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THE TIME-VARYING IMPACT OF COVID-19 ON STOCK RETURNS: EVIDENCE ON DEVELOPED COUNTRIES FROM A BOOTSTRAP ROLLING WINDOW CAUSALITY METHOD

COVID-19'un Hisse Senedi Getirileri Üzerindeki Zamanla Değişen Etkisi: Gelişmiş Ülkeler Üzerinde Bootstrap Rolling Window Nedensellik Yönteminden Kanıtlar

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Keywords:
Stock Return, COVID-19, Pandemic, Kao Panel Cointegration, Bootstrap Rolling Window Causality

JEL Codes:
C32, C33, G10

Abstract

This study examines the time-varying impact of the Novel Coronavirus (COVID-19) on stock returns by employing the bootstrap rolling window causality test. For this purpose, we use the daily data of COVID-19 confirmed cases and stock returns of six most hard-hit developed countries from the COVID-19 pandemic, namely France, Germany, Italy, Spain, the United Kingdom, and the United States. Before investigating the time-varying impact of COVID-19 on stock returns, we first examine the long-run relationship between COVID-19 confirmed cases and stock returns with the Kao panel cointegration method and we find that there exists a long-run relationship between variables. The bootstrap rolling window causality test results show that confirmed cases of COVID-19 have a time-varying impact on stock returns for each country. We also find that among the six developed countries in this study, the impact of daily COVID-19 confirmed cases on stock returns is the least in Germany, while it is the most in Italy. These results are thought to provide important information to market participants.

Anahtar Kelimeler:
Hisse Senedi Getirisi, COVID-19, Pandemi, Kao Panel Eşbütünleşme, Bootstrap Rolling Window Nedensellik

JEL Kodları:
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Özet

Bu çalışma, yeni Coronavirüs'ün (COVID-19) hisse senedi getirileri üzerindeki zaman içinde değişen etkisini bootstrap rolling window nedensellik testini kullanarak incelemektedir. Bu amaç için, Fransa, Almanya, İtalya, İspanya, Birleşik Krallık ve Amerika Birleşik Devletleri olmak üzere COVID-19 pandemisinden en çok etkilenen altı gelişmiş ülkenin COVID-19 teyit edilen vakaları ile hisse senedi getirilerinin günlük verileri kullanılmıştır. COVID-19'un hisse senedi getirileri üzerindeki zaman içinde değişen etkisi araştırılmadan önce, ilk olarak COVID-19 teyit edilmiş vakalar ile hisse senedi getirileri arasındaki uzun vadeli ilişki Kao panel eşbütünleşme yöntemi ile incelenmiş ve değişkenler arasında uzun vadeli bir ilişki olduğu bulunmuştur. Bootstrap rolling window nedensellik testi sonuçları, COVID-19 teyit edilmiş vakaların her ülke için hisse senedi getirileri üzerinde zaman içinde değişen bir etkiye sahip olduğunu göstermiştir. Ayrıca, bu çalışmadaki altı gelişmiş ülke arasında, günlük COVID-19 teyit edilen vakaların hisse senedi getirileri üzerindeki etkisinin Almanya'da en az, İtalya'da ise en fazla olduğu belirlenmiştir. Bu sonuçların piyasa katılımcılarına önemli bilgiler sağlayacağı düşünülmektedir.

