IMPACT OF COVID-19 ON FINANCIAL MARKETS: CASE OF THE ITALIAN STOCK EXCHANGE

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Abstract *The aim of this study is to shed light on the repercussions of Corona pandemic on financial markets. Using the Vector Autoregression, VAR, model, we estimate the relationship between the Italian Stock Exchange's Index, FTSEMib, and the number of cases and deaths by Covid-19 in Italy over the period February 24, 2020 to May 15, 2020. We find that both the number of infections and the number of deaths from Coronavirus negatively affect the stock market, and that the analysis of variance shows that the relative importance of daily infections by Covid-19 in explaining the fluctuations of the Italian Stock Exchange index has reached 17% in the medium and long terms, while the relative importance of daily deaths from Covid-19 in explaining the fluctuations of the Italian Stock Exchange index does not exceed 2% in the medium and long terms.*

Keywords: Covid-19, financial markets, Italian stock exchange, VAR.

JEL Classification: G01, G12, G15, G18.

1. INTRODUCTION

Corona pandemic, known for short in the prevailing literature as Covid-19, appeared in Wuhan, a Chinese city, in late 2019, and then spread to Italy and Europe before it spread to the United States and the rest of the world within a few weeks. It greatly impacted all countries on the five continents, and influenced every country according to its economic structure and the precautionary measures it has taken, and pushed the World Health Organization, WHO, to declare it a world pandemic on 3/11/ 2020 (Zhang et al, 2020).

Coronavirus was not the first pandemic to hit humanity, but it was preceded by many pandemics such as the plague, or, as it is known, by the black death, which killed two-thirds of the population of medieval Europe; the Spanish flu, which caused the death of more than 50 million people in 1918 (Boissay and

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Rungcharoenkitkul, 2020), SARS in 2002, Ebola in 2013 and other pandemics. However, Covid-19 was distinguished from other pandemics in that it affected developing and developed countries alike, despite the latter's availability of enormous human and material capabilities; it is a global health crisis that has led to unexpected human and economic costs in a short period of time; it also came in a completely different international environment, where the world economy became more integrated and connected, and interest rates were very low or zero, or even on negative territory in some countries; it also affected both supply and demand for goods and services at the same time. Another feature is that this pandemic came in tandem with two trade wars, namely the trade war between China and the US, and the oil prices war between Russia and Saudi Arabia, which led to the collapse of its price to unprecedented levels.

This pandemic caused a severe shock to the whole world and took them by surprise, as the number of infected people in the world became in tens of millions and the number of deaths in millions, which prompted all countries to take multiple and strict measures to protect their populations from this devastating pandemic, and led to unprecedented repercussions on various economic, social and strategic levels. Educational institutions were closed, jobs were cut, borders closed to air, land, and sea navigation; restrictions were placed on the movement of individuals, and entire cities and regions were isolated in order to limit the transmission of the virus to them. In addition, shops and all non-essential activities were closed, and their peoples had to enter into strict measures, such as confinement and social distancing.

These measures caused severe damage to many economic and social sectors, and the most affected was the services sector, especially services related to domestic and international tourism, as the demand for these services decreased dramatically and suddenly, to the point of its absence in some cases as a result of canceling reservations. The transport industry of various kinds has also been strongly hit, among them airlines and cruise companies; as well as the hospitality industry, with millions of hotels, entertainment centers, restaurants, cafes, clubs and retail centers closed. High costs of international transactions in terms of exports and imports, that is, high costs of foreign trade, were also recorded due to the drop in global production of goods and services and the disruption of global supply chains, among other reasons. This has led to an unprecedented rise in unemployment rates in developed and developing countries with a service oriented economy, especially those that specifically depend on tourism. For example, the number of unemployed persons who applied for unemployment benefits reached 40.7 million workers in the USA during only 10 weeks, that is from mid-March to the end of May 2020 (CNN,

5/29/2020). As a result, incomes fell, consumption dropped on a large scale and consequently consumer confidence was undermined.

In addition, impacted countries have taken many other measures to mitigate and contain the devastating effects of the pandemic, as they have canceled trade fairs, public gatherings, sports competitions and religious activities. They have also taken expansionary fiscal and monetary policies with the aim of providing liquidity and facilitating credit for banks and investors in affected economies, among other measures. Despite all of this, the human and economic costs were great by all standards, which called for international coordination and cooperation, whether in terms of intensifying efforts to find a vaccine for the pandemic or sharing necessary information and experiences to limit its wide impacts.

