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Casablanca Stock Exchange response to the COVID-19 pandemic

Khalil Nait Bouzid[a*] and Ulrich Ekouala Makala[a]

[a] Central University of Finance and Economics (CUFE), Beijing, China

[*] Corresponding author's email: khalilnaitb94@gmail.com

Abstract

This study investigates the Casablanca Stock Exchange response to the COVID-19 by considering the impact of the COVID-19 related cases and deaths of eleven selected countries affected by the COVID-19, including Morocco, on the Moroccan Stock Market (MASI Index), over the period from June 13, 2019, to June 11, 2020. This study employs the GARCH (1,1) model for this purpose, in which we are allowing for the impact of changes in the COVID-19 related cases and deaths in both the conditional-mean and the conditional heteroscedasticity equations. Furthermore, we extend our analysis by employing the VAR-X model to examine stock market returns and trading volume response to the COVID-19 related cases and deaths. Finally, we use the Markov-Switching models to inspect whether the COVID-19 has caused a structural break in the stock market returns. Empirical results indicate that in some of the selected countries, changes in the number of cases and deaths related to the COVID-19 have had an impact on the volatility of the MASI Index as well as the MASI Index returns. Furthermore, the Markov-Switching model results suggest that at the end of February 2020, the COVID-19 pandemic crisis has caused a structural break on MASI Index returns and the relationship between trading volume and MASI index returns has turned negative.

Keywords: COVID-19; Casablanca Stock Exchange; MASI index; GARCH model; VAR-X model; Markov-Switching model.

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1. Introduction

Coronavirus disease 2019 (COVID-19) was first identified in December 2019 in the city of Wuhan, which is in the Hubei province of China. The virus continued to spread more widely in China and to other parts of the world, through the movement of people in early 2020 and has resulted in an ongoing pandemic.

The World Health Organization (WHO) declared the outbreak a Public Health Emergency of International Concern on January 30, 2020, to activate international supports and coordinate international responses to this disease. On March 12, 2020, it has been declared as a pandemic. As of June 11, 2020, more than 7.34 million cases of the COVID-19 were reported in more than 188 countries, resulting in more than 416,434 deaths. There was a significant increase in the number of cases and deaths, especially in the U.S., Italy, the U.K., and Brazil. Currently, it is contended whether the COVID-19 might raise to a global pandemic.

The spread of the COVID-19 affected economic activities in China. Amid the slowdown of the Chinese economy with disturbances to production, the global supply chain's functioning has been disrupted. Many manufacturing firms that rely on imported intermediate inputs from China have started experiencing shrinkages in production. Transportation restrictions have additionally decelerated global economic activities. Perturbation from quarantines, restrictions on travel, and decline in many of the services sector activities has brought significant disruption to the global economy, as a result, it has engendered panic among firms and consumers who have distorted typical consumption patterns and created anomalies in the market.

Different Financial and Monetary International organizations and platforms have warned that the novel COVID-19 will have profound and serious effects on the global economy and the effects will probably exceed the 2007-2008 world economic crises. (Harvey, 2020) illustrated the differences between the Global Financial Crisis and the COVID-19 crises and refers to the emerging epidemic crisis as the “Great Compression”. The World Economic Form asserted that “the coronavirus shock is severe even compared to the Great Financial Crisis in 2007-2008, as it hit households, businesses, financial institutions, and markets all at the same time, first in China and now globally”.

Given all of these negative effects, it seems unavoidable that stock markets, will also have a share in these situations. Global financial markets have also been

sensitive to the changes and global stock indices have dropped significantly and continuously.

(Sharif *et al.*, 2020) argued that the COVID-19 pandemic is a source of systematic risk, thus there is an urgent necessity for further research on the financial effects of coronavirus spread. The unfortunate state triggered by the COVID-19 provides us a unique opportunity to assess the impact of an unexpected and feared disease on the financial markets. This paper, specifically focuses on the Moroccan Stock Market for several reasons, first, the future economic response to this pandemic is still very uncertain, and therefore, in this context, it would be interesting to study the incorporation of information linked to the coronavirus in the performance of Casablanca stock market index. Second, the Casablanca stock market response to the COVID-19 pandemic is believed to be a serious concern to the investors, as it has triggered a channel of cumulated panic and unprecedented uncertainties. By mid-March, only a few cases were disclosed in Morocco, but their number started growing exponentially by the end of March. According to the Worldometer Data Tracker (WDT), the number of Morocco confirmed cases exponentially rose to above 4321, with 168 deaths by April 29, 2020. The literature suggests that as the COVID-19 has escalated across the world, it has created significant uncertainty in investing in financial markets, increased investors' fear, and created pessimistic sentiments on future expected returns, as a result, various global financial markets have become too volatile and stock prices have considerably gone down.

Third, the context marked by an economic crisis triggered by the spread of the Coronavirus has delivered a pessimistic scenario in the Casablanca Stock Exchange. Casablanca Stock Exchange indicators recorded, in the first quarter of 2020, a sharp drop in the most leading indices of the Casablanca Stock Exchange, MASI and MADEX fell to 8987,89 and 7277,97 points respectively, recording a decrease of 26.26% and 26.81% during March, a level never seen in the history of the Casablanca Stock Exchange.

Therefore, the main purpose of this study is to investigate the Casablanca Stock Exchange response to the COVID-19 by considering more particularly the impact of the COVID-19 related cases and deaths on the Moroccan Stock Market (MASI Index). This study will employ the GARCH (1,1) model for this purpose, in which we will allow for the impact of changes in reported deaths and cases of eleven countries majorly affected by the COVID-19 including Morocco, in both the conditional-mean and the conditional heteroscedasticity

equations. Then we will extend our analysis by employing the VAR-X model (VAR models with exogenous variables) to examine stock market returns and trading volume (endogenous variables) response to the COVID-19 cases and deaths (exogenous variables). After, we will use the Markov-Switching models to inspect whether the COVID-19 has caused a structural break in the stock market returns with regard to trading volume.

There is a small but fast-growing literature on the impact of the COVID-19 on the stock market, (Gormsen & Koijen, 2020), (Yilmazkuday, 2020) and (Baker *et al*., 2020). However, this study attempts to fill the gap in the literature by investigating the impact of COVID-19 under the context of the frontier market. To the best of our knowledge, this is the first study on this matter in the context of the Casablanca Stock Market. Therefore, it is to believe that this study would be able to provide valuable insights to the existing knowledge of this particular topic. More particularly, this paper contributes to current research on the stock markets response to the COVID-19 pandemic and the effects of pandemics in general on financial markets, as well as to research on the economic impact of the COVID-19 by providing empirical evidence that the COVID-19 has spillover effects on Casablanca Stock Exchange taking into consideration the COVID-19 situation of eleven other countries affected by the outbreak.