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1. Introduction

The Novel Coronavirus named COVID-19, which appeared in December 2019 in the city of Wuhan in Hubei province of China, quickly spread many regions of the World via international travels. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 as a global pandemic, and directed countries to take strict measures to control the COVID-19 pandemic (Göker, Eren and Karaca, 2020). Although countries take many strict measures, the spread of COVID-19 among people has not been stopped yet. Globally, as of 12 July 2020, a total of 12.552.765 COVID-19 confirmed cases and 561.617 deaths have been reported to WHO (World Health Organization [WHO], 2020a). The COVID-19 outbreak has affected not only the physical and psychological health of the people but also and most important economic and financial systems of the countries (Ramelli and Wagner, 2020). Although countries have announced new packages[1] to prevent the economic effects of the COVID-19 (Çıtak, Bağcı, Şahin, Hoş and Sakinc, 2020), the high uncertainty about the evolution of COVID-19 and its economic impact makes it tough for policymakers to develop an proper economic and financial policy response (McKibbin and Fernando, 2020). Panic seen among companies, investors, and consumers due to the COVID-19 outbreak has caused unusual consumption behaviour and also some market anomalies. Financial markets of countries have also been reacted to the changes caused by the COVID-19 pandemic and stock indices around the world have plunged (McKibbin and Fernando, 2020). According to Baker et al. (2020), no previous infectious disease outbreaks, including the Spanish Flu, the Bird Flu (H5N1), SARS (Severe Acute Respiratory Syndrome), the Swine Flu (H1N1), MERS (Middle Eastern Respiratory Syndrome)/Ebola, has impacted the stock markets as powerfully as the COVID-19 pandemic. Motivated by these information, we consider the impact of COVID-19 over stock markets.

Limited numbers of studies have investigated the economic or financial effects of COVID-19. Al-Awadhi, Alsaifi, Al-Awadhi and Alhammadi (2020) examine the effect of the COVID-19 pandemic on the stock market for China and find that the daily growth in total number of both confirmed cases and deaths due to the COVID-19 pandemic have statistically significant negative effects on returns for the Chinese stock market. Alber (2020) investigates the effects of COVID-19 spread on stock markets for China, France, Germany, Italy, Spain, and the United States and report that COVID-19 spread has a negative effect on returns of the stock market for China, France, Germany, and Spain, but not for the United States and Italy. Baker et al. (2020) investigate stock market reaction to COVID-19 for the US and report that the US stock market volatility rocketed upwards due to COVID-19. Estrada, Park, Koutronas, Khan and Tahir (2020) empirically assess the negative effects of the COVID-19 outbreak over the Chinese economy. Gunay (2020) investigates the influence of COVID-19 on stock markets for China, Italy, Spain, Turkey, the United Kingdom, and the United States and finds that all stock markets exhibit structural breaks due to COVID-19 and also COVID-19 has contagious effects. Luo and Tsang (2020) examine the economic effect of the COVID-19 pandemic on both China and the global economy and find that the output lose is 4% for China due to labor loss, and global economy suffers about 1% loss of output per period because of the economic contraction in China. McKibbin and Fernando (2020) investigate the effects of the COVID-19 pandemic

[1] See for more information about packages https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19.

over the global macroeconomy with seven scenarios and report that COVID-19 has significant impact over the global economy, especially in the short run. Öztürk, Şişman, Uslu and Çıtak (2020) analyze the effects of the COVID-19 outbreak on the Turkish stock market and find that Turkish sectoral indices are affected by the number of confirmed cases reported in Turkey than the number of confirmed cases in Europe and in the World. The effect of the COVID-19 pandemic over financial markets for China and the US is reported by Sansa (2020). Yan (2020) examines how Chinese stock markets react to COVID-19 and finds that COVID-19 leads to big moves in stock prices. Zeren and Hızarcı (2020) examine the impacts of the COVID-19 outbreak over stock markets for China, France, Germany, Italy, South Korea, and Spain and find that total death and stock markets act together in the long run. They also find that total cases and stock markets have a cointegration relationship for China, South Korean, and Spain.