Returning to the topic of research, it can be said that financial markets, or FMs in short, collapsed with the expansion of the pandemic in various parts of the world, and their levels decreased in developed and emerging countries alike, for fear of slowing growth of the global economy, or even recording negative growth rates; occurrence of deep recession; increasing doubts about financial distress, and default of individuals who lost their jobs and companies that stopped their activities (AIMD, ASEAN, 2020). As a result, the stock and bond holders, i.e., individual investors and financial institutions, recorded heavy losses, especially after the central banks of most developed countries cut interest rates. Fear that the pandemic will lead to a deep economic and financial crisis, has led investors, after losing confidence in those markets, to resort toward safe havens and invest their money in other assets, such as treasury bonds, sovereign bonds, gold, and some commodities such as soybeans, West Texas Intermediate oil, WTI, some relatively stable currencies, and even cryptocurrencies, especially bitcoin, among other tools (Conlon and McGee, 2020; Corbert et al, 2020; Ji et al, 2020).

As a result of uncertainty and extreme volatility that has characterized the main FMs since the outbreak of Covid 19, contagion has spread to the rest of the global and emerging markets, and this led to an increase in risks and costs of lending, and to capital flight from developing markets towards safer havens in developed countries, which negatively affected the real economy. This also led to the collapse of stocks of affected companies such as airlines, financial institutions, energy companies, industrial companies among others. Accordingly, trading was halted in many global stock exchanges, that were panic-stricken; and investors lost confidence in dealing, as a result of the wide fluctuations in asset prices. For example, the trading floor of the New York Stock Exchange was closed to individual dealers for nearly

two months, as its activity remained limited to electronic trading, then it was reopened on May 29, 2020 (CRS, Apr 17, 2020).

The rest of the article is organized as follows. The second section briefly deals with previous studies on the topic. The third analyses the financial markets' response to information related to Coronavirus, focusing on the New York Stock Exchange, since it is the locomotive of global financial markets. The fourth deals with the empirical study where the relationship between the Italian Stock Exchange Index and the number of cases and deaths from Covid-19 in Italy, was estimated. The fifth analyses the findings and the sixth concludes.

2. RELATED LITERATURE

Many studies focus on the economic and social impacts of Corona pandemic, especially on human and economic costs, centering mainly on the hospitality industry, transport, tourism, foreign trade, unemployment, and so on (Boissay and Rungcharoenkitkul, 2020; Niestadt, 2020; Kochhar, 2020; Tagliapietra, 2020; Maliszewska and Matoo, 2020). While another part of literature is concerned with the impact of that pandemic on financial markets and increasing stock price volatility and their response to its development (Ramelli and Wagner, 2020; Sansa, 2020; Yan et al, 2020; Baker et al, 2020; Ashraf, 2020; Zhang et al, 2020; Al-Awadhi et al, 2020; Çitak et al, 2020). The third part pays attention to safe havens in times of crisis such as *bitcoin*, some stable currencies such as the Swiss franc and the Japanese yen, gold, oil and a limited number of other commodities, such as soy (Gil-Alana and Aikins Abakah, 2020; Corbet et al, 2020; Conlon and McGee, 2020; Ji et al, 2020).

3. FINANCIAL MARKETS' RESPONSE TO COVID-19

A follower of global, emerging, and even active developing financial markets, during the first semester of 2020, can easily note that those markets ignored the emergence of Corona pandemic at the beginning of the year 2020, and some of them achieved the highest levels ever, although the pandemic appeared in late 2019. But as soon as the pandemic spread in China and first death cases were recorded, those markets panicked and suddenly collapsed in a few days. However, after several months, they returned to relatively acceptable levels, ignoring once again that the pandemic continues to claim many lives, especially in the US, and inflicting more losses to the global economy (see Table 1 and Appendix 1).

Figure 1: Evolution of the number of cases, WTC, and the number of deaths, WTD, in the world during the first half of 2020
(On a bi-monthly basis)

Source: Authors' calculations based on statistics available at:
<https://www.worldometers.info/coronavirus/>

It is noticed from the previous figure, that the number of confirmed cases worldwide, WTC, was increasing in a geometric sequence, as it accelerated in the last weeks of this semester in a real fearful way. It reflects the great impact of this pandemic on all aspects of life in the world, including financial markets, which is the subject of our study, as they collapsed in a relatively short period of time and lasted at lower levels for weeks thereafter.