The main empirical results based on the GARCH model (1,1) suggest that the changes in the number of cases reported in Morocco and in four other countries affected by the COVID-19 crisis have an impact on the returns of the MASI index, while changes in the number of reported deaths in Morocco and seven other countries have no impact on the returns of the MASI index, with the exception of the changes in the number of reported deaths in Spain, France and Italy. Nevertheless, there is significant evidence of a positive impact, for some countries, on the conditional heteroskedasticity of MASI index returns. Furthermore, VAR-X models suggest that the number of reported cases in Morocco and seven other countries has a negative impact on MASI Index returns, and no impact on trading volume, except from the number of deaths reported in Italy. However, the number of reported deaths in France, Italy, Iran, and the U.K. has a negative impact on MASI Index returns, while the number of reported deaths in Brazil and Turkey has a negative impact on the trading volume. Finally, the Markov-Switching model results suggest that at the end of February 2020, the COVID-19 pandemic crisis has caused a structural break on MASI Index returns and the relationship between the trading volume and the returns of the MASI index has turned negative.

Our study will be organized as follow: Section 2 presents a brief background. Section 3 discusses the literature review of previous studies. Section 3 describes the methodology that will be used, the data collection, and discusses the empirical results. Finally, conclusion.

2. Background

On December 31, 2019, cases of pneumonia of unknown origin were detected in the city Wuhan, China, where a new Coronavirus 2019-nCoV was detected on January 7, 2020, later called SARS-CoV-2. In the face of the rapidly changing international epidemiological situation of the COVID-19, the World Health Organization has declared it a Public Health Emergency of International Concern on January 30, 2020, and a pandemic on March 12, 2020. As soon as the initial alert for this new virus, Morocco began the process of preparing and developing its national monitoring and response plan for the COVID-19.

A total of 8,455 cases of COVID-19 were registered in Morocco by June 01, 2020, and a total death of 210. The first case of the COVID-19 was confirmed in Casablanca on March 02, 2020. It was a Moroccan immigrant residing in Bergamo, who have arrived from Italy on February 27, 2020. The second case was confirmed later that same day involving a Moroccan woman of 89 years residing in Italy, who had returned to Morocco on February 25, 2020, from Bologna, Italy.

As the outbreak widened in Morocco, in mid-March the Government implemented measures of social distancing on March 16, 2020, consisting of: the suspension of international passenger flights, the closure of land and air, the cessation of education for all grade levels, the cessation of prayers at the mosque, the lockdown of cities. On March 19, 2020, Morocco was quarantined, and by March 22, 2020, the Government decided to implement the protocol of Chloroquine.

These measures inevitably affected the economic activity of Morocco. For instance, the equity market experienced a decrease of MASI and MADEX indices to 26.26% and 26.81%, respectively, during March, a level never seen in the history of the Casablanca Stock Exchange. (See Figure 1 and Figure 2).

FIGURE 1: PRICES OF MASI & MADEX INDICES FROM JUNE 13, 2019, TO JUNE 11, 2020

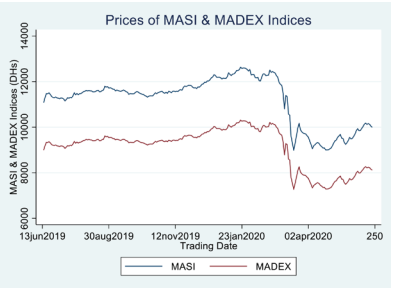
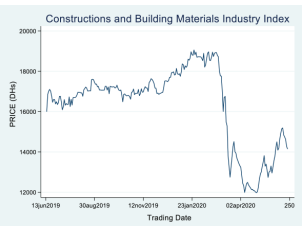
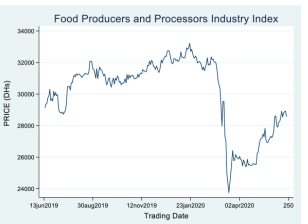
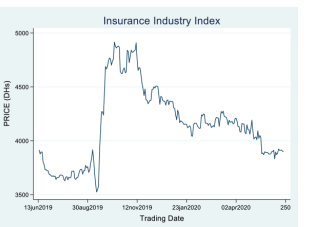
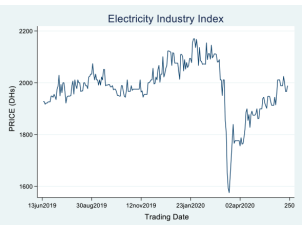


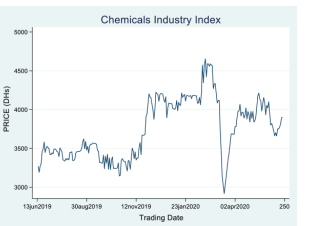
FIGURE 2: PRICES OF INDUSTRY INDICES FROM JUNE 13, 2019, TO JUNE 11, 2020

