The Impact of COVID-19 on Firm Stock Price Volatility

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I hereby declare that the work submitted is mine and that where I have made use of another's work; I have attributed the source(s) according to the Regulations set in the Student's Handbook.

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ABSTRACT

This dissertation was written as part of the MSc in Banking and Finance at the International Hellenic University. The present study seeks to determine the impact of the Covid-19 external shock on the stock return volatility of global firms. To accomplish the above objective, the study uses a sample of 30,516 firms, scattered across 63 countries, for the period 31 December 2019 to 30 September 2020. Panel data analyses verify the hypothesis that Covid-19 cases (fatalities) have a positive and statistically significant impact on stock return volatility of global firms, measured at different estimation intervals (windows of 30, 60, 90, 180, and 250 days). In particular, a one standard deviation increase in Covid-19 cases (fatalities) is associated with 0.79% (0.86%) increase in firm volatility. In this light, the study might be advantageous to a wide spectrum of investors, portfolio managers, and decision-makers who have to invest in an uncertain world.

Keywords: COVID-19, volatility, return stability

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1. INTRODUCTION

The high uncertainty of the Covid-19 has battered the global market and had drastic consequences for trade, supply chains, and economies. The most noticeable effect of the outbreak has been an unexpected decline in global transport activity. By the end of March 2020, global road transport was almost 50% below the 2019 average, while the commercial flight activity was almost 75% below 2019 by mid-April 2020[1]. It's also worth stating, at the outset, that the demand for global oil in April was estimated to be 29mb/d lower than the previous year, down to a level last seen in 1995[2]. To the extent of the damage, equities drastically plummeted, while market volatility soared upwards globally. By late March, the US stock market hit the circuit breaker mechanism four times. Moreover, stock markets in Europe and Asia were particularly sensitive during this period. The strongest overreaction was noted among the hardest-hit countries. For example, FTSE and the UK's main index plunged by more than 10%, also Japan's stock market declined by more than 20%[3].

The novel Covid-19 was triggered in Wuhan China in late December 2019 and soon expanded to other cities across China. According to media reports and government data, the first reported cases outside China can be dated back to 20 January 2020. While the occurrence of the Covid-19 could not be prevented, European coordination to control the situation was far from perfect. Consequently, Italy was the first European country that proclaimed the outbreak on 11 March. By evaluating the remarkable transmissibility of the virus and the velocity of its global spread, the World Health Organization (WHO) declared the Covid-19 outbreak a global pandemic on 11 March 2020[4].

Ever since governments worldwide have applied rigorous measures to minimize both fatalities and infections which tend to become more intense in the long term. China was the first country that has adopted extreme measures to minimize Covid-19 expansion including restraining people to their homes, encouraging social distancing, prohibiting large-scale private and public gatherings, and even locking down one-third of its cities[5]. In light of this, also De Bruin et al., (2020) provided a detailed analysis of risk mitigation measures that are taken by countries around the world

[1] See more: Azzam Abu-Rayashet al.,(2020) Analysis of electricity demand amidst the COVID-19 Coronavirus Pandemic, Energy Research and Social Science.,68

[2] Source: IEA (2020), IEA Oil Market Report-April 2020, https://www.iea.org/reports/oil-market-report-april-2020

[3] See more: Zhang et al (2020) Financial markets under the global pandemic of COVID-19, Finance Research Letters,36

[4] Source: European Centre for Disease Prevention and Control, https://www.ecdc.europa.eu/en/covid-19/timeline-ecdc-response

[5] Source: The short-term impacts of COVID-19 lockdown on urban air pollution in China, (He et al., 2020)

such as restrictions to move freely, economic-social distancing, communication, hygiene measures, etc.

The Covid-19 threat inevitably led to tremendous health and economic damages. A report by John Hopkins University real-time data analytics, confirms that 43,385,581 people have been infected worldwide with a total cumulative death of 1,157,714[6]. The expansion of the pandemic was so rapid, that even the most advanced economies were unable to respond to it immediately and adequately. In the first quarter of 2020, China proclaimed a drop in GDP of 6.3% compared to the first quarter of 2019[7] while the US economy shrank by 4.8% (Erdem, 2020). The EU's GDP is also estimated to drop by 6.3% according to Gormsen and Koijen (2020) estimation. Consequently, the world is expecting to face budget cuts, since the cost of Covid-19 may result in a loss of $8.8 trillion, or around to 10% of global gross domestic product. On the other hand travel restrictions and lockdowns could cut global capital by $1.7 trillion to $2.6 trillion[8]. Under this scenario, the International Monetary Fund planned a global growth rate of -3% in 2020 (Erdem, 2020).

Given the importance of Covid-19, the analysis sheds light on the global stock market returns as a response to the outbreak. Researchers have fairly recently started to investigate the Covid-19 impact on stock price volatility (Yousef, 2020; Al-Awadhi, Alsaifi, Al-Awadhi and Alhammadi, 2020). Yousef (2020) affirms that the equity returns of G7 indices and their volatility are likely to be positively related to the number of daily new cases, and the growth rate of daily new cases invoked by Covid-19. Meanwhile, Al-Awadhi, Alsaifi, Al-Awadhi and Alhammadi (2020) revealed that the stock market has reacted with strong negative returns to the daily growth in total confirmed cases/deaths caused by Covid-19.