The existing literature provides some useful information about the economic or financial impacts of COVID-19; however, little is known about the time-varying impacts of daily confirmed cases of COVID-19 on stock returns, which is one of the most important indicators for not only investment and portfolio allocation decisions but also option pricing and financial market regulation (Balcilar, Gupta and Kyei, 2018; Poon and Granger, 2003). Empirical studies that investigate economic or financial impacts of the COVID-19 pandemic may reach inappropriate findings with full-sample data series when the data series show structural instability. Since time-series data experience structural instability, the causal relationships between time-series can display changes across different sub-samples (Balcilar, Ozdemir and Arslanturk, 2010). Therefore, in this study, we investigate the time-varying impact of daily confirmed cases of COVID-19 on stock returns via the bootstrap rolling window causality test of Balcilar et al. (2010) for six developed countries, namely France, Germany, Italy, Spain, the United Kingdom, and the United States. This method robust to any structural shifts in the model and allow us to detect the links between variables over time. We also examine the long-run relationship between confirmed cases of COVID-19 and stock returns using the Kao panel cointegration test. Our contribution to the literature is two-fold. First, according to the best of our knowledge, this study is one of the first studies to investigate the time-varying impact of daily confirmed cases of COVID-19 on stock returns for most hard-hit developed countries, i.e. France, Germany, Italy, Spain, the United Kingdom, and the United States. Second, the study uses different econometric techniques (the Kao panel cointegration and the bootstrap rolling window causality) than existing literature to analyze the connection between the number of confirmed daily cases of COVID-19 and the stock returns. The remainder of the paper is structured as follows. Section 2 presents some information about the methodology and the data, while Section 3 reports and discusses the empirical results. Lastly, Section 4 concludes the paper.

2. Data and Methodology

To employ empirical tests, we use the daily data from six developed countries with the highest number of COVID-19 total confirmed cases among developed countries as of 13 April 2020 (WHO, 2020b). While countries' COVID-19 daily confirmed cases data are obtained from https://data.europa.eu/, the data on daily closing values of the stock market indices are downloaded from https://www.investing.com. The daily returns are computed as $R_{it} = \ln(V_{it}/V_{it-1}) \times 100$, where ln() denotes the natural logarithm, V_{it} and V_{it-1} are the values of the relevant index on day t and t-1, respectively. The starting date of the data span used in this paper differs for countries (21 January 2020 for the United States, 28 January 2020 for Germany, 29 January 2020 for France, 31 January 2020 for Italy and the United Kingdom, 10 February 2020 for Spain) due to the confirmed first case date, but the ending date is 9 July 2020 for all countries. Since the stock markets are closed on weekends and public holidays, we manually extract the data of the confirmed cases seen on the relevant holidays in order to ensure consistency in the data for all countries. We present descriptive statistics of daily returns for all countries in Table 1. From the table, it is observed that all developed countries indices used the study have negative average returns, most likely driven by the COVID-19 outbreak. Judging from the mean values, the DAX index of Germany has the lowest negative daily average return with -4.4%, while the IBEX 35 index of Spain has the highest negative daily average return with the -28.7%. In terms of standard deviation, return volatility for the FTSE 100 index of UK is the smallest among the six countries, 2.504%, while that for the FTSE MIB index of Italy is 3.078%, which is the largest of the six countries. We find that the return distributions of all indices are negatively skewed, and are exhibit excess kurtosis, which indicate non-normality in the return series. The non-normal distributions of the return series are also seen from the results of the Jarque-Bera test for normality.

Table 1. Descriptive Statistics

	France CAC 40	**Germany DAX**	**Italy FTSE MIB**	**Spain IBEX 35**	**UK FTSE 100**	**US S&P500**
Minimum	-13.09	-13.055	-18.541	-15.151	-11.512	-12.765
Maximum	8.056	10.414	8.549	7.528	8.667	8.968
Mean	-0.155	-0.044	-0.177	-0.287	-0.179	-0.046
Std. dev.	2.745	2.776	3.078	2.918	2.504	3.003
Skewness	-1.084	-0.744	-2.246	-1.310	-0.855	-0.580
Kurtosis	7.342	7.997	14.834	8.906	7.205	6.766
Jarque-Bera	111.896	129.164	747.731	184.406	95.294	76.986
Probability	0.000	0.000	0.000	0.000	0.000	0.000
Observations	114	114	112	106	111	119

Note: Std. dev. stands for standard deviation. Probability denotes the probability values of the Jarque-Bera test for normality.