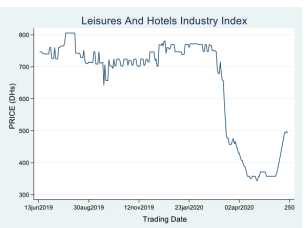


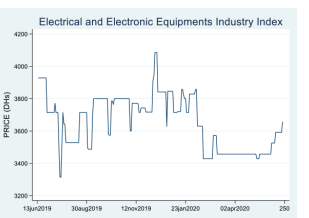


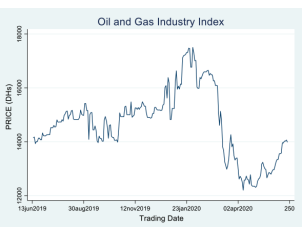


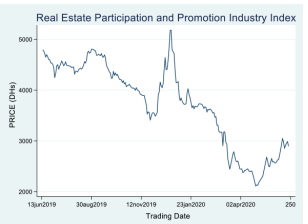


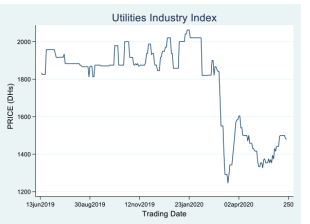


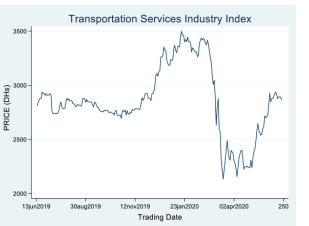


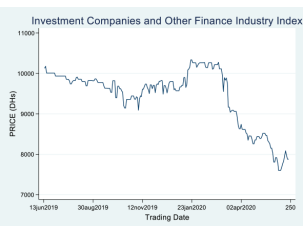


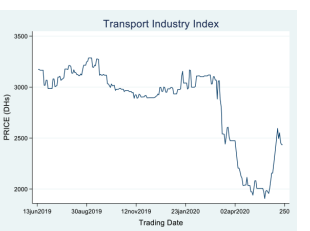


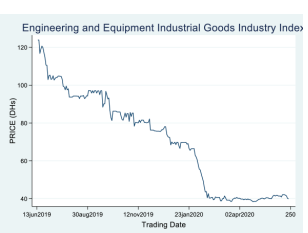


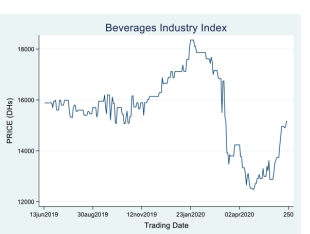


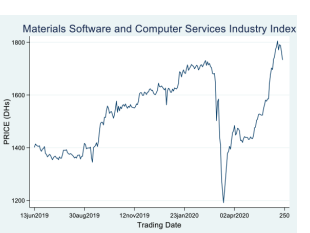












3. Review of literature

The COVID-19 pandemic is a global tragedy and has a growing and considerable impact on the global economy. Besides the hazardous consequences for our health, its emerging economic consequences are significant, with financial markets regarded as one of the more noticeable channels reflecting the effect of the pandemic on the economy. By using textual analysis, Baker *et al*., (2020) argued that the impact of news related to the COVID-19 on stock market

volatility has had a much larger effect on stock market volatility than other previously recorded infectious diseases, such as Ebola and SARS epidemics.

There is an emerging literature documented about the impact of the COVID-19 on stock markets. Yilmazkuday (2020) investigated the effects of the COVID-19 related cases in the U.S. on the S&P 500 Index, using daily data covering the period between December 31, 2019, and May 1, 2020. Based upon, a structural vector autoregression model, the empirical findings suggest that a 1% increase in cumulative daily COVID-19 related cases in the U.S., causes about 0,01% of a cumulative decrease in the S&P 500 Index after one day, and about 0,03% of a decrease after one month. Furthermore, when decomposing the historical values of the S&P 500 Index, the negative effects of the COVID-19 cases in the U.S. on the S&P500 Index are mostly observed during March 2020.

In the same line, based on a GARCH(1,1) model and data from April 8, 2019, to April 9, 2020, Onali (2020) examined the impact of the COVID-19 related cases and deaths on the U.S. stock market (Dow Jones and S&P500 indices), by allowing for changes in trading volume and volatility expectations. The empirical findings show that variations in the COVID-19 related cases and deaths in the U.S. and six other countries majorly affected by the COVID-19 crisis do not affect the U.S. Stock Market returns, except, the COVID-19 related cases in China. Nevertheless, there is empirical evidence of a positive effect, for some countries, on the conditional heteroscedasticity of the S&P500 and Dow Jones returns. When using, VAR models, the findings suggest that the number of reported deaths in Italy and France has a negative effect on stock market returns, and a positive effect on the VIX returns. Finally, when using Markov-Switching models, findings suggest that at the end of February 2020, the extent of the negative effect of the VIX on U.S. Stock Market returns increased threefold.

Sansa & Hasan (2020) investigated the effect of the COVID-19 on the U.S. and China Financial Markets (New York Dow Jones & Shanghai Stock Exchange) from March 1, 2020 to March 25, 2020. Based on a simple regression model, the findings suggest that there is a positive significant relationship between the COVID-19 confirmed cases in both financial markets, which further emphasizes that the COVID-19 had a significant effect on the financial markets.

Liu *et al*. (2020) investigated the short-run impact of the COVID-19 pandemic on 21 leading stock market indices in major affected countries. Based on an event study methodology, the findings show that the stock markets of the main affected countries fell rapidly after the virus outbreak. In particular, Asian countries experienced more negative abnormal returns than other countries.

Furthermore, using a panel fixed effect regression, the empirical findings support the adverse impact of the COVID-19 related cases on stock indices abnormal returns through an effective channel by adding up the VIX index as a gauge of investors' fears of uncertainties and pessimistic sentiments on expected returns.

In a recent study, He *et al*. (2020) investigated spill-overs and the direct effects of the COVID-19 on stock markets of China, France, Italy, Spain, South Korea, Japan, Germany, and the U.S. Based on conventional t-tests and nonparametric Mann–Whitney tests, the empirical evidence suggests that the COVID-19 has a negative but short-run impact on stock markets of affected countries. Moreover, the findings show that the impact of the COVID-19 on stock markets has two-way spreading effects between Asian countries, European and American countries. Nevertheless, there is no sign that the COVID-19 negatively affects these countries' stock markets more than it does the global average (compared to S&P 1200 Global index).

Using daily data between January 23, 2020, and March 13, 2020, Zeren & Hizarci (2020) investigated the effects of the COVID-19 related cases and deaths on stock markets of China, Spain, Italy, South Korea, France, and Germany. Based on the Maki (2012) cointegration test, the empirical evidence suggests that all stock markets examined with total death act together in the long run. Furthermore, considering that the COVID-19 related cases and deaths have increased, the results suggest that investing in the stock market is not the right option for investors. However, considering the possibility of investing in gold markets, cryptocurrencies, derivative markets, and in the stock markets of countries where the COVID-19 is relatively low might be considered as one of the optimal options for investors to avoid the risk.

In understanding the relationships between investors' decisions over a disease crisis and asset-price instability. Papadamou *et al*. (2020) investigated the impact of a google trend synthetic index concerning the COVID-19 as a proxy indicator of searching term, on the implied volatility of thirteen major stock markets, covering Asia, Europe, Australia regions, and the U.S. The findings show that increased anxiety caused by increased searching queries for the COVID-19 not only has a direct impact on implied volatility but also has an indirect impact through stock returns highlighting a risk-aversion channel operating over pandemic conditions. More specifically, these direct and indirect effects are stronger in Europe compared to the rest of the world.

4. Methodology & data

4.1. Data collection

The dataset used in this study comprises daily market-level data of the Casablanca Stock Exchange over the period from June 13, 2019, to June 11, 2020. In addition, data on the number of COVID-19 reported cases and deaths at the daily level is collected from the website https://ourworldindata.org/. The daily prices and trading volume of the MASI Index (Moroccan All Shares Index) are used as it is regarded as the major stock market index in Morocco, which tracks the performance of all companies listed on the Casablanca Stock Exchange. In this study, we consider eleven countries: Morocco, Italy, Spain, China, the U.S., France, Iran, Brazil, Turkey, Germany, and the U.K.

4.2. Methodology

4.2.1. GARCH (1,1) MODEL

To investigate to which extent the COVID-19 related cases and deaths affect the Casablanca Stock Exchange, we employ a GARCH model, which is widely used in the modeling of financial time series, as it helps to describe financial markets in which volatility can change, becoming more volatile during periods of financial crises or extreme events (COVID-19 in our case) and less volatile during periods of tranquility and steady economic growth.