Despite similarities with the aforementioned studies, my study diverges in the following ways. To the best of my knowledge, this is the first study that estimates the impact of Covid-19 on global stock return volatility. Hence, it contributes to the literature on the impact of external shocks on stock return volatility. I capture Covid-19 impact using daily observations for Covid-19 measures, while I simultaneously control for firm-level determinants associated with return volatility (on a quarterly basis), to capture the impact of Covid-19 on stock return volatility. The study also contributes to the global financial markets current literature. Thus, it extends the literature of global

[6] https://coronavirus.jhu.edu/map.html, Last updated: 2020/10/27

[7] Source: Hofman (2020) The global Pandemic. How COVID-19 has changed the world, *Journal of International Relations and Sustainable Development*, pp. 60-69

[8] Source: Bloomberg Quint, https://www.bloombergquint.com/global-economics/coronavirus-may-cost-the-global-economy-8-8-trillion-adb-says, Last Updated:2020/05/16

financial markets, by taking into consideration a global scale. The sample selection model tracks 60% from approximately 51.000 active listed global firms[9].

According to Jones et al., (2004), high levels of volatility relates to a greater chance of a bearish market. Based on this framework the more persistent and higher the volatility is the higher the uncertainty and the probability of risk. Furthermore, they support the study finding by claiming that both uncertainty and risk may generate a decline in equity markets value. The finding is also in harmony with (De Garcia and Biscarri, 2004; Gonzalez et al., 2005; Tu, 2006) conjecture. They suggest that stock market volatility appears to be higher during bear markets rather than bull markets.

This study contributes to prior literature in the following ways. First, the analysis adds to the existing studies which have explored the impact of external shocks (natural disasters, financial crises) on the stock market. For example, Rastogi (2014) argues that stock markets of different nations have been overwhelmed by the financial crisis of 2008 impact on the volatility and leverage parameters. In the same context, Anagnostidis et al., (2016) confirm that the 2008 crisis has unfavorably affected the stock price efficiency of major Eurozone capital markets. Second, it expands the existing limited literature which examines the impact of Covid-19 on financial market volatility. Zaremba et al., (2020) highlighted the influence of government responses to Covid-19 on international equity market volatility. The results documented pronounced increases in volatility. Further, Baker et al., (2020) used textual analysis of news mentions and noticed that the Covid-19 pandemic has resulted in the highest stock market volatility among all recent infectious diseases including the Spanish Flu of 1918.

The rest of this paper is organized as follows: The next section provides the theory and hypothesis development. Section 3 presents the research methodology. Section 4 presents the data and empirical tests, while section 5 concludes the study.

2. THEORY AND HYPOTHESIS DEVELOPMENT

Risk is prescribed as an event where the outcome is linked with uncertainties. Thus, the impact of risk is very much reflected in the financial performance of the firm, since it reveals information about fluctuations that may occur in share price (market risk) (Bloom and Milkovich, 1988).

[9] Source:Release, The World Federation of Exchanges Publishes H1 2019 Market Highlights, https://webcache.googleusercontent.com/search?q=cache:oWYsB4yZzRIJ:https://focus.world-exchanges.org/storage/app/media/statistics/WFE%2520H1%25202019%2520Market%2520Highlights%2520press%2520release%2520draft%25205%252016.08.2019.pdf+&cd=5&hl=en&ct=clnk&gl=gr

Against this background, controlling for stock return volatility is crucial for investors as it affects a firm's future strategies (e.g., to take advantage of emerging opportunities or to reduce the risk of failures) (Bloom and Milkovich, 1988; Purdy et al., 1997). More specifically, market risk is essential for investor's portfolio diversification decisions. Prior research presumed that most investors choose not to "fully" diversify their portfolio for several reasons such as a) transactions costs (Ang et al., 2006), b) investor preferences heterogeneity (e.g., preferences for stocks with higher volatility) (Goetzmann & Kumar, 2008) c) financial constraint (Xu & Malkiel, 2003), d) background risk as in (Heaton and Lucas, 2000), etc. Therefore, understanding the firm market risk key drivers is essential for enhancing investor's wealth, since under-diversification may result in higher risk (Abdelsalam et al., 2020).

Risk mitigation is also crucial for a wide spectrum of portfolio managers, and decision-makers. Portfolio managers must be aware of the current risk structure, and how it changes. Besides, they should assure investors that uncertainties and risks are carefully administrated (DeLoach, 2000). As risk expands very quickly, decision-making processes also ought to be well-planned (e.g., decisions to diminish potential losses will inevitably lead to larger safety measures costs such as safer technologies)[10]. In this framework, the process of handling risk suitably has been problematic, as markets have had to make their adjustments against a back-drop of challenging and volatile markets environment.

This topic has gained even more increasing attention during the global financial crisis period, when individual assets and markets were crushed by catastrophic events, whose ex-ante likelihood was considered negligible. Earlier studies have identified several external shocks that have affected stock returns such as weather events, earthquakes, recession, and diseases (Ho et al., 2004). Hence, a large number of volatility models have been applied to analyze market reaction to these shocks.

Scholars have long debated the impact of financial events on the global economy. Existing literature confirms that the economy cannot adjust immediately to unexpected price changes, leading to catastrophic consequences. According to Bekaert and Wu (2000) if volatility is priced, an anticipated increase in its levels will lead to a higher required return on equity and lower stock price. The divergence of market prices from real values is not only a phenomenon of the present but also prominent since the past hundred years e.g., the Great Recession of 1929, the Dotcom

[10] Source: https://unece.org/fileadmin/DAM/trade/Publications/WP6_ECE_TRADE_390.pdf

bubble of 1999-2001[11] and the 2008 global financial crisis. Not surprisingly, the presence of a series of downward shift prices during these periods made people uncertain about the level of future revenues.