This study first explores the long-run relationship between daily confirmed cases of the COVID-19 pandemic and stock returns for six developed countries (France, Germany, Italy, Spain, the United Kingdom, and the United States) by panel data analysis. The presence of horizontal cross-section dependency should be tested in panel data analysis. In the case of horizontal cross-section dependency between units, second-generation unit root tests are employed to test the stationarity of variables. Also, testing the homogeneity of the series is important in panel data analysis. The assumption that the series are homogeneous is unrealistic. Therefore, a homogeneity test should be done. In this study, the homogeneity test is done with the Delta test developed by Pesaran and Yamagata (2008). The Kao Panel cointegration test is applied to figure out the long-run relationship between variables. Finally, the time-varying causality links between the variables in the paper is determined via the bootstrap rolling window causality test of Balcilar et al. (2010) for each country.[2,3] The econometric model used in the study is shown in equality (1).

[2] Research and publication ethics are followed in this study.

$$RETURNS_{i,t} = \alpha_i + \beta_1 CC_{i,t} + \varepsilon_{i,t} \quad (1)$$

In equality (1) the RETURNS variable denotes to stock returns, α is the constant coefficient, β is the slope coefficient, CC is the COVID-19 confirmed case number, and ε is the error term.

3. Empirical Results

To decide whether to test the stationarity of variables with first-generation tests or second-generation tests, it is necessary to test the horizontal cross-section dependency of the variables. For this reason, to test the horizontal cross-section dependency in the variables; Breusch-Pagan LM, Pesaran Scaled LM, Bias-corrected Scaled LM, and Pesaran CD tests are used and the results of these test are shown in Table 2.

Table 2. Horizontal Cross Section Dependency Test Results

Tests	RETURNS		CC	
	Statistic	**Prob.**	**Statistic**	**Prob.**
Breusch-Pagan LM	876.1263	0.0000***	690.0903	0.0000***
Pesaran scaled LM	157.2194	0.0000***	123.2541	0.0000***
Bias-corrected scaled LM	157.1940	0.0000***	123.2286	0.0000***
Pesaran CD	21.56818	0.0000***	23.83561	0.0000***

Note: *** denotes statistical significance at the 1% level.

As a result of the horizontal cross-section dependency tests, it is determined that all variables have horizontal cross-section dependence at 1% significance level. After determining the cross-sectional dependency, the stationarity test should be done with unit root tests, which take into consideration the cross-sectional dependency and which is expressed as the second generation test. For this reason, the PANIC test developed by the second generation tests Bai and Ng (2004) is used for unit root testing and the results are shown in Table 3.

Table 3. PANIC Unit Root Test Results

PANIC Unit Root Test		RETURNS	CC
		Level	
Constant	PCe_Choi	-6.704 (0.000)	1.496 (0.932)
	PCe_MW	70.848 (0.000)	5.170 (0.952)
Constant and Trend	PCe_Choi	-5.778 (0.000)	3.074 (0.988)
	PCe_MW	54.422 (0.000)	1.436 (0.998)
		First Differences	
Constant	PCe_Choi		-6.742 (0.000)
	PCe_MW		79.677 (0.000)
Constant and Trend	PCe_Choi		-5.778 (0.000)
	PCe_MW		64.297 (0.000)

[3] Ethics committee permission and/or legal/special permission is not required for this study.

As a result of the PANIC panel unit root test, we determine that the RETURNS variable is stationary in both constant and constant + trend at the level. While the CC variable is not stationary at the level, it is concluded that when the first degree difference is taken, it becomes stationary. Therefore, it would be appropriate to investigate the relationship between these variables by cointegration analysis. However, before conducting cointegration analysis, it is necessary to decide whether the model is homogeneous or heterogeneous. For the homogeneity test in the model, $\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$ tests are used. The results are shown in Table 4.

Table 4. Homogeneity Test Results

	Tests	Statistic	Prob.
Homogenity	$\tilde{\Delta}$	154.645	0.0000***
	$\tilde{\Delta}_{adj}$	158.467	0.0000***

Note: *** denotes statistical significance at the 1% level.