In this study, we implement a GARCH (1,1) model with robust standard errors by using the following specification for the conditional-mean equation (eq: 1) and the conditional-variance equation (eq: 2):

$$y_t = \alpha + \beta_1 Volume_t + \beta_2 X_t + \epsilon_t \quad (1)$$

$$\delta_t^2 = exp(\lambda_0 + \lambda_1 X_t) + \gamma_0 \epsilon_{t-1} + \gamma_1 \delta_{t-1}^2 \quad (2)$$

Where, y_t and $Volume_t$ are the first-difference of the price and trading volume (in logs) of the MASI Index at time t, ϵ_t are the innovations, δ_t^2 is the conditional variance. The variables related to the COVID-19 reported cases and deaths are represented by X_t, which is equal to the first-difference in $ln(1+X_t)$, where ln represents the natural logarithm function and X_t is either the cumulative reported number of cases (*Total cases*) or the cumulative reported number of deaths (*Total deaths*) at time t. More specifically, we use a GARCH model with multiplicative heteroscedasticity component, (G. G. Judge *et al*., 1990), which includes the COVID-19 cases and deaths as a structural component in the volatility.

The empirical results for the GARCH (1,1) model for cases and deaths in Morocco are reported in Table 1. The results suggest that *Total cases* (*ln*) has

a negative impact on the Moroccan Stock Market returns in the conditional-mean equation, and a significant impact on the multiplicative heteroscedasticity (as described in the column so-called" HET") in the conditional-variance equation. However, *Total deaths* (*ln*) are, on the other hand, insignificant for both the conditional-mean and the conditional-variance equation. The results on the control variables suggest that there is a positive correlation between stock market returns and trading volume, which is consistent with the previous literature on the correlation between stock returns and trading volume using GARCH models, (Lee & Rui, 2002).

Table 1: MASI Index Returns, Confirmed Cases and Deaths in Morocco: GARCH (1,1) Estimations

Panel A: Morocco	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0012267*** (3.92)			.001199*** (4.09)		
Total Cases Morocco (ln)	-.0153147 ** (-1.98)	4.789073*** (5.03)				
Total Deaths Morocco (ln)				-.0091437 (-0.63)	.2904705 (0.01)	
L.arch			.3183901*** (3.25)			.370428*** (4.45)
L.garch			.5611891*** (6.58)			.6104989*** (8.10)
Constant	.0006019 (1.37)	-12.09501*** (-38.21)		.0006551 (1.55)	-12.4921*** (-35.33)	
Observations	248	248	248	248	248	248

Notes: The columns MASI reports the results for the conditional-mean equation. The column ARCH reports the results for the conditional-variance equation, where L.ARCH is ϵ_{t-1} in (eq: 2) and L.GARCH is δ_{t-1}^2 in (eq: 2). The column HET reports the results of λ_0 and λ_1. Z-statistics are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2 reports the results for the MASI Index, considering cases and deaths reported in Spain (Panel B) and France (Panel C). The results indicate that the total number of cases reported in Spain (in logs) has a negative impact on the MASI Index returns, and significantly correlated with conditional heteroscedasticity. Nevertheless, there is little evidence that *Total deaths* (*Ln*), has a negative impact on the MASI Index returns in the conditional-mean equation whereas, significant impact on the conditional-variance equation. For France, on the other hand, the coefficients on total deaths and cases are negative and significant in the conditional-mean equation, and significantly positive in the conditional-variance equation. These findings suggest that both *Total cases* (*Ln*) and *Total*

deaths (*Ln*) have a statistically significant impact on the volatility of the MASI. In fact, the coefficient on *Total deaths* (*Ln*) in the conditional-variance equation is the largest among the eleven countries considered.

Table 2: MASI Index Returns, Confirmed Cases and Deaths in Spain and France: GARCH (1,1) Estimations

Panel B: Spain	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0013463*** (4.36)			.0012091*** (7.02)		
Total Cases Spain (ln)	-.0165005** (-2.25)	4.789165 *** (9.24)				
Total Deaths Spain (ln)				-.0234574* (-1.86)	4.580409*** (7.29)	
L.arch			.1175761** (2.01)			.2228042** (2.51)
L.garch			.7778869 *** (10.09)			.6322896*** (7.02)
Constant	.0008112** (2.14)	-12.941*** (-30.90)		.000602 (1.41)	-12.14674*** (-39.50)	
Observations	248	248	248	248	248	248

Panel C: France	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0013324 *** (4.41)			.0011652 *** (3.30)		
Total Cases France (ln)	-.0155352** (-2.14)	3.854425*** (6.94)				
Total Deaths France (ln)				-.0272576*** (-2.62)	6.543304*** (6.23)	
L.arch			.1994044*** (3.21)			.23892** (2.32)
L.garch			.6882437*** (9.62)			.5706862*** (4.89)
Constant	.000814** (2.02)	-12.65386 *** (-36.86)		.0005603 (1.40)	-12.08181*** (-38.51)	
Observations	248	248	248	248	248	248

Notes: The columns MASI reports the results for the conditional-mean equation. The column ARCH reports the results for the conditional-variance equation, where L.ARCH is ϵ_{t-1} in (eq: 2) and L.GARCH is δ_{t-1}^2 in (eq: 2). The column HET reports the results of λ_0 and λ_1. Z-statistics are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 3: MASI INDEX RETURNS, CONFIRMED CASES AND DEATHS IN US AND UK: GARCH (1,1) ESTIMATIONS

Panel D: US	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0012169*** (3.87)			.0012269*** (3.86)		
Total Cases US (ln)	-.0109318 (-1.61)	4.141038 *** (4.58)				
Total Deaths US (ln)				-.0136476 (-1.15)	4.72829*** (7.81)	
L.arch			.2435948*** (3.09)			.2277197*** (2.97)
L.garch			.65148 *** (8.56)			.6665625*** (7.76)
Constant	.0007493* (1.74)	-12.49273*** (-35.48)		.0006587 (1.56)	-12.43958*** (-35.42)	
Observations	248	248	248	248	248	248
Panel E: UK	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.001235*** (3.90)			.0012015*** (3.81)		
Total Cases UK (ln)	-.0198127** (-2.45)	5.15393*** (6.64)				
Total Deaths UK (ln)				-.0149254 (-1.36)	4.405165*** (3.37)	
L.arch			.2105493 *** (2.86)			.2794485*** (3.09)
L.garch			.6311404*** (8.16)			.6342039*** (7.20)
Constant	.0007426* (1.80)	-12.37176*** (-39.46)		.0006856 (1.62)	-12.35976*** (-37.82)	
Observations	248	248	248	248	248	248

Notes: The columns MASI reports the results for the conditional-mean equation. The column ARCH reports the results for the conditional-variance equation, where L.ARCH is ϵ_{t-1} in (eq: 2) and L.GARCH is δ_{t-1}^2 in (eq: 2). The column HET reports the results of λ_0 and λ_1. Z-statistics are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3 reports the results for cases and deaths related to the COVID-19 in U.S. (Panel D) and the U.K. (Panel E). The coefficients on *Total cases* (*Ln*) and *Total deaths* (*Ln*) of both countries, in the conditional-variance equation, suggest that both variables enhance the volatility of the Moroccan Stock Market. On the other hand, *Total cases* (*Ln*) in the U.S. has a statistically insignificant

impact on the MASI Index, However, *Total cases* (*Ln*) in the U.K. has a negative and statistically significant impact on the MASI Index. For total deaths in the conditional-mean equation, neither U.S or U.K. has a significant impact on the MASI Index returns.