Empirical evidence confirmed that stock market panics during the 1929 crash enforced consumers to forgo purchases of durable goods. On the other hand, the reduced income as a sequel of the stock market panic diminished the collateral on which individuals and corporations used to borrow and thus gave a pass to the first step of the Great Recession (Romer, 1990; Sumner, 1992). During this period several political and economic events took place such as the Smoot-Hawley tariff, the rise of the Nazi party, and the banking failures in the United States and France. All these events were linked with sharp breaks in stock and commodity prices. From 1929 to 1932, U.S. gross domestic product (GDP) dwindled from $103.1 billion to $58.0 billion. The Dow reached its low (40.56 points) in July 1932 (James, 2010). In a similar vein (Parker) approve that the supply of money declined by 35 percent, while prices went down by 33 percent.

Graham et al., (2011) expand the literature by analyzing the cost of distress on firm-level data. The results report that firms with high leverage levels and firms with low bond ratings place a priority on becoming financially distressed, confirming the trade-off theory. As claimed by Schwert, (1990a), highly leveraged firms are related to high levels of volatility since stockholders must bear the major part of the risk of the assets. Although many attempts are undertaken to examine risk-return relations in developed countries (the US, Japan, UK) little is done on exploring this relationship in the global stock market. For instance, (Li et., al 2005) provide evidence that a significant and negative relationship exists between stock returns and volatility in 6 out of 12 global stock markets examined.

The notable effort of Siegel (1992) simulates the relation of the linkage between various factors of investment sentiment and the returns on the US stock market during the 1987 meltdown. He concluded that shifts in investor sentiment such as the ratio of odd-lot sales, discounts on closed-end funds, etc, were a fundamental component in the 1987 stock slump. Empirically, the crash implies the greatest single-day decline in history, where the Dow Jones industrials dropped by 508 points and the Standard and Poor (S&P) 500 index dropped by 20.5%. Karunanayake-Athukoralalage et al., (2010) study the dynamics of volatility spillover on the stock market return of Australia, Singapore, the UK, and the US during two major financial crises (Asian 1997 and global

[11]The dotcom bubble of 1999-2001 is labeled by many as the “Nasdaq bubble”. Specifically, the Nasdaq 100 Index increases by 128% ante to its peak in March 2000. By the end of 2000 however, the level of the Nasdaq was almost 30% of its peak value. During this period, the return volatility rose while stock prices experienced a sharp decline. The impact of the bubble was not confined to the US but spread throughout the world (Bakshi & Wu, 2010).

financial crisis of 2008). More specifically, findings reveals that both crises drive a significant jump in the stock return volatilities in Australia, Singapore, the US, and UK equity markets. Besides, they provide evidence of volatility transmission among all equity markets and unilateral volatility spillovers from the US and UK to the smaller markets of Australia and Singapore. The results also support the assumption of Schwert (1990b) that financial crisis raises the stock return volatility.

Ample studies have affirmed that also European stock markets are vulnerable to exogenous shocks exceptionally during periods of financial turmoil. Sensoy and Tabak (2015), for instance, is the earliest survey that scrutinizes the global financial crisis of 2008 implications on the efficiency of the European stock markets. Their findings point out that the crisis has a damaging effect on emerging countries, relative to developed countries. In a similar manner Anagnotidis et al., (2016) support that market efficiency on the Eurozone stock market was affected by the global financial crisis of 2008, resulting in crucial levels of market inefficiency and abnormal price co-movements. An extensive survey of the empirical literature on global transmission of the 2007-09 financial crisis on European stock markets is provided in (Chudik and Fratzcher, 2011; Syllignakis and Kouretas, 2011; Kotkatvuori-Örnberg et al., 2013).

However, the crash of the 2008 global finance is not confined exclusively to stock markets of major economies such as the Eurozone, or the U.S. For example, Adamu's (2010) research relies on the behavior of the daily All Share Index (ASI) of the Nigerian Stock Exchange to the recession of 2008. The sample is divided into the pre and post-crisis period. The results confirm that the market is sensitive to international events and volatility is much higher in the pre-crisis period. The global crisis also spread to China Yang et al., (2014), and relatively moderate economies like Asia Kanjamapornkul et al., (2016), Latin America Güloğlu et al., (2016).

During recent years, public awareness towards natural events has declined compared to those of human origin. Nonetheless, different types of natural disasters (e.g., hurricanes, earthquakes, floods, bushfires, cyclones, tsunamis) still cause unpredictable harm to a global marketplace. In this spirit, various studies have been undertaken to scrutinize the impact of natural events on different parameters (e.g., entire stock market index, stock returns, and volatilities of local firms, real estate or single sector indices (e.g., insurance)) (Valizadeh et al., 2017).

Bourdeau-Brien and Kryzanowski (2017) examine the behavior of stock returns and volatilities of U.S. firms to natural disasters. The results showed that wider abnormal returns are found in firms placed in the disaster zone, compared to firms in nearby states. Moreover, the extreme effects have been more profound in the two or three months after the peak of disaster news cover-

age. On the other hand (Worthington and Valadkhani, 2004) through light on the impact of severe disaster shocks (e.g., floods, wildfires, earthquakes, storms, cyclones) on the Australian stock market from 1982 to 2002. They pointed out that market returns are more sensitive to shocks provided by natural events like cyclones, bushfires, and earthquakes. Shelor et al., (1990) research the real estate companies and discussed the stock return reaction after the California Earthquake of 1989. The analysis suggests that this catastrophic event has a significant negative impact on stock returns among the firms performing in the San Francisco territory. Gangopadhyay et al., (2010) extend the literature by examining the impact of two Hurricanes (Katrina, Rita) on the insurer share price. Insurer share prices reacted negatively to hurricane Katrina. On the other hand, the reaction of insurer share prices to hurricane Rita was significant, though mixed, with positive/negative results being influenced by Rita's changing circumstances.

