such as returns and variance. However, risk transmission can sometimes occur through higher-level contagion channels such as return-skewness, return-kurtosis, and variance-variance. Considering this in portfolio optimization and risk management policies can lead to beneficial outcomes in these processes.

Furthermore, it is crucial to acknowledge that shocks in other stock markets during crises can significantly affect the national stock market. Investigating the dependence and the transmission channels in this regard may yield valuable insights for future research.

APPENDIXES

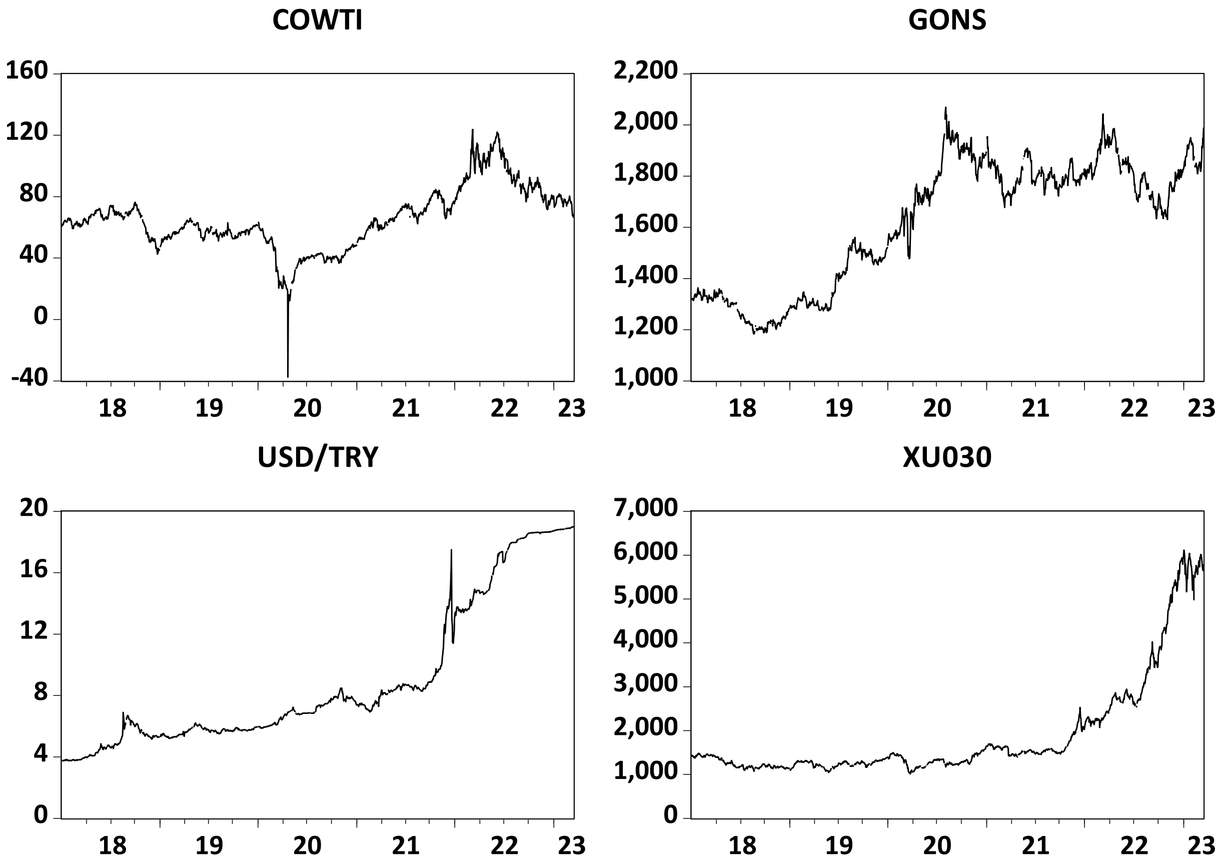
Appendix 1: Pre-Crisis Period Correlation Matrixes