Table 4: MASI Index Returns, Confirmed Cases and Deaths in Italy and Iran: GARCH (1,1) Estimations

Panel D: Italy	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0012676*** (4.18)			.0012456*** (3.70)		
Total Cases Italy (ln)	-.0047842** (-2.07)	1.45227*** (5.81)				
Total Deaths Italy (ln)				-.0212139** (-2.17)	4.642224*** (5.06)	
L.arch			.2916706*** (4.40)			.2321045*** (3.01)
L.garch			.6517393*** (10.60)			.6625641*** (8.22)
Constant	.0006994* (1.66)	-12.63227 *** (-38.05)		.000679 (1.61)	-12.42369*** (-38.14)	
Observations	248	248	248	248	248	248

Panel D: Iran	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.00117*** (3.69)			.0011339*** (3.44)		
Total Cases Iran (ln)	.0023786 (0.56)	1.936289** (2.40)				
Total Deaths Iran (ln)				-.0096244 (-1.00)	3.301793*** (2.98)	
L.arch			.3772892*** (3.89)			.3528961*** (3.71)
L.garch			.5691291 *** (6.66)			.5840711 *** (6.82)
Constant	.0005126 (1.23)	-12.35094*** (-39.32)		.0005498 (1.31)	-12.34754*** (-38.40)	
Observations	248	248	248	248	248	248

Notes: The columns MASI reports the results for the conditional-mean equation. The column ARCH reports the results for the conditional-variance equation, where L.ARCH is ϵ_{t-1} in (eq: 2) and L.GARCH is δ_{t-1}^2 in (eq: 2). The column HET reports the results of λ_0 and λ_1. Z-statistics are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The results reported in Table 4 refer to the impact of cases and deaths in Italy (Panel F) and Iran (Panel G) on the MASI Index. The results suggest that the total number of cases and deaths in Italy have a positive impact on the MASI Index volatility, and a negative impact on its returns. Similarly, *Total cases* (*Ln*) and *Total deaths* (*Ln*) in Iran have a significant impact on the volatility of the MASI Index, but they do not affect its returns.

Table 5: MASI Index Returns, Confirmed Cases and Deaths in Brazil and China: GARCH (1,1) Estimations

Panel D: Brazil	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0013432*** (3.74)			.0012284*** (4.16)		
Total Cases Brazil (ln)	-.0017571 (-0.19)	5.832589 *** (8.67)				
Total Deaths Brazil (ln)				.0048995 (0.43)	1.870439 (0.17)	
L.arch			.1176118* (1.66)			.3710291*** (4.49)
L.garch			.6735981 *** (6.08)			.6037591 *** (8.12)
Constant	.0006284 (1.50)	-12.14996*** (-33.79)		.0005993 (1.36)	-12.44889*** (-36.71)	
Observations	248	248	248	248	248	248
Panel D: China	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0012347*** (4.25)			.0011905*** (4.18)		
Total Cases China (ln)	-.0011354 (-0.27)	.0814575 (0.05)				
Total Deaths China (ln)				-.0015647 (-0.35)	2.069839* (1.69)	
L.arch			.3791057*** (4.39)			.342699 *** (4.49)
L.garch			.6018565 *** (8.55)			.6227456*** (9.07)
Constant	.0006781 (1.52)	-12.47593*** (-33.85)		.000678 (1.58)	-12.57753*** (-35.89)	
Observations	248	248	248	248	248	248

Notes: The columns MASI reports the results for the conditional-mean equation. The column ARCH reports the results for the conditional-variance equation, where L.ARCH is ϵ_{t-1} in (eq: 2) and L.GARCH is δ_{t-1}^2 in (eq: 2). The column HET reports the results of λ_0 and λ_1. Z-statistics are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 6: MASI INDEX RETURNS, CONFIRMED CASES AND DEATHS IN GERMANY AND TURKEY: GARCH (1,1) ESTIMATIONS

Panel D: Germany	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0013659 *** (4.57)			.0012067*** (4.11)		
Total Cases Germany (ln)	-.0158963 (-1.87)	4.915488 *** (6.72)				
Total Deaths Germany (ln)				-.0091482 (-0.73)	3.773911 (0.69)	
L.arch			.1782559*** (2.86)			.3706073 *** (4.59)
L.garch			.7114226 *** (9.56)			.5946645 *** (8.29)
Constant	.0008499 ** (2.16)	-12.74987 *** (-34.23)		.000661 (1.56)	-12.40192*** (-36.77)	
Observations	248	248	248	248	248	248

Panel D: Turkey	**(1)** MASI	**(2)** HET	**(3)** ARCH	**(4)** MASI	**(5)** HET	**(6)** ARCH
MASI Volume (ln)	.0011959*** (4.05)			.0012223*** (4.17)		
Total Cases Turkey (ln)	-.0129984 (-1.22)	2.950815 (1.47)				
Total Deaths Turkey (ln)				.0034286 (0.25)	.6182824 (0.03)	
L.arch			.3574925*** (4.56)			.3748507*** (4.44)
L.garch			.601665 *** (8.50)			.6050242*** (8.01)
Constant	.0006895 (1.63)	-12.40977*** (-37.75)		.0006152 (1.45)	-12.46658*** (-36.05)	
Observations	248	248	248	248	248	248

Notes: The columns MASI reports the results for the conditional-mean equation. The column ARCH reports the results for the conditional-variance equation, where L.ARCH is ϵ_{t-1} in (eq: 2) and L.GARCH is δ_{t-1}^2 in (eq: 2). The column HET reports the results of λ_0 and λ_1. Z-statistics are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5 reports the results for cases and deaths related to the COVID-19 in Brazil (Panel H) and China (Panel I). The results indicate that the total number of cases reported in Brazil (in logs) has an insignificant impact on the MASI Index returns, but it is correlated with conditional heteroscedasticity, implying

that *Total cases* (*Ln*) affects the volatility of the MASI Index. The coefficients on *Total deaths* (*Ln*) are insignificant in both the conditional-mean and the conditional-variance equation. In fact, the coefficient on *Total cases* (*Ln*) for Brazil in the conditional-variance equation is the largest among the eleven countries considered. For China, on the other hand, the coefficients on the *Total cases* (*Ln*) and *Total deaths* (*Ln*) are both insignificant in the conditional-mean equation and the conditional-variance equation, except for Total deaths (ln) with a little evidence in the latter.