In his research, Thomann (2013) investigates the impact of the 10 most costly natural catastrophes (e.g., the hurricane seasons of 2004 and 2005, Hurricane Andrew, 9-11 attacks) on the volatility of US insurance stocks and the correlation of insurer's stocks with the market. The results generally support the hypothesis that natural disasters increase stock volatility and diminish the correlation except in the case of 9-11 attacks. (Hood et al., 2013; Takao et al., 2013) report that the Great East Japan Earthquake (also known as the 2011 Tohoku earthquake) is a strong example of a natural disaster. One obvious effect of this event is a significant decline in the stock prices of insurance companies compared to non-life insurance companies. Furthermore, Real GDP fell sharply by 0.8% in 2011 while Nikkei 225 Index plummeted 179.95 yen or 17.3% from the previous year (The World Factbook, 2012)[12]. It seems that major natural hazards tend to harm stock market returns. In particular, a slump in the value of the firm's stock could enhance financial leverage and its debt to equity ratio. Consequently, this may lead to increases in risk mitigation and higher volatility.

The market's performance has recently been hit by an ascending number of infectious diseases such as Ebola virus, MERS CoV, SARS, Zika virus, seasonal flu etc. The spread of these contagious diseases not only affects people's health and life but also induces a decline in economic growth (Liu et al., 2020). For example, Ichev and Marinc (2018) investigate the effect of various announcements and mass media news on the Ebola outbreak from 2014-2016. It is shown that this outbreak hard-hit small and volatile stock of companies established in West African Countries and the US that were exposed to media coverage. Chen et al., (2007) examine the impact of the

[12]Source: https://www.cia.gov/library/publications/download/download-2012/index.html

SARS outbreak in 2003 on the Taiwan tourism industry. They state that the epidemic affects almost all sectors negatively, while the tourism sector suffered the most. Their event study results show that the stocks of the tourism sector experience a 29% decrease within one month after the outbreak.

The outbreak of Covid-19 is one of the most recent events on the international scene. Consequently, there is scarce literature examining the stock market behavior during this period. However, various studies emphasized that the spread of the virus is causing great fear or shock to the financial markets that need further investigation. Baek et al., (2020) examined the stock market volatility of 30 industries operating in the US. They observe that volatility is affected by different economic indicators and is sensitive to Covid-19 news. In addition, they document that systematic risk is higher for defensive industries (e.g., utilities, telecom) and lower for aggressive industries (e.g., business equipment, automobiles).

Heyden and Heyden (2020) investigate the short-term market reactions of US and European stocks to the public information about Covid-19. While the first case of the Covid-19 does not have a significant impact, the announcement of the first death stimulates a negative stock price reaction to the Covid-19. Another strand of quickly developing literature reviews the impact of Covid-19 on an international scale. Liu et., al (2020) aimed to analyze the short term impact of the Covid-19 outbreak on 21 major stock market indices including (e.g., the US, Italy, Germany, Japan, Singapore, the UK, etc) and suggested that stock markets in most vulnerable countries and areas faced higher negative abnormal returns relative to other countries.

In another study Bash (2020) look for the effect of the first registered case of Covid-19 on stock market returns of 30 countries. According to the results of the event study, Covid-19 has a significant negative impact on index return. This finding is in line with Zhang et., al (2020) estimation. They examined the volatility of ten stock markets in the countries with the highest number of confirmed cases between January and February 2020 and found that volatility increased substantially in February due to Covid-19. Building on the work of Al-Awadhi et., al (2020), which reveals that stock markets around the world have reacted to the Covid-19 pandemic with strong volatility I map out the below hypothesis:

H: The number of Covid-19 cases (fatalities) is positively associated with stock return volatility of global firms.

3. RESEARCH DESIGN

3.1 Empirical model

I rely upon a panel data analysis over the classic event study methodologies for the following reasons: First, the spread of Covid-19 evolves a matter of days and is not one point in time. Second, panel data regression explains further the time-varying relationship between the dependent and independent variables (Ashraf, 2017). Third, panel data analysis reduces problems such as heteroscedasticity, estimation bias, and multicollinearity as it extracts both cross-sectional and time-series variation from the underlying panel data (Wooldridge, 2010). To evaluate the impact of Covid-19 cases (fatalities) on stock return volatility of global firms, I estimate a regression following the specification outlined in equation (1):

$$\text{VOLATILITY}_{i,t} = \beta_0 + \beta_1 \text{COVID}_{i,t,c} + \beta_2 \text{ROA}_{i,t} + \beta_3 \text{LnASSETS}_{i,t} + \beta_4 \text{LEVERAGE}_{i,t} \quad \textbf{(1)}$$
$$+ \beta_5 \text{MB}_{i,t} + \sum_{t=1}^{n} \beta_t \text{YEAR}_t + \sum_{d=1}^{n} \beta_d \text{INDUSTRY}_d + \sum_{c=1}^{n} \beta_c \text{COUNTRY}_c + \varepsilon_{i,t}$$

where, the dependent variable (VOLATILITY) is a vector representing the volatility of daily stock returns at different estimating windows. Following prior studies (e.g., Dutt and Humphery-Jenner, 2013), I estimate return volatility using a moving variance approach within estimation windows of 30, 60, 90, 180, and 250 days. COVID represents the COVID-19 related measures employed in the study, namely a) the total number of COVID-19 cases in each day (LnCASESTOT) and b) the total number of COVID-19 related fatalities (LnDEATSHSTOT). Both COVID-19 measures are in daily frequency, while in this analysis I transform them into natural logarithms to obtain better distributional properties and to reduce the impact of outliers.