Accordingly, FMs collapsed, as previously mentioned, in response to “bad” news received, and mainly related to Covid-19, especially the number of deaths since mid-February 2020, as share prices of industrial companies and financial institutions, that decreased or even stopped their activities after the pandemic spreading, and consequently, experienced credit defaults for their bad loans. Thus, FMs panicked, price volatility and investment risks increased, resulting to a wide correction process. Experts of the World Bank, WB, believe that this pandemic has led to the following (W.B., March 25, 2020):

- Global FMs volatility and re-pricing of various assets;
- Lack of liquidity in the global FMs;
- Flight of capital from developing and emerging countries, and the appreciation of the US dollar against most currencies;

- Lack of (and in some cases no) dealing in bonds, including the closing of their primary markets; and high borrowing costs;
- Stronger negative effects were reported on small and undeveloped FMs.

In the same context, Baker et al, 2020, believes that FMs responded in an unprecedented way, not only to Covid-19, but also to the strict measures that were taken by various countries to limit the spread of the pandemic on their soil, especially stopping many activities and services and restricting individuals' movement, in a service oriented economy. In addition to contagion effects, FMs negatively responded to the length of time the pandemic lasts, the number of victims, and the speed at which it spreads in the five continents; while they positively responded to policy responses, economic recovery programs, and rescue packages.

These programs have taken various forms, such as lowering interest rates, IRs, as happened in the US, where the Fed cut IRs to nearly zero on March 15, and lowered the required reserve ratio (reserve requirements), to zero for the first time in history. The US government also decided to acquire \$700 billion worth of available assets, and pump 2.3 trillion dollars into the US economy to overcome the devastating effects of the pandemic. For its part, the European Central Bank, ECB, announced the purchase of \$820 billion of bonds; and thereafter many countries followed suit in taking measures related to monetary and fiscal policies, aiming to calm FMs and providing liquidity to the economy. Moreover, countries also adopted a considerable number of programs to strengthen health and social sectors (CRS, Apr 17, 2020; CRS, Jun. 4, 2020).

Despite all this, stock markets lost about 6 trillion dollars in a single week, i.e. from 24-28 February 2020, and the S&P 500 lost more than 5 trillion dollars of its value during the same week (Ozili, 2020). During the period from February 19 to March 20, 2020, Dow Jones lost 34.67% of its value, British FT lost 31.35%, German Dax lost 34.72%, Italian FTSEMib 37.90%, French CAC 33.52% and Spanish Ibex 33.67% (www.statista. com, 2020). This led to the trading suspension on many global stock exchanges during March 2020, due to sharp decline in asset prices. For example, on the morning of Monday, March 9, 2020, the S&P 500 fell by 7% after 4 minutes of trading, and Dow Jones fell by 7.8% and lost about 2013 points, which is the largest loss since the global financial crisis in 1987 (Black Monday, October 19, 1987), that triggered the Automatic Circuit Breaker¹ for the

- ¹ - The **automatic circuit breaker** is a system that was developed by the Securities and Exchange Commission, SEC, after the collapse of 1987, with the aim to automatically halt trading in case of

first time since the 2007-8 financial crisis, and trading was halted on Wall Street and major US stock exchanges for 15 minutes (CRS, Apr. 3, 2020; CRS, Apr. 17, 2020). Wall Street continued to decline losing 2,999 points on March 16, the biggest one-day loss in Dow Jones' history (Fernandes, 2020; AIMD, 2020).

In addition to trading suspension and opening for shorter trading days in FMs, and in order to limit wide fluctuations, many countries such as the UK, the US, France, Italy, Korea, Spain, Turkey and Indonesia have banned short selling deals², which are usually characterized by intense speculation. Stock buybacks have also been prohibited in several countries (CRS, Apr 3, 2020; FSB, Apr. 15, 2020).

Among the price fluctuation signals that global FMs experience from time to time, is the number of deviations or jumps, which are the cases of daily highs and lows in the market index that are greater than 2.5% compared to the previous day's closing prices, as these jumps affect FMs and represent their levels of risk. While there occurred 1143 jumps in the US financial markets from January 2, 1900 to April 30, 2020, hence about 9.5 jumps per year; 18 jumps were recorded only in 22 trading days, i.e., from February 24 to March 24, 2020, which is the highest in one month ever. This means that the number of jumps during this pandemic is 20 times higher than the average number since 1900 (Baker et al, Apr 2020). If this indicates anything, then it indicates the high intensity of FM fluctuations during this period, in response to the evolution of the pandemic on the one hand, and to measures taken by countries, such as monetary policies, financial policies, etc., on the other.