The results reported in Table 6 refer to the impact of cases and deaths in Germany (Panel J) and Turkey (Panel K) on the MASI Index. The results suggest that the total number of cases reported in Germany has a positive impact on the MASI Index volatility, but they do not affect its returns. The coefficients on *Total deaths* (*Ln*) are insignificant in either the conditional-mean and the conditional-variance equation. For Turkey, the results suggest that the *Total cases* (*Ln*) and *Total deaths* (*Ln*) do not have any significant impact in both the conditional-mean equation and in the conditional-variance equation.

4.2.2. VAR-X Model

In this study, we also implement a VAR-X model (VAR models with exogenous variables) to examine stock market returns and trading volume (endogenous variables)[1] response to the COVID-19 cases and deaths (exogenous variables). For the sake of brevity, we only report the coefficients on the variables related to reported cases and deaths, and we do not report the results for the endogenous variables.

The results reported in Table 7 show marginally different results from those for the GARCH (1,1) models. For Morocco, *Total cases* (*Ln*) in morocco has a negative and statistically significant impact on the Moroccan Stock Market returns. However, *Total deaths* (*Ln*) has an insignificant impact on the MASI Index. On the other hand, *Total cases* (*Ln*) and *Total deaths* (*Ln*) do not affect the trading volume of the Moroccan Stock Market. The results *Total cases* (*Ln*) for Spain, France, U.S., U.K, Germany, Brazil, and Turkey suggest a negative impact on the returns of the MASI Index returns. However, the results for *Total*

[1.] According to the test of optimal lag selection based on Akaike's information criterion (AIC) criterion, the models consider four lags for each endogenous variable. (Onali, 2020) considers COVID-19 related cases and deaths as exogenous variables in a VAR-X framework, while (Yilmazkuday, 2020) considers COVID-19 deaths as exogenous variables in a structural VAR framework.

Table 7: VAR-X models: Total Cases and Total Deaths

VARIABLES	**(1)** **Masi**	**(2)** **Volume**
Total Cases Morocco (ln)	-.0478129*** (-7.64)	.2775454 (0.57)
Total Deaths Morocco (ln)	.0055029 (0.65)	-1.011638 (-1.54)
Total Cases Spain (ln)	-.0239225*** (-4.82)	.4224992 (1.19)
Total Deaths Spain (ln)	.0018339 (0.35)	-.0953392 (-0.25)
Total Cases France (ln)	-.0126014 ** (-2.49)	.1391095 (0.38)
Total Deaths France (ln)	-.0248217*** (-3.72)	-.2239286 (-0.46)
Total Cases China (ln)	-.0000934 (-0.03)	.1759388 (0.80)
Total Deaths China (ln)	-.0008003 (-0.13)	-.4496988 (-1.04)
Total Cases Italy (ln)	.0081849 ** (1.99)	-.54844* (-1.85)
Total Deaths Italy (ln)	-.0392129*** -5.06	.7759433 (1.39)
Total Cases Iran (ln)	.0226536** (2.47)	.4540414 (0.69)
Total Deaths Iran (ln)	-.0543669*** (-3.92)	-.9461461 (-0.96)
Total Cases US (ln)	-.0193483 *** (-3.26)	-.13486 (-0.32)
Total Deaths US (ln)	-.0015514 (-0.24)	-.2614559 (-0.58)
Total Cases UK (ln)	-.0117555* (-1.85)	.1392063 (0.30)
Total Deaths UK (ln)	-.0243362 *** (-3.84)	-.1597076 (-0.34)
Total Cases Germany (ln)	-.0301643 *** (-5.65)	.3103285 (0.80)
Total Deaths Germany (ln)	.0165205*** (2.83)	-.4186879 (-0.99)
Total Cases Brazil (ln)	-.0301643 *** (-9.53)	.7556886 * (1.83)
Total Deaths Brazil (ln)	.0165205 *** (6.81)	-1.306876*** (-2.79)
Total Cases Turkey (ln)	-.0521535 *** (-11.43)	.2320624 (0.60)
Total Deaths Turkey (ln)	.057825 *** (10.06)	-1.075157** (-2.20)
Observation	244	244

Notes: The columns MASI and Volume report the results for the log-returns of the MASI Index and Trading volume, respectively for the daily first-difference in market returns and trading volume (in logs). Endogenous variables and constant included but not reported. *** p<0.01, ** p<0.05, * p<0.1.

deaths (*Ln*) reported in France, Italy, Iran, U.K., suggest a negative impact on the MASI Index returns. The results *Total cases* (*Ln*) in Italy suggest little evidence of a negative impact on the trading volume in the Moroccan Stock Market. However, *Total deaths* (*Ln*) in Brazil and Turkey reduce the trading volume for the MASI Index.

The results reported in Table 7 take into consideration reported cases and deaths in the same equation. We further examine separately for reported cases and deaths. The results, reported in Table 8, suggest that the coefficients for the reported cases and deaths in Morocco have the same sign as in Table 7, However, the results for the other countries change. In particular, *Total cases* (*Ln*) in Turkey have a negative impact on the MASI Index returns and *Total deaths* (*Ln*) in the U.K. have a negative impact on the MASI Index trading volume.

The significant relationship between the COVID-19 cases and deaths and the Moroccan Stock Market returns using VAR-X models implies that disregarding changes in conditional heteroscedasticity might lead to wrong implications on the channel through which the COVID-19 related cases and deaths impact the Moroccan Stock Market.