The model also considers several firm-level variables, all measured quarterly, to control cross-sectional differences in firm characteristics that may influence return volatility. I control for profitability and size using the ratio of earnings before interest and taxes (EBIT) to total assets (ROA) and the natural logarithm of total assets (LnASSETS), respectively, since larger and more profitable firms are more likely to experience lower return volatility (Pastor and Veronesi, 2003). As a measure of financial leverage, I use the ratio of total debt over total assets (LEVERAGE) because financially distressed firms are more likely to be leveraged and have higher return volatility (Rajgopal and Venkatachalam, 2011). Previous studies provide an association between volatility and firm growth opportunities since growing firms exhibit more fluctuations in their returns (Pástor and Veronesi, 2003; Cao et al., 2008). Therefore, I consider for firm growth opportunities, operationalized as the market-to-book value of equity (MB). The standard errors of all the regression

estimates are adjusted using heteroskedasticity-corrected and clustered robust standard errors, clustered on firms.

Finally, I winsorize all continuous variables at the 1st and 99th percentiles to mitigate the effect of outliers, while I also include year, industry, and country indicators in all my estimates to alleviate any concerns for the unobserved year, industry, and country effects. YEAR_tare indicator variables with a value of one for year t; zero otherwise. INDUSTRY_dare indicator variables with a value of one for industry d; zero otherwise. COUNTRY_care indicator variables with a value of one for country c; zero otherwise, and ε_(i,t) is the error term. The variable definitions are presented in Appendix A.

3.2 Data

I use a panel data spanning from 31 December 2019 to 30 September 2020. I begin my sample selection utilising the entire universe of active and listed firms in the DataStream database, which is the primary source for stock price information and accounting data. I consider the country of the stock exchange as the relevant company location (similar to Dutt and Humphery-Jenner, 2013), and match the number of COVID-19 cases and/or fatalities reported each day, available through the World Bank. At this stage, the sample comprises of 31,649 firms (translated into 818,532 observations). My data requirements for control variables for my main model (1) further drop 1,105 firms, due to missing data. Following previous studies (e.g., Beck et al., 2013), my sample selection criteria require at least at least four firms in one country, and thus I eliminate 24 firms. Table 1 describes the sample selection process.

[Insert Table 1 about here]

The final sample comprises 30,516 firms (translated into 783,241 observations; see Table 1 for a description) scattered across 63 countries (see Table 2). Drawing upon Table 2 reveals that companies from three countries predominate, namely Japan (26.01), Australia (19.95), and India (19.51). Additionally, the right part of Table 2 informs on the average number of daily cases and fatalities across our in sample firms. In particular, we observe that the US, Turkey, Brazil, Italy and UK belong to the top five countries in terms of the total number of COVID-19 cases (CASESTOT) and the total number of COVID-19 fatalities (FATALITIESTOT).

[Insert Table 2 about here]

4. EMPIRICAL RESULTS

4.1 Univariate Analysis

Table 3 present a descriptive analysis of every single variable. The results show that volatility is higher in the short term, as compared to the long-term, as indicated by the mean, median, and max values of the Vol30, Vol60, Vol90, Vol180, and Vol250. Indicatively, the mean (max) of Vol30 and Vol60 are 0.039 (0.205 and 0.194, respectively), as compared to Vol180 and Vol250 which values are 0.037 (0.178 and 0.174, respectively). Moving to the rest of the cross-control variables, the average firm exhibits negative profitability (the mean of ROA is -0.095). Arithmetic means of LnCASESTOT, LnFATALITIESTOT, firm size, leverage, and market value of equity are 4.495, 2.012, 11.629, 0.617, and 2.102 respectively.

[Insert Table 3 about here]

Table 4 reports the Pearson correlation coefficients among the sample variables. It is observed that all volatility measures are positively correlated with each other, while the same also applies to the COVID-19 measures. Hence, I consider each of them separately in my analyses. Additionally, both COVID-19 measures are positively and statistically significantly correlated with firm return volatility measures. With regards to the remaining pairwise correlation coefficients, none of them is higher than 0.53 (in absolute terms) and thus suggests no serious problem of multicollinearity. This is also verified by the low values of the mean-variance inflation factors (VIFs), which do not exceed 1.4 across all models and are even lower than the cut-off value of 10 (Studenmund, 2016).

[Insert Table 4 about here]

4.2 Multivariate Analysis

I conduct multivariate analyses to test my hypothesis. Table 5 reports the panel data analysis of the effect of Covid-19 cases on firm return volatility. The first row shows the dependent variable scaled to five windows (30, 60, 90, 180, 250 days). The t-statistics indicated in parenthesis, are based on heteroskedasticity corrected robust standard errors, clustered on firms. The empirical result further confirms that (LnCASESTOT) has a positive and statistically significant impact on firm returns volatility during all estimated period. Meanwhile, the t-test strongly approves that Covid-19 had a noticeable effect on volatility especially during early days of confirmed cases (Vol30), (Vol60), (Vol 90). The effect is economically significant, as one standard deviation in-

crease in the number of Covid-19 cases (3.951) is associated with a 0.79% (0.40) increase in firm volatility (calculated as 3.951 x 0.002), within estimating windows of 30, 60, and 90, (180 and 250) days.

The mean-variance inflation factors (VIFs), do not exceed 1.4 across all models and are even lower than the cut-off of 10 (Stundenmund, 2016), inferring that multicollinearity is not likely to be of concern. It is worth noting that all control variables have also proven to be important determinants of return volatility. The coefficients of ROA and MB are significant and negative showing that less profitable firms are exposed to higher return volatility. In the same line (Rowe and Kim, 2010; Lee and Jang, 2006) point out the unfavorable influence of ROA and MB on volatility[13]. Similarly, size negatively influences firm return volatility, imposing that large companies experience less return volatility, while smaller companies are more exposed to higher volatility, and higher returns in both capital gain and dividends (Iqbal and Shah 2012; Olibe et al., 2008). The analogous result has been found at (Breen and Lerner, 1973; Gu and Kim, 2002). On the contrary, the regression outcome implies that leverage had a positive and significant impact on stock return volatility. This indicates that the greater the level of leverage the higher is the probability for the company to be exposed to higher return volatility. Results approve the findings of (Olibe et al., 2008; Gu and Kim, 2002).