In the same order of ideas, the Market Volatility Index, known for short as VIX, is also used as the expected volatility barometer for FMs. It is based on options prices, and has its roots in 1973. Accordingly, since this index was affected by Corona

prices collapse to an extent that harms market liquidity. According to the instructions of that commission, there are 3 thresholds or level, namely:

- The first level: a drop of 7% of the S&P 500, compared to the previous day's closing price, triggers trading suspension for 15 minutes. Trading is not stopped if the decline occurs after 3:25 p.m;
 - The second level: a drop of 13% of the S&P 500, compared to the previous day's closing price, triggers trading suspension for 15 minutes. Trading is not stopped if the decline occurs after 3:25 p.m;
 - The third level: a drop of 20% of the S&P 500, compared to the previous day's closing price, leads to the trading suspension for the rest of the day (www.sec.gov).
- ² - **Short selling** is a strategy that is utilized in financial markets, whereby the investor sells a security that does not actually own, but he borrows it from a broker or an asset management company and sells it at the market price. In this case, the seller is betting on a decline of the security's price in the short term. Therefore, as soon as its price drops, he buys it and delivers it to the broker or company before the deal's due date. Despite the possibility of making high profits, as a result of dealing in this form of speculation, these transactions are not without high risks and the possibility of making unlimited losses, when the investor's expectations are not met. Financial authorities require this seller to have a specific financial guarantee that he puts in a special account.

pandemic it means higher price fluctuations of FMs, and consequently, high levels of risk. This is due mainly to the number of cases, deaths, and the number of affected countries. The high VIX reflects optimism among market participants, while low VIX reflects the possibility of a market correction (Fernandes et al, without date).

What attracts attention here is that, the most important and largest global FMs, achieved relatively high or record levels at the beginning of the year 2020, despite the emergence of the pandemic in China at the end of 2019, which means that they completely ignored that event at the beginning, as we have already indicated. So, the Dow Jones reached 29,551 points on 12/ 02/ 2020, the S&P 500 reached 3386 points on 19/ 02/ 2020, the highest level in its history; Dax 13,789 points on 19/ 02/ 2020; the FT 7675 points on 04/ 02/ 2020; and the Japanese Nikkei 24041 points on 17/ 01/ 2020 (<https://tradingeconomics.com>). It should be noted here that, the American FMs, as the locomotive of global FMs, have witnessed a successive rise over the last 11 years, that ended in mid-March 2020, which is the longest upward period ever, and that ended with the fastest collapse in its history as well (CRS, Apr 3, 2020). That is why the last correction of these markets and other global FMs, which coincided with this pandemic, was devastating and caused heavy losses to investors in a few weeks, as previously indicated.

Figure 2: Evolution of the Dow Jones during the period: 03/ 02/ 2020 to 15/ 05/ 2020

Source: Authors' calculations based on statistics available at:
<https://www.worldometers.info/coronavirus/>

However, during the period in which the crisis intensified, Dow Jones rolled rapidly from February 12, 2020 to March 23, 2020, reaching its lowest level during the first half of this year 2020.

Figure 3: Evolution of the Dow Jones during the period 12/ 02/ 2020 to 23/ 03/ 2020

Source: Authors' calculations based on statistics available at: <https://www.worldometers.info/coronavirus/>

Accordingly, and after recording these positive results before the spread of the pandemic, global FMs witnessed very low levels in a few days, and even collapsed completely once Covid-19 moved from China to Europe, and then to the US and the rest of the world. Fortunately, these markets are also back to acceptable levels after several weeks.

Table-1: Evolution of indexes for some global FMs during the first semester of 2020

Unit: point

Index	country	date	Val 1	data	Val 2	Ch % 1*	date	Val 3	Ch 2*
DJ	US	12/02	29551	23/03	18591	-39.09	08/06	27594	+48.43
FT	GB	04/02	7675	23/03	4930	-35.77	05/06	6484	+31.52
Dax	Ger	19/02	13789	18/03	8489	-38.44	05/06	12848	+51.35
Mib	Italy	19/02	25305	12/03	14930	-41.00	08/06	20231	+35.51
CAC	France	19/02	6064	18/03	3750	-38.16	05/06	5198	+38.61
Ibex	Spain	19/02	10083	16/03	6071	-39.79	08/06	7896	+30.06
Shgh	China	05/03	3071	23/03	2662	-13.32	30/06	2985	+12.13

Source: Authors' calculations based on statistics available at: <https://tradingeconomics.com>

(*) Change 1 represents the ratio between value 2 and value 1; while change 2 is the ratio between the value 3 and the value 2.

From the previous table, it is noted that the sharpest and widest decline was recorded in the Italian market - 41% in about 3 weeks, as this market experienced a shock after the quick outbreak of the pandemic in Italy. On the contrary, the Chinese financial market was the most stable, compared to the rest of global FMs and recorded a decline of 13.32% during the crisis and recovered about 12.13% by the

end of the first half of 2020. On the whole, most FMs have not achieved new record levels after this crisis, but came somewhat close to the levels at which they were at the beginning of the year, then ignoring the actual skyrocketing number of cases and deaths due to Covid-19 all over the world, and that there were no signs on the horizon to find a vaccine for it.

