İSTANBUL UNIVERSITY PRESS

Istanbul Business Research, 51(1), 313-326
DOI: 10.26650/ibr.2022.51.977814
http://ibr.istanbul.edu.tr/
http://dergipark.org.tr/ibr

Istanbul Business Research

Submitted: 02.08.2021
Revision Requested: 05.10.2021
Last Revision Received: 06.10.2021
Accepted: 11.10.2021
Published Online: 29.03.2022

RESEARCH ARTICLE

The Impact of Covid-19 on Selected Turkish Financial Indicators: Empirical Evidence from the Toda Yamamoto Causality Test*

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Abstract

This paper examines the impact of COVID-19 cases and deaths on selected financial indicators in Turkey between March 2020 and July 2020. This study analyzes the causal relationship between COVID-19 and liquidity and risk perception in Turkey. To measure the impact of COVID-19 on liquidity and risk perception in Turkey, financial indicators, such as the BIST100, credit default swap, 2-year Turkish bond yields, and 10-year Turkish bond yields were examined. The stationarity of variables was tested usingunit root tests. Since all variables were stationary at the first difference, the Toda Yamamoto causality test was chosen to examine the causality relationship between variables. According to the Johansen co-integration test, there was a co-integration relationship between variables. The empirical results of the Toda Yamamoto causality test show that there was a unidirectional Granger causality from the number of COVID-19 deaths to credit default swap. Moreover, there was a unidirectional Granger causality from the Turkish bond yields (2- 10 years) to BIST 100. However, between March 2020 andJuly 2020, there is no Granger relationship between the number of COVID-19 cases and the selected financial variables.

Keywords

COVID-19, Financial Indicators, Turkey

Introduction

Humanity has endured outbreaks of fatal infectious diseases throughout history. The plague in the 14th century, bleeding fever in the 16th century, the cholera epidemic in the 19th and 20th centuries, and SARS, MERS, and swine flu in the 21st century are some of the significant epidemics that humanity has witnessed (Peterson, 2002: 48; DeWitte, 2015: 441; da Costa, Morelli, and Saivish, 2020: 1517). Decreasing consumption and job loss as a result of epidemics affect economies negatively (Eichenbaum, Rebelo, and Trabandt, 2020: 1). The economic and financial consequences of outbreaks of infectious disease have been revealed

* This study was presented at the 19th International Conference of MEEA, Istanbul, Turkiye, 2020.

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To cite this article: Arzova, S. B., & Sahin,B. S. (2022). The Impact of Covid-19 on Selected Turkish Financial Indicators: Empirical Evidence from the Toda Yamamoto Causality Test. *Istanbul Business Research, 51*(1), 313-326. http://doi.org/10.26650/ibr.2022.51.977814

in the literature (Haacker, 2004; Ding, Levine, Lin, and Xie, 2020). Similarly, COVID-19 has also affected the world economy.

COVID-19 is an infectious disease that has affected the world. (WHO, 2019a). As a result of the outbreak of this infectious disease that started in December 2019, there has been a sharp fall in global stock markets. In the first quarter of 2020, the S&P 500, Brazil, Hong Kong, Italy, and Japanese exchanges decreased by 34%, 46%, 25%, 42% and 31% respectively (Ding, Levine, Lin, and Xie, 2020: 1). According to the OECD, in April 2020, the unemployment rate in member countries rose to 8.4%. The OECD stated that this increase had been unexpected and that COVID-19 had harmed the labor market (OECD, 2020). The US economy contracted by 32.9% in the second quarter of 2020 due to the new type of coronavirus pandemic (Bureau of Economic Analysis U.S. Department of Commerce, 2020). According to Eurostat, in the Euro Zone(consists of 19 countries), the economy contracted by 12.1% in the second quarter of 2020 (EuroStat, 2020). The IMF stated that the economic devastation resulting from COVID-19 could be dangerous for any gains made in reducing extreme poverty across the world (IMF, 2020). Production and confidence in the Turkish economy fell sharply due to the pandemic. Stakeholders' risk perception of the economy and public debt increased. The increasing numbers of Covid-19 cases affected every aspect of life in Turkey. The Turkish economy experienced a negative change, especially due to quarantine measures, reduced production, and general panic. According to the Turkish Statistics Institute, the Turkish economy contracted 9.9% (Turkish Statistics Institute, 2020).