TABLE 8: VAR-X MODELS: RESULTS CONSIDERING TOTAL CASES AND TOTAL DEATHS SEPARATELY

VARIABLES	**(1) Masi**	**(1) Volume**	**(2) Masi**	**(2) Volume**
Total Cases Morocco (ln)	-.0611015***	.5484608		
	(-6.01)	(0.67)		
Total Cases Spain (ln)	-.0077994	.6997252		
	(-0.98)	(1.10)		
Total Cases France (ln)	-.0098038	-.3800749		
	(-1.32)	(-0.64)		
Total Cases China (ln)	-.0018581	.1526235		
	(-0.70)	(0.72)		
Total Cases Italy (ln)	-.0090386*	-.4021697		
	(-1.81)	(-1.01)		
Total Cases Iran (ln)	.0065878	.0625938		
	(1.04)	(0.12)		
Total Cases US (ln)	.0140351*	-.2645931		
	(1.80)	(-0.42)		
Total Cases UK (ln)	.0044592	.4640315		
	(0.56)	(0.73)		
Total Cases Germany (ln)	-.0005149	-.0926308		
	(-0.07)	(-0.16)		
Total Cases Brazil (ln)	-.0097855	.3191594		
	(-1.15)	(0.47)		
Total Cases Turkey (ln)	.017464	-.8396834		
	(2.27)	(-1.37)		
Total Deaths Morocco (ln)			-.0562796***	-.4796697
			(-7.20)	(-0.64)
Total Deaths Spain (ln)			.0009486	.3949011
			(0.15)	(0.64)
Total Deaths France (ln)			-.018717***	-.0344073
			(-2.36)	(-0.05)
Total Deaths China (ln)			-.0015957	-.3014262
			(-0.38)	(-0.76)
Total Deaths Italy (ln)			-.0052873	.523525
			(-0.72)	(0.75)
Total Deaths Iran (ln)			-.0025905	-.8901436
			(-0.38)	(-1.36)
Total Deaths US (ln)			-.0036888	.2681165
			(-0.58)	(0.44)
Total Deaths UK (ln)			-.0463384***	.2675811
			(-6.86)	(0.42)
Total Deaths Germany (ln)			.0377826***	.1440363
			(4.21)	(0.17)
Total Deaths Brazil (ln)			.0399917***	-.0168364
			(3.74)	(-0.02)
Total Deaths Turkey (ln)			.0171742	-1.300736
			(0.48)	(-1.26)
Observations	244	244	244	244

Notes: The columns MASI and Volume report the results for the log-returns of the MASI Index and Trading volume, respectively for the daily first-difference in market returns and trading volume (in logs). Endogenous variables and constant included but not reported. *** p<0.01, ** p<0.05, * p<0.1.

4.2.3. MARKOV-SWITCHING Model

In this study, we investigate whether the COVID-19 triggered a structural break in the relationship between the stock market returns and trading volume. First of all, we run a Supremum Wald test for an OLS regression where the dependent variable is the log returns on the MASI Index, and the independent variable is the returns on the trading volume. The results of the test indicate the reject the null hypothesis of no structural break at the 5% level and suggest the occurrence of a structural break in the relationship between MASI Index returns and the trading volume on February 26, 2020. Figure 3, illustrates the value of the Wald test statistic at the estimated break date of February 26, 2020. Then, we run a Markov-Switching model with two states by considering the following simple specification:

$$y_t = \mu_{s_t} + \varphi_{s_t} Volume_t + \gamma_{s_{t-1}} Volume_{t-1} + \epsilon_t \quad (3)$$

Where s ∈ (1, 2).

The results reported in Table 9 suggest that in (state 1), the coefficient on trading volume is 0.0017674 for the MASI Index. In state (state 2), the coefficient decreases, in magnitude to 0.0011089. p11 is the estimated probability of staying in state 1 in the next period given that the process is in state 1 in the current period. The estimate of 0.9873557 implies that state 1 is highly persistent. Likewise, p21 is the probability of transitioning to state 1 from state 2. The probability of staying in state 2 is, therefore (1 − 0.104641) = 0,985359, which implies that state 2 is also highly persistent. Figure 3 displays the probability of state 1 and state 2 overtime for the MASI Index. To some extent consistent with the results of the Supremum Wald test (Figure 4), the switch in states occurs around February 26, 2020.

TABLE 9: MARKOV-SWITCHING MODELS: DOW JONES AND S&P500 RETURNS VERSUS TRADING VOLUME

MASI Index	**(1)** **State 1**	**(2)** **State 2**
Volume	.0017674 ***	-.0163629*
	(4.21)	(-1.69)
Volume (first lag)	.0011089 ***	-.0063303
	(2.62)	(-0.71)
Constant	.0008868**	-.0108353*
	(2.03)	(-1.89)
Observation	247	247
Sigma 1	.0056846	
Sigma 2	.0288869	
P11	.9873557	
P21	.104641	

Notes: This table reports the results of a Markov-Switching model for the MASI Index. The model allows for two state-dependent intercepts and variance parameters, switching the coefficient on the Trading volume. p11 is the estimated probability of staying in state 1 in the next period given that the process is in state 1 in the current period. Similarly, p21 is the probability of transitioning to state 1 from state 2. Sigma1 and sigma2 are the estimated standard deviations for state 1 and state 2, respectively. z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1.

FIGURE 3: MARKOV-SWITCHING MODEL FOR THE MASI INDEX: STATE PROBABILITIES FROM JUNE 13, 2019, TO JUNE 11, 2020

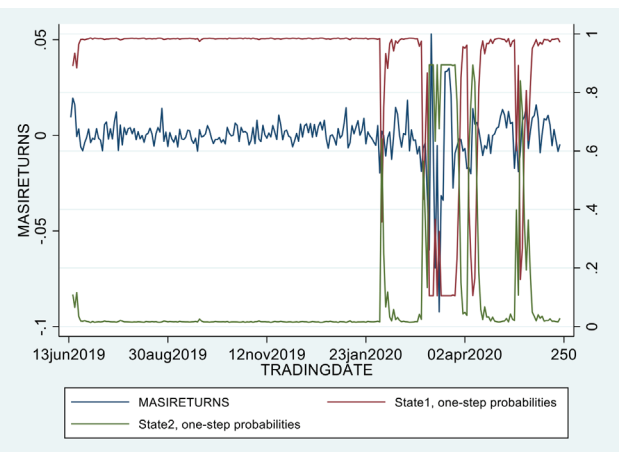
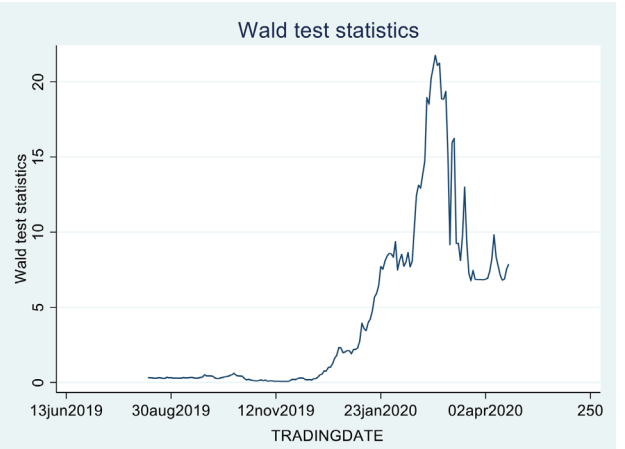


FIGURE 4: STRUCTURAL-BREAK TEST



5. Conclusion

Under the effect of the uncertainty which weighs on the prospects for the Moroccan economy, in connection with the crisis caused by the coronavirus on an international scale, this study investigates the Casablanca Stock Exchange response to the COVID-19 by considering more particularly the impact of the COVID - 19 related cases and deaths of eleven selected countries affected by the COVID-19, including Morocco, on the Moroccan Stock Market (MASI Index). This study employs the GARCH (1,1) model for this purpose, in which we are allowing for the impact of changes in the COVID-19 related cases and deaths in both the conditional-mean and the conditional heteroscedasticity equations. After, we extend our analysis by employing the VAR-X model to examine stock market returns and trading volume response to the COVID-19 related cases and deaths. Finally, we use the Markov-Switching models to inspect whether the COVID -19 has caused a structural break in the stock market returns.