Here it must also be noted that the collapse was not limited to stocks alone, but rather sovereign financial instruments suffered the same crisis, as yields on US Treasury bonds fell to historical levels on March 6 and then on March 9, 2020. What deepens the problem is the shift of investors from stocks to those safer instruments, and to sovereign bonds in general, driven by expectations of lower corporate returns, and consequently lower equity returns (CRS, Apr 17, 2020).

4. EMPIRICAL STUDY

During this part of the study, the relationship between the Italian Stock Exchange Index and the number of confirmed cases and the number of deaths from Covid-19 in Italy, will be estimated, by following the methodological steps and using the statistical and mathematical tools and methods appropriate to our study.

4.1. The Model

The model used in this study is the P-order Vector Autoregressive, VAR, model, that takes the following form (Ben Habib, w.d; Bechichi, 2016):

$$Y_t = \delta + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \varepsilon_t$$

where:

Y_t is the value of the variable in the current period;

$Y_{t-1}, Y_{t-2}, \dots, Y_{t-p}$ are the values of the variable in previous periods;

ε_t is the term error in the current period;

δ is the intercept

The VAR model, using the lagged term L , usually takes the form:

$$Y_t = \delta + \phi_1 L Y_{t-1} + \phi_2 L^2 Y_{t-2} + \dots + \phi_p L^p Y_{t-p} + \varepsilon_t$$

After simplifying and rearranging, we get:

$$\phi(L)Y_t = \delta + \varepsilon_t$$

where

$$\phi(L) = (1 - \phi_1 L - \phi_2 L^2 - \dots - \phi_p L^p)$$

4.2. Study variables

The study variables are:

- the Milan Stock Exchange Index, referred to as "MIB", is the main index at Italiana Stock Exchange, the Italian national stock exchange, and measures the performance of 40 most liquid Italian stocks and largest capitalizations. Currently, it is known as the FTSE MIB, since the British FTSE Group has acquired 50% of its shares;
- the daily number of confirmed cases of Covid-19: "IC"; and
- the daily number of deaths from Coronavirus: "ID".

The time series for the study, i.e., MIB, IC and ID, variables are obtained from the following websites: <https://www.worldometers.info/coronavirus/> <https://tradingeconomics.com>; <https://www.statista.com>, that are available in the form of moving figures. Figure 4 below depicts the evolution of these variables during the period Feb. 24, 2020 to May 15, 2020.

Figure 4: Evolution of the variables used in the study

Source: Authors' calculations based on Eviews8 software output.

4.3. Stationarity tests

To ensure the stationarity of the time series of the variables used in our study, we utilize the Augmented Dickey-Fuller, ADF, to test for the null hypothesis, which means that the time series contain a unit root, i.e. nonstationary; and the alternative

hypothesis, which means that they do not contain a unit root, and therefore, they are stationary. The following table shows these tests.

Table- 2: Augmented Dickie-Fuller, ADF, test for time-series stationarity

Variables	ADF Test Statistic at Level	ADF Test Statistic at 1 st Difference	5% Critical Value	Decision
MIB	-1.986784	-2.471033	-3.513075	non-stat
IC	-3.136165	-1.689399	-3.496960	non-stat
ID	-0.938017	-10.68203	-3.489228	stationar

Source: Authors' calculations based on Eviews8 software output.

Table 2, above, shows that, we reject the null hypothesis with respect to the variable ID, because the absolute value of ADF Test Statistic at the first difference is greater than the absolute value of the 5% critical value, i.e., it is stationary at the first difference and cointegrated of the order I(1). However, for the other variables, MIB and IC, the null hypothesis is accepted due to the existence of the unit root and, consequently, the nonstationarity of the time series for these two variables at the Level and at the first difference, because the absolute values of ADF Test Statistic are less than the absolute values of the 5% critical values. This, necessitates studying their stationarity at the second difference. Table 3 shows these tests.

Table- 3: Augmented Dickie-Fuller, ADF, Unit Root Test at Second Difference

Variables	ADF Test Statistic at 2 nd Difference	5% Critical Value	Decision
MIB	-9.083365	-3.513075	stationary
IC	-9.674549	-3.496960	stationary

Source: Authors' calculations based on Eviews8 software output.