This study investigates if there is any causal relationship between COVID-19 and liquidity and risk perception in Turkey. Due to the emerging atmosphere of panic and increasing economic devastation, COVID-19 may affect the liquidity and risk perception of countries. Additionally, the pandemic period has also affected investors' decisions. Countries' credit default swap and bond rates reflect the liquidity and risk perception. Stock markets are one of the areas that reveal investors' risk perception. Therefore, to measure the impact of COVID-19 on liquidity and risk perception in Turkey, financial indicators such as the BIST100, credit default swap, 2-year Turkish bond yields, and 10-year Turkish bond yields were examined.

This study aims to analyze the relationship between COVID 19 and the selected financial indicators in Turkey from 11 March 2020, when the first case was announced, to 31 July 2020.

Literature Review

Some studies have found a statistical relationship between public health variables (life expectancy, maternal mortality, etc.) and the economy (Bloom and Sachs, 1998; Robalino et

al., 2002). One of the public health elements that can have direct or indirect effects on economies is anoutbreak of infectious disease . Such outbreaks directly affect economies in terms of their impact on the health system, medical care, and supporting services (Mckibbin and Fernando 2020: 3). Job loss, emerging panic, and reduced production are indirect effects of an infectious disease outbreak on economies. Risk and uncertainty reduce investments during an outbreak of an infectious disease. Moreover, consumer confidence decreases as a result of fear and uncertainty and in turn, consumption of goods and services, especially face-to-face services (transport, tourism, etc.), decreases (Eichenbaum, Rebelo, and Trabandt, 2020: 1).

Economic Impact of Outbreaks Infectious Diseases

In the literature, the economic effects of different outbreaks of infectious disease have been examined. Barnett et al. (2000) argued that AIDS affected economic growth negatively. Haacker (2004) pointed out that the AIDS virus affected governments, households, and businesses economically. The decrease in labor efficiency and income affected businesses negatively. Households bear the costs of healthcare spending. AIDS caused more health and social costs for governments. Tekola et al. (2000) analyzed the financial effects of AIDS-related deathson households in Ethiopia. It was found that AIDS-related deaths increased the level of poverty. Conelly and Rosen (2005) examined the situation of small and medium-sized businesses (SMEs) regarding AIDS services with a survey. The survey results showed that SMEs were inadequate in terms of AIDS services.

Gong, Jiang, and Lu (2020) examined the relationship between the H1N1 virus and bank credit in 37 countries from 2009 to 2010. The empirical results showed that the H1N1 virus limited bank credits and increased the cost of these credits. Verikios et al. (2012) examined the effect of H1N1 virus on the Australian economy. According to Verikios et al. (2012), H1N1 had a short-run macroeconomic effect on the Australian economy.

Wang, Yang, and Chen (2013) examined the changes of biotechnical stocks in Taiwan using the Ordinary Least Square method during the outbreak of infectious disease . The empirical results of the study, which examined 38 biotechnical companies, showed that investors acted rationally and adjusted portfolio allocation during the outbreak of infectious disease.

Bloom et al. (2005) estimated the effect of the avian influenza strain on the Asian economy using the Oxford economic forecasting model. In the scenario, in which the mortality rate was 0.5%, it was emphasized that a 3% consumption shock would occur. Prager, Wei, and Rose (2017) examined the effect of the influenza outbreak on the American economy for different scenarios. It was concluded that in different scenarios, the loss of GDP would be $ 25.4 billion. In the scenario modelled with a vaccine, the GDP loss was $19.9 billion.