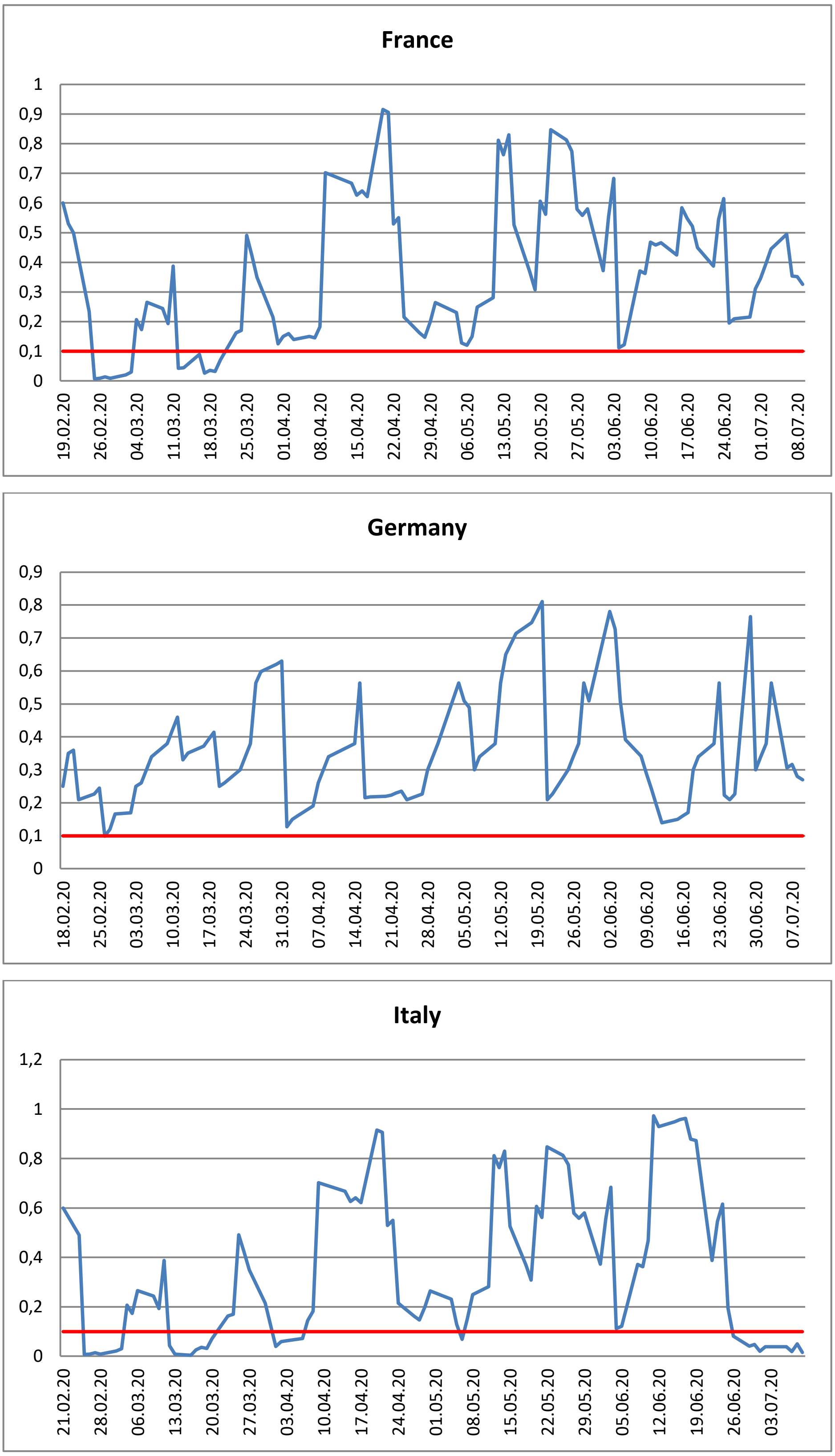
In the test $\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$ tests, the H_0 hypothesis, which claims that the model is homogeneous, is not accepted at the 1% level of significance and it is decided that the model is heterogeneous. This indicates that the effect of a change in confirmed cases of COVID-19 on stock returns differs from country to country. In order to determine the long-run relationships of the variables included in the paper, the Kao panel cointegration test is applied and the test results are shown in Table 5.