We note, here, that the absolute values of ADF Test Statistic at the second difference are greater than the absolute values of the 5% critical values, and accordingly, we reject the null hypothesis for the two variables MIB and IC, that is, they are stationary at the second difference and cointegrated of the order I(2).

To sum up, stationarity tests indicate that the variables are stable at their second difference, except for the number of deaths, ID, which is stationary at its first difference; and accordingly:

- cointegration cannot be tested, because variables do not have the same order of cointegration; and
- causality cannot be tested, because it places restrictions on parameters of the variables to be tested, and it also assumes the stationarity of all variables.

This prevents the use of the vector error correction model, VECM, to study the relationship between the Italian Stock Exchange Index, MIB, and the number of cases and deaths from Covid-19 in Italy, and this calls for the use of the unrestricted VAR model that does not require the cointegration between time series.

Therefore, the relationship between Covid-19 and the Italian stock exchange index will be studied as a short-term phenomenon, since we are not looking for a long-term equilibrium relationship to the evolution of the economy (Boucha, 2012).

4.4. Selection of the optimal lag order

Before estimating the model, it is necessary to select the lag order (Nd) of the VAR model defined for this series, as this is the most difficult stage in building time-series models; and therefore the optimal lag length should be selected, depending on a set of criteria shown in the following table:

Table- 4: Tests to select the optimal lag order

VAR Lag Order Selection Criteria

Endogenous variables: DDMIB DDIC DID

Exogenous variables: C

Date: 06/23/20 Time: 16:36

Sample: 1 60

Included observations: 39

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-878.8059	NA	8.74e+15	45.22082	45.34878	45.26673
1	-853.7116	45.04113	3.84e+15	44.39547	44.90733*	44.57912
2	-838.1307	25.56865	2.77e+15	44.05798	44.95375	44.37938
3	-825.3494	19.00811*	2.33e+15*	43.86407*	45.14373	44.32320*
4	-820.3219	6.703329	2.99e+15	44.06779	45.73135	44.66466

* indicates lag order selected by the criterion

Source: Authors' calculations based on Eviews8 software output.

From the precedent table, we notice that most criteria have chosen the third lag order as an optimum lag length, that we can use to estimate the VAR model.

4.5. Estimation of the VAR model

The VAR model is as follows:

$$\text{VAR}=\text{F}(\text{DID}, \text{DDIC}, \text{DDMIB}, \text{C})$$

Assuming that all variables are endogenous, meaning that they change within the model, i.e., their values can be predicted internally; and after selecting the lag order (Nd=3), we estimate the Vector Autoregression, VAR, model, using the results of the assessment and the Eviews8 software described in Appendix 2. The estimated relationship can be summarized as follows:

$$\begin{aligned} \text{MIB} = & 8.487 - 0.91 \text{DDMIB}(-1) - 0.44 \text{DDMIB}(-2) - 0.037 \text{DDMIB}(-3) - 0.286 \text{DDIC}(-1) - 0.17 \text{DDIC}(-2) \\ & - 0.21 \text{DDIC}(-3) + 2.33 \text{DID}(-1) + 0.46 \text{DID}(-2) - 1.05 \text{DID}(-3) \\ F = & 5.194759 \quad \bar{R}^2 = 0.4794 \quad R^2 = 0.5937 \end{aligned}$$

From the above estimated equation, we note that:

- from an economic point of view, we find that the Italian Stock Exchange Index has a negative relationship with the daily number of infections with Covid-19, during the three lagged terms. The Index also responds negatively to the daily number of deaths during the same lagged terms; and therefore, we can admit that the model is economically acceptable;
- with regard to the adjusted coefficient of determination, $\bar{R}^2$, which is estimated at 0.4794, meaning that 47.94% of the change in the Italian Stock Exchange is explained by the lagged variables at three lagged terms;
- by testing the overall significance of the model, it is found that the calculated F-statistic is greater than the tabulated F-statistic (2.60), that is, there is at least one variable that is not equal to zero, and therefore, the model is statistically acceptable.

It is evident from the previous model, that there is a negative effect of medium strength of the daily number of cases of Coronavirus at three lagged periods, on the performance of the Italian Stock Exchange, i.e., a one unit change in IC leads to a decrease in MIB of 0.286 points at the first lagged period, and it decreases by 0.17 and 0.21 During the second and third lagged periods, respectively. It was also evident that there is a negative effect of medium strength of the daily number of deaths from Covid-19 at three lagged periods, on the performance of the Italian Stock Exchange, which appears at the third lagged period, i.e., a one unit change in ID leads to a decrease in MIB of 1.05 points.

4.6. Stability of the model

In order to trust the VAR model results and their explanatory capacity of the relationships between variables, the stability of this model must be tested; since its instability makes the obtained results incorrect. The following figure summarizes the results of testing its stability.