Studies in the literature have revealed the economic impact of previous outbreaks of disease on countries, businesses, and households.

Economic Impacts of COVID-19

COVID-19 has been studied in the literature in terms of economic and financial results. Huo and Qiu (2020) examined the effect of COVID-19 on the stock market in China using the Cumulative abnormal returns method. According to Huo and Qiu (2020), retail investors reacted more strongly to the lockdown news. Baker et al. (2020) argued that the consumption of households changed radically in the COVID-19 pandemic process. Households' credit card spending, food items, and retail spending increased. Bartik et al. (2020) analyzed the effect of COVID-19 on small businesses in the USA using a survey. The survey included 5.819 participants. According to the survey, 43% of the participants temporarily closed their businesses, and businesses reduced their employee numbers by 40%. Liu et al. (2020) showed that COVID-19 harmed the world's leading stock markets. According to the fixed effect panel model, Asian stock markets were more affected by COVID-19 than other stock markets. Luo and Tsang (2020) pointed out the importance of China in the world supply chain. According to Luo and Tsang (2000), the economic loss due to COVID-19 in China could reduce world production by at least 1%. Estrada et al (2020) argued that China's economic growth would see a decrease of 2% due to COVID-19 in 2020.

Aydın and Ari (2020) analyzed the impact of COVID-19 on non-recoverable economic sectors in Turkey with ORANI-G, a multisectoral computable general equilibrium model. The empirical results showed that COVID-19 decreased gross domestic product by 1.16 but falling oil prices compensate for this decrease . Kartal (2020) examined how Credit Default Swaps (CDS) behaved during COVID-19. The result of the analysis showed that CDS was affected by the BIST100 index, VIX index, MSCI Turkey index, and USD/TL foreign exchange rates during COVID-19. There was no statistically significant relationship between COVID-19 and CDS. Cakmaklı et. al. (2020) stated that a partial lockdown was more harmful than a full lockdown for the Turkish economy. As normalization takes a long time in partial lockdown, the cost to the economy can increase.

Chaouachi and Chaouachi (2020) analyzed the effects of the COVID-19 disease on the Saudi Arabian stock market using the Toda Yamamato Causality test. The Toda Yamamato Causality test revealed that the number of COVID-19 cases affected the stock market. According to Wang and Enilov (2020), there was a Granger causality between COVID-19 case numbers and stock markets in G7. Erokhin and Gao (2020) investigated the effect of COVID-19 on trade and economy in terms of food security in 45 countries. According to the results of the Toda Yamamato Causality Test, there was a causal relationship between the number of COVID-19 cases and poor nutrition in Colombia, Latin Africa, Peru, and Turkey. Unvan (2020) examined the causal relationship between COVID-19 and the dollar, gram gold prices, BIST 100 Index, euro, and 2-year bond yields in Turkey. According to Unvan (2020), there was no causality relationship between COVID-19 and other variables. Mele and Magazzino (2020) analyzed the causality relationship between COVID-19 death numbers,

economic growth, and pollution in India using the Toda Yamamato causality test. According to Mele and Magazzino (2020), the mortality of COVID-19 did not affect economic growth. Saleh and Musa (2020) showed that the number of COVID-19 cases affected the exchange rate in Nigeria. Andrieş, Ongena, and Sprinciean (2020) stated that there was a Granger causality between the number of COVID-19 cases and deaths and the 5-year sovereign Credit Default Swap (CDS) in Europe.

The literature has revealed that COVID-19 had a wide impact on economic growth, money and capital markets, food securityand production-consumption balance.