Table 5. Kao Panel Cointegration Test Results

	t-Statistic	Prob.
ADF	5.386217	0.0000
Residual variance	2598833.	
HAC variance	1704984.	

For the Kao panel cointegration test, the null hypothesis is "no cointegration". When the probability value is analyzed, the null hypothesis is rejected and it is concluded that there are long-run co-integrated vectors between confirmed cases of COVID-19 and stock returns. In other words, there is a long-run relationship between these two variables.

The causality relationship between stock returns and confirmed cases of COVID-19, which have a long-run relationship, is examined separately for each country via the bootstrap rolling window causality test of Balcilar et al. (2010). The test is applied to daily data with the fixed-length rolling windows of 15 observations as suggested in Aslan, Destek and Okumus (2018); Inglesi-Lotz, Balcilar and Gupta (2014); and Liu, Lee and Lee (2016). Applying the test to rolling window sub-samples of the dataset and plotting the results from each sub-sample yields causality relationship between the variables in various sub-periods, which could in turn be interpreted as a time-variant impact of the COVID-19 pandemic on stock returns (Verheyden, De Moor and den Bossche, 2015). We collect the test statistics, i.e. p values for the bootstrap rolling window causality test, from each sub-samples and compare them to 10% significance level. The fact that the p-value is below 10% significance level in any sub-period indicates that the null hypothesis of no causality in the corresponding sub-period is rejected. The p-values of the bootstrap rolling window causality test for each country are plotted in Figure 1.