[Insert Table 5 about here]

I obtain similar results when considering the number of Covid-19 fatalities (LNFATALITIESTOT) as my main variable of interest. Table 6 indicates that (LNFATALITIESTOT) attains positive and significant coefficients, at 1%, across all estimation windows of return volatility. The effect of Covid-19 fatalities is higher as compared to Covid-19 cases, as a one standard deviation increase in the number of Covid-19 fatalities (2.861) is associated with a 0.86% (0.57%) increase in firm volatility (calculated as 2.861 X 0.003) within estimating windows of 30, 60, and 90 (180 and 250) days. In addition, the results for the control variables are generally harmonious with my expectancies and the above results.

[Insert Table 6 about here]

[13]The outcome is consistent with the market book value of equity expectancies, since profitability is positively related with growth (Collins & Kothari, 1989). Given that future earnings are affected by growth opportunities, the lower the market to book value of equity ratio, the lower the expected earnings growth.

5. CONCLUSIONS

This study provides concurrent-evidence about the severe impact of Covid-19 on global markets. The empirical results suggest that both Covid-19 cases and fatalities have a positive and significant impact on the stock return volatility of global firms. The effect of Covid-19 fatalities is higher as compared to Covid-19 cases, within estimating windows of 30, 60, and 90 (180 and 250) days. In particular, regression results propose that stock markets react firmly during the early days of confirmed cases (Vol30), (Vol60), (Vol90) respectively. Also, control variables (ROA, LnAssets, Leverage and Market to Book Value of Equity Ratio) have played an important role on firm volatility during the entire period. This study contributes to prior literature in the following ways.

First, the analysis adds to the existing studies which have explored the impact of external shocks (natural disasters, financial crises) on the stock market. Second, it complements the existing limited literature which examines the impact of Covid-19 on financial market volatility. Third, as far as I am concerned, this is the first study that estimates the impact of Covid-19 on global stock return volatility. Thus, it extends the literature of global financial markets, by taking into consideration a global scale. The sample tracks 60% from approximately 51.000 active listed global firms[14], and thus the reported results reflect the impact of the Covid-19 pandemic on large scale data. Given the above results, the negative profitability and growth rate caused by the Covid-19 are likely to have had a negative influence on the global GDP. The empirical in some way confirms previous research estimation that global GDP is going to decline by a significant percentage in the future (Gormsen and Koijen, 2020).

In this light, the study might be advantageous to a wide spectrum of investors, portfolio managers, and decision-makers, since results confirm a significant negative impact on return volatility. Although the Covid-19 external shock has been extended worldwide, not all countries have reacted in the same way. Hence, investigating the impact of Covid-19 on the most affected countries such as Italy, Spain, France, the UK, or the United States, would be a worthwhile contribution to the existing literature.

[14] As of mid-2019, there were approximately 51.000 listed companies worldwide with a market value exceeding USD 80 trillion, equal to the global GDP, Press Release, The World Federation of Exchanges Publishes H1 2019 Market Highlights, https://webcache.googleusercontent.com/search?q=cache:oWYsB4yZzRIJ:https://focus.world-exchanges.org/storage/app/media/statistics/WFE%2520H1%25202019%2520Market%2520Highlights%2520press%2520release%2520draft%25205%252016.08.2019.pdf+&cd=5&hl=en&ct=clnk&gl=gr

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APPENDIX A - Variable Definitions

Variable	Definition
Panel A: Volatility Measures	
Vol30	The variance of daily stock returns over the past 30 days (Data source: DataStream).
Vol60	The variance of daily stock returns over the past 60 days (Data source: DataStream).
Vol90	The variance of daily stock returns over the past 90 days (Data source: DataStream).
Vol180	The variance of daily stock returns over the past 180 days (Data source: DataStream).
Vol250	The variance of daily stock returns over the past 250 days (Data source: DataStream).
Panel B: Main independent variable – COVID-19 measures	
LnCASESTOT	Natural logarithm of the total number of COVID-19 cases reported in the country the company is listed (Data source: World Bank).
LnFATALITIESTOT	Natural logarithm of the total number of COVID-19 fatalities reported in the country the company is listed (Data source: World Bank).
Panel C: Firm fundamentals	
ROA	Return on assets, measured as the ratio of income before extraordinary items over total assets (Data source: DataStream).
LnASSETS	Natural logarithm of total assets (Data source: DataStream).
LEVERAGE	Leverage ratio, measured as total debt over total assets (Data source: DataStream).
MB	Market-to-book value of equity (Data source: DataStream).