Methodology

The Toda Yamamoto Causality test was applied to analyze the causality relationship between COVID-19 and financial indicators in Turkey. In VAR analysis, the loss of information is experienced in the level of values of the integrated variables that are stationary at the first difference. In the analysis developed by Toda and Yamamoto (1995), this loss of information is prevented, and variables are included in the analysis with their level values (Duasa, 2007:87). The Toda Yamamoto test is suitable for integrated and co-integrated variables. Thus, the maximum order of integration of series ($D_{\max}$) should be calculated. Then, the optimal lag of the vector auto-regression model is determined with the Schwarz Information Criterion (SIC). The VAR model can be calculated with (k) and ($D_{\max}$) values with seemingly unrelated regression. Lastly, the Wald test is performed on the model to test the hypothesis (Siami-Namini, 2017: 604). The Toda Yamamoto model is as follows:

$$Y_t = a_1 + \sum_{i=1}^{k+D_{max}} \theta_{1,i} X_{t-i} + \sum_{i=1}^{k+D_{max}} \theta_{2,i} Y_{t-i} + \varepsilon_{y,t} \qquad (1)$$

$$X_t = a_2 + \sum_{i=1}^{k+D_{max}} \theta_{1,i} X_{t-i} + \sum_{i=1}^{k+D_{max}} \theta_{2,i} Y_{t-i} + \varepsilon_{x,t} \quad (2)$$

The above equations are examined for the presence of a Granger causality relationship between X and Y with the Wald test. Before the Toda Yamamoto test, unit root tests are used to test the stationarity of the series. Then, the Johansen co-integration test is applied and finally, the causality relationship of the variables is analyzed with the Toda Yamamoto test.

The Toda Yamamoto Causality test has been frequently used to examine the relationship between COVID-19 and financial variables (Sahoo, 2021; Chaouachi and Chaouachi, 2020; Andrieş, Ongena, and Sprinciean, 2020). In our study, the Toda Yamamoto Causality test was chosen to reveal the causality relationship between COVID-19 and financial variables and the direction of this relationship with daily data from Turkey. Using this method means that the cause and effect relationship between the variables can be mutually analyzed beyond the one-way effect. In addition, all variables are not stationary at the level. For this reason, the Toda Yamamoto Causality test is applied instead of the Granger Causality test.

Econometric Data Description

The analysis is based on daily time series data from Turkey for the period of 11 March 2020 to 31 July 2020. The period was narrowed down between 17 March 2020 and 31 July 2020 to analyze the impact of deaths resulting from COVID-19. The variables used were: the number of COVID-19 cases (CASE), the number of COVID-19 related deaths (DEATH), the BIST 100 index (BIST100), 5 years credit default swap (CDS), 10-year Turkish bond yields (BONDY10), and 2-year Turkish bond yields (BONDY2). All of the data were available from The Health Ministry of the Republic of Turkey and Bloomberg.

The Health Ministry of the Republic of Turkey announced that all people testing positive for COVID-19 would be counted as "Cases" starting from March 11th, 2020 until July 29th 2020.

However, after July 29th, 2020, policy changes were made and it was decided not to announce the number of cases without symptoms. Only the number of patients was shared with the public. As of December 10th, 2020, the number of cases and patients started to be announced separately.

This study covers the period of March 2020 - July 2020 in its analysis. For this reason, the data relating to COVID-19 cases that is used in the analysis reflects the number of both cases and patients combined.

During the pandemic period, businesses have stopped their activities, and production and consumption have been interrupted. There have been problems in the cash flow of governments, businesses, and households. Therefore, changes may occur in cash needs and risk perception of economic factors. This study aims to examine the impact of COVID-19 on Turkey in the context of liquidity and risk perception in Turkey. The bond market for liquidity, CDS, and stock market for risk perception are included in the analysis. CDS is insurance against credit risk. In addition, CDS is also used to measure country risk.. COVID-19 is an important risk factor for the economy. Therefore, CDS is useful to analyze the economic effects of COVID-19 (Andries, Ongena, and Sprincean, 2020: 4; Kartal, 2020: 493). Stock markets are one of the indicators that reflect investor risk perception. Some studies have revealed the relationship between country risk and stock markets (Fung et al., 2008; Perotti and Van Oijen, 2001). Theeffect of COVID 19 on the economy and the risk perception of investors can be examined in stock markets. In the literature, some studies have found a statistically significant relationship between COVID-19 and stock markets (Huo and Qiu, 2020; Liu et al. 2020). Bond yields are important data revealing the risk perception and liquidity of countries. Unvan (2020) used the bond yields variable to examine the economic effect of COVID-19 in Turkey.