Figure 5: VAR Model Stability Test
Inverse Roots of AR Characteristic Polynomial

Source: Authors' calculations based on Eviews8 software output.

It is evident from the figure that, all the inverse roots of AR characteristic polynomial lie within the unit circle, and this means that the estimated VAR model is stable.

4.7. Dynamic analysis of the model

Perhaps the most important characteristic of VAR models is the possibility of studying the dynamic behavior of the relationships between variables, and this through the functions of response pulses and variance segmentation.

4.7.1. Analysis of response pulses functions. The results of the test of the functions of response pulses are as shown in the following figure.

Figure 6: Response pulse functions
Response of DDMIB to DDIC

Through the above figure, we note that the occurrence of a positive structural shock to the number of daily infections with Covid-19, IC, amounting to 1%, led to a zero response (0%) to the Italian Stock Exchange index, MIB; it decreases and becomes negative by 1.1% in the second year of the shock. This response quickly turns into a positive one by 1.6% in the third year, then it becomes negative again in the fourth year, and remains at the same pace where it becomes positive and then negative in the following years and, so that the effect becomes almost non-existent starting from the eighth year of the shock.

Moreover, the occurrence of a positive structural shock amounting to 1% in the daily number of deaths from Covid-19, led to a negative and weak response of the Italian Stock Exchange index of 0.2%. This response quickly turns into a positive one of 1.9% in the second year after the shock. Then the response becomes negative again in the third and fourth years, and fluctuations in the response remains between positive and negative during the rest of the period.

4.7.2. Variance segmentation. An analysis of variance shows the relationship between variables and the effect of each of them on the other, by determining the amount of variance in the prediction for each variable, due to the prediction error in the same variable and the amount due to the prediction error in other variables. The following table shows the results of the variance segmentation.

Table 5: Results of the variance segmentation test for the Italian Stock Exchange index

Period	S.E.	DDMIB	DDIC	DID
1	765.6379	100.0000	0.000000	0.000000
2	1059.559	95.78660	2.731984	1.481417
3	1118.004	89.99536	8.408339	1.596303
4	1138.062	87.62795	10.78989	1.582158
5	1164.584	84.96121	13.09981	1.938983
6	1189.259	81.80568	15.97333	2.220986
7	1200.679	80.35079	17.23129	2.417914
8	1201.261	80.31637	17.25463	2.428999
9	1201.758	80.27321	17.26960	2.457188
10	1202.437	80.21228	17.26270	2.525016

Source: Authors' calculations based on Eviews8 software output.

The above table illustrates the contribution of the study variables in explaining the change in the Italian Stock Exchange index, as we note that the circumstantial fluctuations that MIB index experienced are primarily caused by self-shocks of the variable itself during the first period of the shock. These shocks allow an explanation of 100% of changes in the Italian Stock Exchange Index. However, this percentage dropped to 95% in the second year and continues to decline at weak rates until it reached 81% in the sixth year; and remained close to 80% in the medium and long terms. In parallel with that, the relative importance of the daily number of infections with Covid-19, IC, in the interpretation of changes in the Italian Stock Exchange index increased from 2% in the second period to 8% in the third period of shock, and increased to 15% in the sixth period; and then remained constant during the last four periods, where it came close to 17%. We also note the rise in the relative importance of the variable ID (the daily number of deaths from Covid-19) in explaining the fluctuations at the Italian Stock Exchange to 1.5% in early periods of the shock, and then remained close to 2.5% in the medium and long terms.

5. EMPIRICAL RESULTS

This study attempts to estimate the relationship between the Italian Stock Exchange index and the daily number of infections and deaths from Covid-19 in Italy. It concludes:

- the existence of a statistically significant negative relationship between the daily number of infections with Covid-19 and the Italian Stock Exchange index;
- the existence of a statistically significant negative relationship between the daily number of deaths from Covid-19 and the Italian Stock Exchange index (appearing in the third lagged period);
- the analysis of random shocks shows that the occurrence of a positive shock in the daily number of infections with Covid-19 leads to a null response, and then negative one, to the Italian Stock Exchange index during the first and second periods respectively. This response turns into a positive one during the third period, and remains at the same frequency of fluctuation until the effect is almost non-existent starting from the eighth year of the shock. Almost the same observation can be made regarding the response of the Italian Stock Exchange index in the case of a positive structural shock in the daily number of deaths from Covid-19, then its responses fluctuate between positive and negative during the whole period;
- analysis of variance shows that the relative importance of the daily number of infections with Covid-19 in explaining the fluctuations of the Italian Stock Exchange index reached 17% in the medium and long terms, while the relative importance of the daily number of deaths with Covid-19 in explaining the fluctuations of the Italian Stock Exchange did not exceed 2% in medium and long terms.