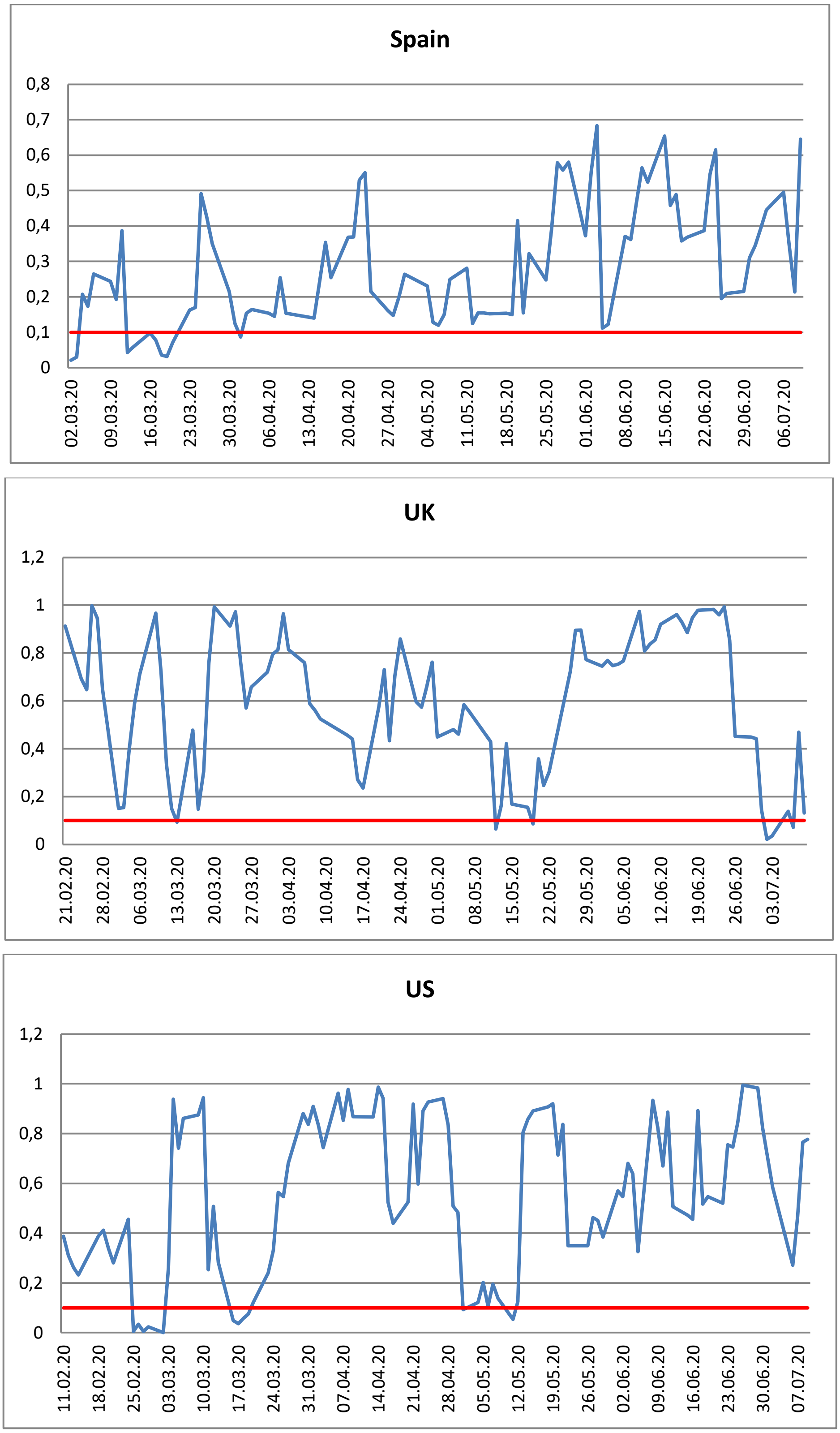


Figure 1. Bootstrap Rolling Window Causality Test Results
Note: Bootstrap rolling window causality test is applied with a fixed window of 15. The fluctuated line indicates p-values of the bootstrap rolling window causality test; null that confirmed cases of COVID-19 do not Granger cause stock returns. The horizontal line indicates 10% significance level.

A first observation from the different plots in Figure 1 is confirmed cases of COVID-19 have an impact on stock returns for all countries used in this study. For each country, the impact of the COVID-19 pandemic over stock returns is varying through time.

Table 6. Periods where the null hypothesis of no causality is rejected

France	Germany	Italy
25.02.2020-03.03.2020	26.02.2020	25.02.2020-03.03.2020
12.03.2020-20.03.2020		12.03.2020-20.03.2020
		01.04.2020-06.04.2020
		06.05.2020
		26.06.2020-09.07.2020
Spain	**UK**	**US**
02.03.2020-03.03.2020	13.03.2020	25.02.2020-02.03.2020
12.03.2020-20.03.2020	12.05.2020	16.03.2020-19.03.2020
01.04.2020	19.05.2020	01.05.2020
	02.07.2020-03.07.2020	11.05.2020
	07.07.2020	

Table 6 presents a better observation of the periods where the null hypothesis that the confirmed cases of COVID-19 do not Granger cause stock returns is rejected at the 10-percent level of significance. With the information in Table 6, we can make the following observation. The impact of daily COVID-19 confirmed cases on stock returns is the least in Germany, while it is the most in Italy.

4. Conclusion

This study examines the impact of COVID-19 on stock returns for six most hard-hit developed countries (France, Germany, Italy, Spain, the United Kingdom, and the United States) from COVID-19. For this purpose, we employ the Kao panel cointegration and the bootstrap rolling window causality tests using the daily data of COVID-19 confirmed cases and stock returns for each country. After the analyses, we have reached the following conclusions: (1) There is a long-run relationship between confirmed cases of COVID-19 and stock returns. (2) The COVID-19 pandemic affects the stock markets of all countries used in the study. (3) The impact of COVID-19 on stock returns varies over time. (4) Confirmed cases of COVID-19 most affect stock returns in Italy, while least affect stock returns in Germany. These results clearly show that the impact of the COVID-19 pandemic on stock returns varies from country to country and time to time. This study demonstrating the impact of COVID-19 on stock returns provides important information to individual investors, portfolio managers, and policymakers.

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