Table 1

Descriptive Statistic (10 March- 31 July)

	CASE	BIST100	CDS	BONDY10	BONDY2
Mean	1,604.73	1,040.98	524.24	12.35	10.12
Median	1.186	1,021.58	516.44	12.11	9.74
Maximum	4.801	1,195.67	651.91	14.56	12.71
Minimum	0	842.46	407.70	11.33	7.01
Std. Dev.	1,204.79	104.92	65.09	816.24	1.30

Table 1 shows descriptive statistics for the dataset with 97 observations. In Turkey, the highest number of COVID-19 cases,recorded was 4.801. Between 10 March and 31 July, the CDS value was a maximum of 651,91. The highest 10-year and 2-year Turkish bond yields were 14,56 and 12,71 respectively. The lowest value of the BIST 100 index was 842,46.

Table 2

Descriptive Statistic (17 March- 31 July)

	DEATH	BIST100	CDS	BONDY10	BONDY2
Mean	41.17	1,045.47	528.81	12.39	10.06
Median	23.00	1,039.89	517.32	12.19	9.45
Maximum	126	1,195.67	651.91	14.56	12.71
Minimum	1	842.46	414.79	11.33	7.01
Std. Dev.	34.68	105.28	63.33	821.91	1.31

Table 2 shows descriptive statistics for a dataset with 92 observations. In Turkey, the highest number of COVID-19 deaths recorded was 126. There was no significant difference in other variables in Table 1.

Empirical Results

The stationarity of the data was analyzed using unit root tests. Table 3 and 4 show Augmented Dickey-Fuller (ADF) and Philips Peron (PP) unit root tests. For the optimal lag length,Schwarz Information Criteria was used.

Table 3

ADF and PP Unit Root Tests (COVID-19 Case Impact)

	ADF				PP			
	Level		First Difference		Level		First Difference	
	T stat.	P-value	T stat.	P-value	T stat.	P-value	T stat.	P-value
CASE	-1.72	0.41	-10.88	0.00	-1.72	0.41	-10.82	0.00
BIST100	-0.65	0.85	-10.67	0.00	-0.70	0.83	-10.63	0.00
CDS	-3.64	0.01	-12.86	0.00	-2.56	0.01	-12.86	0.00
BONDY10	-2.38	0.14	-10.47	0.00	-2.58	0.09	-10.44	0.00
BONDY2	-1.70	0.42	-12.09	0.00	-1.63	0.46	-11.93	0.00

According to Table 3 and 4, some variables had a unit root problem in the level. All variables were stationary in the first difference. Therefore, the Toda Yamamoto causality test was suitable for these variables.

Table 4

ADF and PP Unit Root Tests (COVID-19 Death Impact)

	ADF				PP			
	Level		First Difference		Level		First Difference	
	T stat.	P-value	T stat.	P-value	T stat.	P-value	T stat.	P-value
DEATH	-1.11	0.70	-7.18	0.00	-1.44	0.55	-7.37	0.00
BIST100	-1.53	0.51	-10.44	0.00	-1.59	0.48	-10.52	0.00
CDS	-2.64	0.08	-12.42	0.00	-3.34	0.01	-12.43	0.00
BONDY10	-2.17	0.21	-10.27	0.00	-2.31	0.17	-10.24	0.00
BONDY2	-1.68	0.43	-11.78	0.00	-1.61	0.47	-11.64	0.00

Tables 5 and 6 show that the VAR model was stable, the residuals were normally distributed and they did not demonstrate heteroscedasticity problems and serial correlation.