	RXU030	RGONS	RCOWTI	RUSD/TRY
RXU030	1			
RGONS	0,054521	1		
RCOWTI	0,007741	-0,01167	1	
RUSD/TRY	0,021974	-0,01051	-0,04583	1

Appendix 2: Crisis Period Correlation Matrix

	RXU030	RGONS	RCOWTI	RUSD/TRY
RXU030	1			
RGONS	0,046002	1		
RCOWTI	-0,03082	0,047251	1	
RUSD/TRY	0,062706	-0,05895	-0,01544	1

Appendix 3: Graphs of the Time Series



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EXTENDED ABSTRACT
GENİŞLETİLMİŞ ÖZET

BİST HİSSE SENETLERİ PİYASASINDA BULAŞMA KANALLARI

Giriş ve Çalışmanın Amacı (Introduction and Research Purpose): Bu çalışma, ilk olarak Forbes ve Rigobon (2002) tarafından kavramsallaştırılan bulaşma kanalının COVID-19 salgını sırasında finansal piyasalar üzerindeki etkisini incelemeyi amaçlamaktadır. Küresel finansal krizler, ekonominin bir bölümünde meydana gelen bir şokun ekonominin diğer sektörlerine yayılarak küresel düzeyde etkiler oluşturduğunu göstermektedir. Bu tür piyasa hareketleri, portföylerini çeşitlendirmek isteyen yatırımcılar üzerinde olumsuz etkilere sahip olabileceği gibi, iç ve uluslararası politika yapıcıların kararları üzerinde de etkileri bulunmaktadır. Bu çalışmanın temel amacı Türkiye hisse senetleri piyasasıyla diğer ilişkili olabileceği döviz, altın ve ham petrol piyasaları arasındaki bulaşma kanallarının araştırılmasıdır. Apergis vd., (2019), Tabak vd., (2015) gibi çalışmalarda risk yayılımında eşçarpıklık, eşbasıklık gibi yayılma kanallarının da etkili olabileceğine yönelik bulgular söz konusudur. Bu bağlamda, Forbes ve Rigobon (2002) korelasyon testi gibi düşük momentli bağlantı kanallarının yanında Fry-McKibbin vd. (2010) ve Fry-McKibbin vd. (2018) yüksek momentli yayılım kanallarının da etkisi araştırılarak etkinlikleri karşılaştırmalı olarak gözlemlenecektir. Bu nedenle piyasa çiftleri arasında bağlantılar ile yayılımın momenti çalışmanın üzerinde durduğu hususlardan biridir.