Table 1 Sample selection process

Sample selection stages	Number of firms	Number of firm years
Companies with COVID-19 data available through World Bank.	31,649	818,532
Delete: Companies with missing financial data for our empirical model.	1,105	34,177
Delete: Observations of companies don't meet the four companies per country criterion.	28	1,114
Final sample.	**30,516**	**783,241**

Table 2 Country distribution of observations

No	Country	Firms	Obs	Percent	CASESTOT	FATALITIESTOT
1	Australia	1,370	156,268	19.95	3,613.19	45.01
2	Austria	52	755	0.10	3,247.93	100.04
3	Bahrain	31	48	0.01	0.00	0.00
4	Belgium	106	886	0.11	12,002.58	1,750.07
5	Bermuda	7	251	0.03	89.74	5.39
6	Botswana	4	260	0.03	36.20	0.99
7	Brazil	263	718	0.09	70,411.73	3,685.29
8	Canada	1,604	30,614	3.91	17,146.53	1,226.99
9	China	4,124	7,244	0.92	24,401.47	1,033.32
10	Croatia	62	62	0.01	0.00	0.00
11	Czech Republic	12	12	0.00	0.00	0.00
12	Denmark	105	1,341	0.17	4,730.30	215.65
13	Egypt	149	3,575	0.46	9,445.83	400.72
14	Estonia	16	142	0.02	802.18	23.56
15	Finland	131	131	0.02	0.00	0.00
16	France	526	3,573	0.46	21,546.95	3,556.49
17	Germany	496	2,186	0.28	41,079.58	1,595.40
18	Greece	157	157	0.02	0.00	0.00
19	Guernsey	36	938	0.12	170.67	7.63
20	Iceland	16	81	0.01	88.04	0.17
21	India	2,385	152,837	19.51	224.33	5.93
22	Indonesia	474	710	0.09	39.69	3.18
23	Iraq	25	89	0.01	43.61	3.44
24	Ireland	62	1,406	0.18	9,664.24	592.33
25	Israel	396	585	0.07	1,839.24	25.60
26	Italy	262	973	0.12	59,770.08	8,070.75
27	Jamaica	10	400	0.05	288.25	5.21
28	Japan	3,270	203,753	26.01	2,483.56	83.80
29	Jersey	5	170	0.02	216.14	16.97
30	Kenya	5	125	0.02	856.86	26.57
31	Kuwait	138	518	0.07	2,161.80	16.55
32	Lithuania	27	149	0.02	640.97	22.58
33	Luxembourg	45	285	0.04	145.90	1.31
34	Malaysia	781	32,981	4.21	2,831.76	41.87

No	Country	Firms	Obs	Percent	CASESTOT	FATALI-TIESTOT
35	Mexico	121	121	0.02	0.00	0.00
36	Monaco	10	66	0.01	3.55	0.00
37	Netherlands	121	641	0.08	12,545.17	1,504.05
38	New Zealand	107	8,781	1.12	455.69	6.80
39	Nigeria	91	913	0.12	1,625.20	43.96
40	North Macedonia	27	27	0.00	0.00	0.00
41	Norway	165	165	0.02	0.00	0.00
42	Oman	78	326	0.04	1,997.83	8.86
43	Pakistan	224	18,099	2.31	31,712.75	640.73
44	Philippines	201	571	0.07	1,717.22	86.43
45	Poland	12	541	0.07	11,149.63	486.03
46	Qatar	43	43	0.01	0.00	0.00
47	Romania	83	83	0.01	0.00	0.00
48	Russia	169	169	0.02	0.00	0.00
49	Saudi Arabia	5	95	0.01	388.74	1.16
50	Singapore	500	14,631	1.87	8,895.19	6.43
51	South Africa	135	6,065	0.77	19,464.87	383.37
52	South Korea	1,943	4,218	0.54	2,661.26	46.58
53	Spain	163	487	0.06	33,360.36	3,406.37
54	Sri Lanka	203	9,483	1.21	16.01	0.03
55	Sweden	581	3,638	0.46	13,788.42	1,385.09
56	Switzerland	227	1,854	0.24	7,770.70	328.66
57	Taiwan	1,760	1,760	0.22	0.00	0.00
58	Thailand	591	2,960	0.38	812.31	13.05
59	Turkey	5	200	0.03	85,231.79	2,252.36
60	United Arab Emirates	103	103	0.01	0.00	0.00
61	United Kingdom	1,018	35,513	4.53	53,768.40	7,607.10
62	United States Of Amer-ica	3,848	65,830	8.40	625,540.95	29,776.66
63	Vietnam	830	1,635	0.21	47.78	0.00
	Total	**30,516**	**783,241**	**100**	-	-
	Average	**-**	**-**	**-**	**19,094.812**	**1,119.786**

This table presents the country distribution of the companies included in our sample. The last four Columns depict the average number of: a) the total number of COVID-19 cases (CASESTOT); and b) the total COVID-19 fatalities (FATALITIESTOT), as per country. COVID-19 data are derived on a daily frequency through the World Bank (https://github.com/owid/covid-19-data/blob/master/public/data/README.md)

Table 3 Descriptive statistics

	Obs	Min	25th	Mean	Median	75th	Max	StDev
Vol30	783,241	0	0.016	0.039	0.029	0.049	0.205	0.035
Vol60	783,241	0	0.017	0.039	0.03	0.048	0.194	0.034
Vol90	783,241	0	0.018	0.039	0.03	0.048	0.187	0.033
Vol180	783,241	0.004	0.018	0.037	0.029	0.044	0.178	0.03
Vol250	783,241	0.004	0.018	0.037	0.028	0.043	0.174	0.029
LnCASESTOT	783,241	0	0.693	4.495	3.434	7.937	14.443	3.951
LnFATALITIESTOT	783,241	0	0	2.012	0	3.784	11.592	2.861
ROA	783,241	-3.486	-0.048	-0.095	0.022	0.061	0.332	0.474
LnASSETS	783,241	4.754	9.933	11.629	11.667	13.325	17.826	2.563
LEVERAGE	783,241	-4.489	0.016	0.617	0.235	0.767	9.406	1.549
MB	783,241	-12.64	0.59	2.102	1.1	2.32	27.58	4.314

This table presents the descriptive statistics of the variables employed in our analyses. The continuous variables are winsorized at the 1st and 99th percentiles. All variables are defined in the Appendix A.