Table 5

VAR Model Normality, Heteroscedasticity, and Serial Correlations Tests Results (COVID-19 Case Impact)

	P-Value
LM Test For Serial Correlation	0.24
Normality	0.34
Test For Heteroscedasticity	0.10

Table 6

VAR Model Normality, Heteroscedasticity, and Serial Correlations Tests Results (COVID-19 Death Impact)

	P-Value
LM Test For Serial Correlation	0.17
Normality	0.31
Test For Heteroscedasticity	0.14

Table 7 and 8 show the Johansen co-integration test. The Johansen test consists of trace test and eigenvalues of transformations values.

Table 7

Johansen Co-integration test (COVID-19 Case Impact)

Based on the trace of the stochastic matrix			Based on the maximal Eigenvalue of the stochastic matrix		
Hypothesized no. of CE(s)	Statistic	5% Critical Value	Hypothesized no. of CE(s)	Statistic	5% Critical Value
None	82.89112	76.97277	None	35.55457	34.80587
At Most 1	49.33655	54.07904	At Most 1	29.78624	28.8808
At Most 2	21.55031	35.19275	At Most 2	10.20918	22.29962
At Most 3	11.34113	20.26184	At Most 3	7.984861	15.89210
At Most 4	3.356267	9.164546	At Most 4	3.356267	9.164546

Table 7 and 8 show that the variables had a co-integration relationship. According to the results, there was co-movement between the variables in the study. There was a co-integrating vector; thus, a long-term association was established between variables. In the case impact, a maximum of 1 long-term relationship was found according to the trace test and there were 2 long-term relationships according to the max test. Also, there was a maximum of 1 long-term relationship according to trace and max tests for death impact.

Table 8

Johansen Co-integration test (COVID-19 Death Impact)

Based on the trace of the stochastic matrix			**Based on the maximal Eigenvalue of the stochastic matrix**		
Hypothesized no. of CE(s)	**Statistic**	**5% Critical Value**	**Hypothesized no. of CE(s)**	**Statistic**	**5% Critical Value**
None	98.91058	76.97277	None	48.59392	34.80587
At Most 1	50.31666	54.07904	At Most 1	23.44138	28.58808
At Most 2	26.87528	35.19275	At Most 2	11.59998	22.29962
At Most 3	15.27530	20.26184	At Most 3	8.713215	15.89210
At Most 4	6.562085	9.164546	At Most 4	6.562085	9.164546

The Granger causality relationship between variables was analyzed with the Toda Yamamoto test. The optimal lag length was calculated with the Schwarz Information Criteria (SIC). 1 lag length was determined for both the case impact and the death impact models.

Table 9

Toda Yamamoto test (COVID-19 Case Impact)

	Independent Variable				
Dependent Variable	**CASE**	**BIST100**	**CDS**	**BONDY10**	**BONDY2**
CASE	-	0.003553 (0.9525)	0.037626 (0.8462)	1.449299 (0.2286)	1.015111 (0.3137)
BIST100	0.269999 (0.6033)	-	0.429721 (0.5121)	15.55289 (0.0001)	14.94355 (0.0001)
CDS	2.008696 (0.1564)	1.395268 (0.2375)	-	5.132735 (0.0235)	3.743853 (0.0480)
BONDY10	0.001196 (0.9724)	4.911979 (0.0267)	2.187512 (0.1391)	-	2.365290 (0.1241)
BONDY2	0.649572 (0.4203)	0.443731 (0.5053)	2.057437 (0.1515)	0.133398 (0.7149)	-

In Table 9, the causality relationship between the number of cases between 11 March and 31 July and financial indicators was examined. The number of cases does did notaffect any financial indicator variables. The BIST 100 and 10-year bond yields affected each other mutually. There was unidirectional causality from bond yields (both 2 and 10 years) to CDS. Likewise, there was unidirectional causality from 2-year bond yields to the BIST 100.