Kavramsal/kuramsal çerçeve (Literature Review): Forbes ve Rigobon (2002), Fry-McKibbin vd., (2010) ve Fry-McKibbin vd., (2018) tarafından geliştirilen bulaşma testleri, önceden belirlenmiş bir "kriz dönemi"ni bir "sakin dönem" ile karşılaştırır ve istatistiksel olarak anlamlı yapısal kırılmalar aracılığıyla bulaşmayı test eder. Bu dönemlerin uygun seçimi genellikle "temel bir bileşen" olarak kabul edilir. Varlık getirilerinde azalma ve volatilitenin artması, finansal krizlerin yaygın bir özelliğidir. Bu durum, riskten kaçınan yatırımcının kriz öncesi dönemde daha yüksek getiriler elde etmesi karşılığında kriz döneminde daha büyük risk üstlenmesi ile tutarlıdır (bkz. Sharpe, 1964; Lintner, 1965; Black, 1972). Bulaşma için yapılan ilk testlerde (King ve Wadhwani (1990)), iki piyasanın varlık getirileri arasındaki çapraz-korelasyonun kriz dönemi ile kriz öncesi dönem arasındaki değişip değişmediğine odaklandı. Finansal piyasalarda bulaşma kanıtı aramak için kullandığımız temel yaklaşım, önceki korelasyon testlerinde yer alan heteroskedastikliğe bağlı yanlılığı düzeltme çerçevesinde geliştirilen Forbes ve Rigobon (2002) tarafından geliştirilen korelasyon analizi çerçevesini takip etmektedir. Ancak, varlık getirilerinde bulaşmanın ilk iki moment ile yeterince tarif edilemeyeceğine dair önemli kanıtlar bulunmaktadır (bkz. Kraus ve Litzenberger, 1976; Harvey ve Siddique, 2000). Birkaç yazar (Harvey ve Siddique, 2000; Smith, 2007; Poti ve Wang, 2010), eşçarpıklık ve eşbasıklığın riskin oldukça önemli boyutlarından biri olabileceğini göstermektedir. Kostakis vd. (2012), negatif eşçarpıklık ve pozitif eşbasıklık değerlerine sahip hisse senedi getirilerinin, yani piyasa portföyü getirilerine göre sağa çarpık olan getirilerin, sırasıyla pozitif eşçarpıklık ve negatif eşbasıklığa sahip olan benzer firmaların getirilerine kıyasla normalüstü getiriler sağladığını ifade etmektedirler. Bir varlık getirisinin önemli bir özelliği, bir şok sonrası getiri dağılımının sola çarpıklıktan sağa çarpıklığa geçmesidir. Bu durum, yatırımcıların sağa çarpık getirileri olan varlıkları, sola çarpık getirilere sahip varlıklara tercih etmelerine atfedilebilir (Fry vd., 2010). Bir varlık getirisinin bir diğer özelliği ise, kriz döneminde basıklığın yükselmesiyle leptokürtik davranış sergilemesidir. Brunnermeier ve Pedersen (2009), sakin dönemde gözlenen daha düşük basıklığın, yatırımcıların pozitif getiri ve negatif sağa çarpıklığı olan varlıkları tercih etmelerinden kaynaklandığını göstermektedirler. Ancak, krizden sonra, yatırımcıların negatif getiri ve negatif çarpıklığı olan varlıklar tutmaya başladıklarını, bu da daha yüksek basıklığa neden olduğunu ifade etmektedir. Fry-McKibbin vd. (2018), daha yüksek düzey momentleri test etmek için teorik bir motivasyon sağlayarak, yüksek düzey momentlerin fayda fonksiyonlarının risk özellikleriyle bağlantılı olarak ilişkili olabileceğini ifade etmektedir.

Yöntem ve Bulgular (Methodology and Findings): Çalışmada hisse senedi ve diğer majör piyasalar arasındaki bulaşma etkisi Forbes ve Rigobon (2002) korelasyon testi, Fry vd. (2010) eşçarpıklık testi, Fry-McKibbin, Hsiao (2018) eşbasıklık ve eşvolatilite testi istatistiksel yöntemleri kullanılarak gözlemlenmiştir.

Sonuç ve Öneriler (Conclusions and Recommendation): Çalışmanın sonuçları bahsi geçen piyasalar arasında yüksek momentler üzerinden bulaşma etkisi olduğunu göstermektedir. Ayrıca altının diğer piyasalarla etkileşimin sınırlı olduğu gözlemlenmiştir. Sonuçlarımız, bulaşma olaylarının daha iyi anlaşılması, varlık değerleme, risk yönetimi ve finansal istikrar gözetimi için ihtiyati önlem araçların geliştirilmesi açısından önem arz etmektedir.

KATKI ORANI BEYANI VE ÇIKAR ÇATIŞMASI BİLDİRİMİ

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Yazarların Listesi / *List of Authors*

Sıra *No*	**Adı-Soyadı** *Name - Surname*	**Katkı Oranı** *Author Contributions*	**Çıkar Çatışması** *Conflicts of Interest*	**Destek ve Teşekkür (Varsa)** *Support and Acknowledgment*
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