Table 4 Pearson correlation matrix

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Vol30	1.00										
2. Vol60	0.91***	1.00									
3. Vol90	0.85***	0.96***	1.00								
4. Vol180	0.79***	0.89***	0.94***	1.00							
5. Vol250	0.76***	0.86***	0.91***	0.98***	1.00						
6. LnCASESTOT	0.30***	0.33***	0.33***	0.26***	0.22***	1.00					
7. LnFATALITIESTOT	0.24***	0.28***	0.30***	0.25***	0.21***	0.92***	1.00				
8. ROA	-0.35***	-0.40***	-0.42***	-0.47***	-0.49***	-0.08***	-0.07***	1.00			
9. LnASSETS	-0.38***	-0.43***	-0.46***	-0.51***	-0.53***	-0.00***	0.01***	0.47***	1.00		
10. LEVERAGE	-0.07***	-0.08***	-0.08***	-0.09***	-0.09***	-0.02***	-0.01***	0.10***	0.21***	1.00	
11. MB	-0.04***	-0.05***	-0.05***	-0.05***	-0.05***	0.01***	0.02***	0.03***	0.01***	0.32***	1.00

This table correlation coefficients of the variables used in our main analysis. All variables are winsorized at the 1st and 99th percentiles. Values with asterisks *, **, and *** indicate significance at the 10, 5, and 1 % levels, respectively (2-tailed). All variables are defined in the Appendix A.

Table 5 The impact of COVID-19 cases on firm return volatility

	(1)	(2)	(3)	(4)	(4)
Dependent Variable:	**Vol30**	**Vol60**	**Vol90**	**Vol180**	**Vol250**
LnCASESTOT	0.002***	0.002***	0.002***	0.001***	0.001***
	(57.87)	(55.85)	(54.03)	(44.34)	(41.95)
ROA	-0.013***	-0.011***	-0.009***	-0.010***	-0.011***
	(-15.11)	(-14.12)	(-11.18)	(-13.00)	(-14.47)
LnASSETS	-0.003***	-0.004***	-0.005***	-0.005***	-0.005***
	(-28.52)	(-39.10)	(-41.58)	(-36.25)	(-31.76)
LEVERAGE	0.001***	0.002***	0.003***	0.002***	0.002***
	(5.15)	(10.92)	(12.14)	(9.35)	(9.05)
MB	-0.000***	-0.001***	-0.002***	-0.001***	-0.001***
	(-2.67)	(-8.93)	(-9.07)	(-5.60)	(-5.28)
(intercept)	0.065***	0.085***	0.099***	0.102***	0.100***
	(27.32)	(35.90)	(38.33)	(38.86)	(36.25)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.335	0.413	0.440	0.476	0.494
Mean VIF	1.261	1.302	1.326	1.337	1.345
Observations	783,172	783,172	783,172	783,172	783,172

This table reports the panel data analyses of the effect of COVID-19 cases on firm return volatility. The dependent variables are: a) the variance of daily stock returns over the past 30 days – Vol30 (Column 1); b) the variance of daily stock returns over the past 60 days – Vol60 (Column 2); c) the variance of daily stock returns over the past 90 days – Vol90 (Column 3); d) the variance of daily stock returns over the past 180 days – Vol180 (Column 4); and e) the variance of daily stock returns over the past 250 days – Vol250 (Column 5).The *t*-statistics in parentheses are based on heteroskedasticity corrected robust standard errors, clustered on firms. All continuous variables are winsorized at the 1st and 99th percentiles The statistical significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***.All variables are defined in the Appendix A.

Table 6 The impact of COVID-19 fatalities on firm return volatility

	(1)	(2)	(3)	(4)	(4)
Dependent Variable:	**Vol30**	**Vol60**	**Vol90**	**Vol180**	**Vol250**
LnFATALITIESTOT	0.003***	0.003***	0.003***	0.002***	0.002***
	(41.56)	(44.72)	(46.28)	(41.31)	(39.48)
ROA	-0.012***	-0.011***	-0.009***	-0.010***	-0.011***
	(-14.15)	(-13.63)	(-11.20)	(-13.28)	(-14.68)
LnASSETS	-0.003***	-0.004***	-0.005***	-0.005***	-0.005***
	(-30.01)	(-39.20)	(-40.18)	(-33.65)	(-29.28)
LEVERAGE	0.001***	0.002***	0.002***	0.002***	0.001***
	(6.50)	(10.80)	(11.45)	(8.34)	(7.95)
MB	-0.000***	-0.001***	-0.002***	-0.001***	-0.001***
	(-4.21)	(-8.65)	(-8.29)	(-4.59)	(-4.22)
(intercept)	0.067***	0.087***	0.099***	0.101***	0.098***
	(28.08)	(36.09)	(37.80)	(37.17)	(34.40)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.316	0.403	0.441	0.480	0.497
Mean VIF	1.244	1.289	1.317	1.334	1.342
Observations	783,172	783,172	783,172	783,172	783,172

This table reports the panel data analyses of the effect of COVID-19 fatalities on firm return volatility. The dependent variables are: a) the variance of daily stock returns over the past 30 days – Vol30 (Column 1); b) the variance of daily stock returns over the past 60 days – Vol60 (Column 2); c) the variance of daily stock returns over the past 90 days – Vol90 (Column 3); d) the variance of daily stock returns over the past 180 days – Vol180 (Column 4); and e) the variance of daily stock returns over the past 250 days – Vol250 (Column 5).The *t*-statistics in parentheses are based on heteroskedasticity corrected robust standard errors, clustered on firms. All continuous variables are winsorized at the 1st and 99th percentiles The statistical significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***.All variables are defined in the Appendix A.