Table 10

Toda Yamamoto test (COVID-19 Death Impact)

	Independent Variable				
Dep. Variable	**DEATH**	**BIST100**	**CDS**	**BONDY10**	**BONDY2**
DEATH	-	1.764780 (0.1840)	2.891648 (0.0890)	0.078674 (0.7149)	4.335028 (0.0573)
BIST100	0.023680 (0.8777)	-	0.100700 (0.7510)	5.972094 (0.0145)	5.502051 (0.0190)
CDS	6.896844 (0.0086)	0.033513 (0.8547)	-	6.486684 (0.0109)	4.708490 (0.0300)
BONDY10	0.268708 (0.6042)	8.554247 (0.0034)	2.215009 (0.1367)	-	5.273460 (0.0217)
BONDY2	2.059819 (0.1512)	1.011040 (0.3147)	0.961555 (0.3268)	0.001959 (0.9647)	-

In Table 10, the causality relationship between the number of deaths between 17 March and 31 July and financial indicators was examined. There was a one-way causality from the number of deaths to CDS. The number of COVID-19 deaths affected CDS. A bidirectional causality relationship was found between BIST 100 and 10-year bond yields. 2-year bond yields affected 10-year bond yields. Similar to the case effect, there was unidirectional causality from bond yields (both 2 and 10 years) to CDS. There was a one-way causality from 2-year bond yields to BIST 100.

Conclusion

Humanity has experienced outbreaks of infectious disease throughout its history. The last such outbreak of infectious disease was COVID-19. The first official case of COVID-19, (a member of the coronavirus family), occurred in Wuhan, China in December 2019. Countries have been affected economically due to healthcare, social supports, and loss of production caused by COVID-19. Also, businesses have closed, unemployment has increased and consumption has decreased. As a result of panic and a decrease in investor confidence, there has been a sharp fall in stock markets. The effects of COVID-19 have been analyzed in the literature with variables such as credit, stock market, bond market, CDS, production, and unemployment.

In this paper, the effects of COVID-19 on the selected financial indicators in Turkey were examined. The causality relationship was analyzed using the Toda Yamamoto test. The empirical results show that 10-year bond yields and BIST 100 affected each other. Also, 10-year bond yields and 2-year bond yields affected CDS. There was a unidirectional Granger casuality from the number of COVID-19 deaths to CDS.

The Toda Yamamoto causality test showed that the number of COVID-19 cases did not affect any financial indicators in Turkey. However, there was a unidirectional Granger causality

from the number of COVID-19 deaths to CDS. COVID-19 deaths affected CDS. The increase in the severity of the pandemic affected Turkey's country risk. Our findings show that bond yields had an effect on CDS. An increase in bond yields can be perceived as a country's liquidity problem. Moreover, increased debt can increase a country's risk perception. Therefore, an increase in bond yields may affect investor perception and country risk.

Considering these findings, policymakers should manage the pandemic process to reduce country risk. However, CDS is affected by more than one indicator. The pandemic and measures taken to fight it may also cause an increase in CDS. A lockdown decision may cause a decrease in economic growth. Therefore, rational policies should be established by striking a balance which takes management of a pandemic process and the economy into consideration.

Peer-review: Externally peer-reviewed.
Author Contributions: Conception/Design of study: S.B.A.; Data Acquisition: B.Ş.Ş.; Data Analysis/Interpretation: S.B.A., B.Ş.Ş.; Drafting Manuscript: B.Ş.Ş.; Critical Revision of Manuscript: S.B.A.,B.Ş.Ş.; Final Approval and Accountability: S.B.A.,B.Ş.Ş.
Conflict of Interest: The author has no conflict of interest to declare.
Grant Support: The author declared that this study has received no financial support.

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