6. CONCLUSION

Corona pandemic began as a health and humanitarian crisis and turned into a devastating global economic and financial disaster, which prompted various countries of the world to take draconian measures to contain the virus and limit its effects. These measures, notably the suspension of many economic and social activities and the restriction of the movement of individuals over a period of several months, led to a considerable disruption in the global economy, a sharp decline in stock prices and wide fluctuation in global financial markets. Accordingly, by estimating the VAR model to determine the relationship between the Italian Stock

Exchange index and each of the daily number of infections with Coronavirus and the daily number of deaths from the virus, we found that there is a negative impact of a medium strength of the daily number of infections with Covid-19 and the daily number of deaths from the virus lagged for three periods on the Italian Stock Exchange performance. This confirms the negative relationship between the performance of financial markets and this pandemic, i.e. the negative impact of Covid-19 on those markets.

APPENDICES

Appendix 1: Some information on Coronavirus until 06/30/2020

Country	Number of Cases	Number of deaths	Date of 1 st case	Date of 1 st death
USA	2729060	130313	22/01/2020	29/02/2020
GB	283253	43730	31/01/2020	05/03/2020
Germany	195832	9052	27/01/2020	09/03/2020
Italy	240599	34767	31/01/2020	21/02/2020
France	164801	29818	24/01/2020	15/02/2020
Spain	296351	28355	01/02/2020	03/03/2020
China	83531	4634	22/01/2020	22/01/2020
World	10573550	517121	22/01/2020	22/01/2020

Source: Authors' calculations based on statistics available at:
<https://www.worldometers.info/coronavirus/>; and Ashraf, B.N., 2020.

Appendix 2: VAR model estimation results

Vector Autoregression Estimates

Date: 06/23/20 Time: 16:30

Sample (adjusted): 6 60

Included observations: 42 after adjustments

Standard errors in () & t-statistics in []

	DDMIB	DDIC	DID
DDMIB(-1)	-0.913390 (0.17914) [-5.09873]	0.213984 (0.17989) [1.18953]	-0.008742 (0.01375) [-0.63571]
DDMIB(-2)	-0.444384 (0.22901) [-1.94047]	0.155683 (0.22997) [0.67698]	-0.009434 (0.01758) [-0.53663]
DDMIB(-3)	-0.037289 (0.18552) [-0.20100]	0.011719 (0.18629) [0.06291]	0.017044 (0.01424) [1.19678]
DDIC(-1)	-0.286097 (0.15986) [-1.78968]	-0.866094 (0.16053) [-5.39527]	0.020411 (0.01227) [1.66326]
DDIC(-2)	-0.175251 (0.18716) [-0.93637]	-0.576375 (0.18794) [-3.06674]	0.040299 (0.01437) [2.80482]

DDIC(-3)	-0.211442 (0.16577) [-1.27552]	-0.333800 (0.16646) [-2.00524]	0.036964 (0.01273) [2.90472]
DID(-1)	2.334623 (1.99413) [1.17075]	-4.044847 (2.00248) [-2.01992]	-0.227891 (0.15308) [-1.48867]
DID(-2)	0.463939 (1.78216) [0.26032]	-1.935911 (1.78962) [-1.08175]	0.466158 (0.13681) [3.40732]
DID(-3)	-1.053063 (1.84711) [-0.57011]	1.408878 (1.85485) [0.75957]	0.260167 (0.14180) [1.83478]
C	8.487103 (120.818) [0.07025]	38.40190 (121.323) [0.31652]	8.518976 (9.27483) [0.91850]
R-squared	0.593665	0.590395	0.538784
Adj. R-squared	0.479384	0.475194	0.409067
Sum sq. resids	18758443	18915788	110547.0
S.E. equation	765.6379	768.8422	58.77578
F-statistic	5.194759	5.124901	4.153535
Log likelihood	-332.7946	-332.9700	-224.9815
Akaike AIC	16.32355	16.33191	11.18959
Schwarz SC	16.73728	16.74564	11.60332
Mean dependent	10.69048	28.88095	10.38095
S.D. dependent	1061.120	1061.299	76.45912
Determinant resid covariance (dof adj.)		1.05E+15	
Determinant resid covariance		4.65E+14	
Log likelihood		-888.0384	
Akaike information criterion		43.71611	
Schwarz criterion		44.95731	

Source: Authors' calculations based on Eviews8 software output.

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