Based on GARCH (1,1) model and data from June 13, 2019, to June 11, 2020, our results suggest that changes in the number of cases in Morocco and four other countries affected by the COVID-19 crisis has an impact on the Casablanca Stock Market returns, while the number of reported deaths in Morocco and seven other countries does not have an impact MASI Index returns, apart from the number of deaths reported in Spain, France and Italy. However, there is empirical evidence of a positive impact, for some countries, on the conditional heteroscedasticity of the returns of the MASI Index.

VAR-X models suggest that the number of reported cases in Morocco and seven other countries has a negative impact on Stock Market returns, and no impact on trading volume, except from the number of deaths reported in Italy. However, the number of reported deaths in France, Italy, Iran, and the U.K. has a negative impact on MASI Index returns, while the number of reported deaths in Brazil and Turkey has a negative impact on the trading volume. These findings indicate that the significant relationship between the COVID-19 related cases and deaths and the Moroccan Stock Market returns using VAR-X models implies that disregarding changes in conditional heteroscedasticity might lead to wrong implications on the channel through which the COVID-19 related cases and deaths impact the Moroccan Stock Market.

Furthermore, the Markov-Switching model suggests that at the end of February 2020, the COVID-19 pandemic crisis has caused a structural break on stock returns and the relationship between trading volume and stock returns has turned negative.

The COVID-19 has created an unprecedented shock, caused a severe economic downturn and put the financial markets under extraordinary stress. Moreover, it has created a sentiment of panic among investors, who have exhibited various behavioral biases during this pandemic period, which have caused stock prices to deviate from their fundamental values; consequently, leading to market inefficiency. Therefore, future research might help understand the trading behavior of investors during this pandemic period. Besides, future research might go further to extend the time period, especially after different countries announcing economic recovery plans. Further research might also provide a comprehensive study on the Casablanca industry index returns response to the COVID-19 crisis.

Biographical Notes

Khalil Nait Bouzid (Ph.D) is currently a PhD student in finance at Central University of Finance and Economics (CUFE), Beijing, China, undertaking a thesis on "Empirical Evidence of Herding Behavior on the Chinese Stock Market". His main research area lies in the fields of behavioral finance, financial markets and machine learning applied to finance.

Ulrich Ekouala Makala (Ph.D) is currently a PhD student in finance at Central University of Finance and Economics (CUFE), Beijing, China, undertaking a thesis on "Fiscal Policy and Public Debt Sustainability in a Sub-saharan

Economic and Monetary Union: Evidence from CEMAC. His research interests are anchored on macroeconomics, public finance, and international finance.

References

Baker, S. R., Bloom, N., Davis, S. J., Kost, K., Sammon, M., & Viratyosin, T. (2020). The Unprecedented Stock Market Reaction to COVID-19. *The Review of Asset Pricing Studies*, 10(4), 742-758. doi:10.1093/rapstu/raaa008

G. G. Judge, Hill, R. C., Griffiths, W. E., Lutkepohl, H., & Wiley, T. L. J. (1990). Introduction to the Theory and Practice of Econometrics, 2nd ed. , New York, 1988. *Journal of Applied Econometrics*, 5(3), 306-308. doi:https://doi.org/10.1002/jae.3950050311

Gormsen, N. J., & Koijen, R. S. J. (2020). Coronavirus: Impact on Stock Prices and Growth Expectations. *The Review of Asset Pricing Studies*, 10(4), 574-597. doi:10.1093/rapstu/raaa013

Harvey, A. C. (2020). The Economic and Financial Implications of COVID-19 (3rd April, 2020). The Mayo Center for Asset Management at the University of Virginia Darden School of Business and the Financial Management Association International virtual seminar series. https://www.darden.virginia.edu/mayo-center/events/virtual-speaker-series

He, Q., Liu, J., Wang, S., & Yu, J. (2020). The impact of COVID-19 on stock markets. *Economic and Political Studies*, 8(3), 275-288. doi:10.1080/20954816.2020.1757570

Lee, B.-S., & Rui, O. M. (2002). The dynamic relationship between stock returns and trading volume: Domestic and cross-country evidence. *Journal of Banking & Finance*, 26(1), 51-78. doi:https://doi.org/10.1016/S0378-4266(00)00173-4

Liu, H., Manzoor, A., Wang, C., Zhang, L., & Manzoor, Z. (2020). The COVID-19 Outbreak and Affected Countries Stock Markets Response. *International Journal of Environmental Research and Public Health*, 17, 2800. doi:10.3390/ijerph17082800

Maki, D. (2012). Tests for cointegration allowing for an unknown number of breaks. *Economic Modelling*, 29(5), 2011-2015. doi:https://doi.org/10.1016/j.econmod.2012.04.022

Ministère de la Santé. (2020). Situation épidémiologique au MAROC . https://www.sante.gov.ma

Onali, E. (2020). COVID-19 and Stock Market Volatility. *SRRN Electronic Journal*. https://ssrn.com/abstract=3571453

Papadamou, S., Fassas, A., Kenourgios, D., & Dimitriou, D. (2020). Direct and Indirect Effects of COVID-19 Pandemic on Implied Stock Market Volatility: Evidence from Panel Data Analysis. Retrieved from https://EconPapers.repec.org/RePEc:pra:mprapa:100020

Sansa, N., & Hasan, A. (2020). The Impact of the COVID -19 on the Financial Markets: Evidence from China and USA. *Electronic Research Journal of Social Sciences and Humanities*.

Sharif, A., Aloui, C., & Yarovaya, L. (2020). COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: Fresh evidence from the wavelet-based approach. *International Review of Financial Analysis*, 70, 101496. doi:https://doi.org/10.1016/j.irfa.2020.101496

World Economic Forum. (2020). The IMF Explains The Economic Lessons From China's Fight. IMF Blog. https://www.themandarin.com.au/128265-the-imf-explains-the-economic-lessons-from-chinas-fight-against-coronavirus/

Yilmazkuday, H. (2020). COVID-19 Effects on the S&P 500 Index. *SSRN Electronic Journal*. https://ssrn.com/abstract=3555433

Zeren, F., & Hizarci, A. (2020). The impact of COVID-19 coronavirus on stock markets: Evidence from selected countries. Muhasebe ve Finans İncelemeleri Dergisi. doi:10.32951/mufider.706159