The Impact of the COVID-19 Pandemic on Global Stock Market Volatility: An Integrated Analysis Using Event Study and GARCH Models

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Abstract. The COVID-19 pandemic, which started in late 2019, caused unprejudiced swings in the global stock markets that showed in a turbulent economy and financial system. This research expands the investigation to the main stock indices, such as S&P 500 (U.S.), CSI 300 (China), FTSE 100 (UK), and DAX (Germany), to show their response to the pandemic-induced shocks which occurred during 2019 to 2021. Carrying out event studies and the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model, the researchers bring to light that there are significant negative abnormal returns after the occurrence of major world events. The events investigated by this approach are WHO's declaration of a Public Health Emergency of International Concern (PHEIC) and lockdowns worldwide. The results of GARCH analysis, which also show emerging markets bearing greater volatility persistence than their developed counterparts, point to the discussed structural vulnerabilities in capital distribution, liquidity, and the communication mechanisms of crises. Such differences are probably indications of the importance of specific market strategies of risk association and, therefore, emphasize the reflection of resilience of the system to the external shocks. The inclusion of various analytical tools not only enhances the comprehension of market behavior during the times of pandemic but also instills a concrete framework to help contextualize the investor reactions in periods marked by the uncertainty and asymmetric information.

1 Introduction

The Covid-19 pandemic, designated as the most terrible public health crisis in the twenty-first century, not only harms human lives but also creates a notably impactful instability in financial markets. Compared with traditional economic shocks, the special nature of the pandemic includes the abrupt starting of the illness, a global outbreak, and the existence of ongoing uncertainty, which exposes some weaknesses of the market structure and investor

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behavior in the traditional economy. The scientific literature of the initial stage had mostly focused on short-run and localized challenges, like those falling from stock market crash in early 2020. Nevertheless, a crucial void in research remains being the question of whether in the medium-term changes in volatility will be observed across other markets as well and whether such changes are accompanied by persistent effects arising from the pandemic shocks. This study is filled with these deficiencies through two main implications. First, it is designed using a global comparative framework, in which the US, China, and Europe indices are scrutinized in order to capture cross-market heterogeneity. Second, in terms of the methodological structure, it integrates the event study method, an approach that isolates short-term market performance and its reaction to specific events, with the GARCH model, which counts clustering of volatility and its persistence over time. The combination of these strategies helps answer the two questions:

How did key pandemic milestones affect stock market volatility?

To what extent are these impacts more severe in emerging markets than in developed ones?

Additionally, this paper contributes to understanding the feedback loops between investor sentiment and policy response during high-uncertainty periods. The role of governments in preparedness or lack thereof is critical in this regard because timing, scale, and clarity of government actions affect market response. Discerning these differences can be the means for identifying the extent to which the volatility market perceive the risks during the pandemic as only reactions or as the dynamic core structural changes.

Another aspect is that the onset of COVID-19 came against the backdrop of an already strongly stressed macroeconomic environment, which included trade tensions, rates of volatility, and declining growth in several parts of the world. This extreme array of pressures most likely contributed to a general increase in the severity of the consequences of pandemic-induced volatility. The association between health data and financial decision-making is also occurring at a level that was never seen before, emphasizing the importance of real-time analytics in forming up investors' psychology. The study seeks to fill the knowledge gap where systemic vulnerabilities exposed through the international comparisons would be particularly highlighted, focusing on how emerging markets became unable to generate fiscal space and healthcare infrastructures.

On the other hand, the pandemic laid bare the discrepancies in pain between investors' relations of retail and institutional operations. Retail customers in those technologically advances societies were affected by social media and subsequently a few stocks were spiked by these social media views and perception. Unlike the retail sector, institutional players adopted this system involving the wait-and-see methods, which created an environment of liquidity fragmentation and wider bid-ask spreads whenever uncertainty peaked.

2 Literature Review

The existing research on pandemic-affiliated monetary fluctuations may be classified as three distinct categories. First, studies are undertaken that describe the response of financial markets to external environmental shocks. Baker, S. R discovered that a market panic, or flight to safety, is especially driven by information fragmentation and is tighter related to a pandemic condition [1]. Other news, like a government lockdown or partial closure of borders, moved the markets further downward.

The second group of studies takes a new methodological approach. Zhang, D took the GARCH model to analyze spillover of volatility in Asian countries and discovered long-term volatility clustering [2]. In addition, Aloui instability to market constraints and policies [3].

As for the third one, regional differences that have emerged both in the global economy and the financial markets are mentioned. One event study conducted in December 2020 by Li Zhibin from China indicated that Chinese A-share stocks reflected the stronger reactions to the COVID-19 outbreak among the stock markets in Hong Kong and the United States first but then remained stable. Contrary to them, Western countries implied instabilities for several months. However, most empirical research comparing world markets is still lacking. It has been noted the absence of the merge of event-driven and time-series approaches. This paper seeks to unite these two different approaches under the same umbrella by developing such a framework.

Moreover, scholars like Ramelli have pointed out that firm-level exposure to global value chains and cross-border operations exacerbated vulnerability to pandemic shocks [4] . This indicates the need to account for structural attributes of the financial systems within which indices operate. Therefore, the financial contagion observed during COVID-19 differs from purely endogenous crises like 2008, underscoring the role of exogenous, health-based triggers.

In broader economic literature, COVID-19 has also reignited interest in the 'black swan' concept introduced by Taleb, with markets experiencing abrupt paradigm shifts that rendered traditional risk models temporarily obsolete [5]. Additionally, studies such as Goodell explore how government transparency and information dissemination strategies influenced volatility across jurisdictions [6]. This growing body of interdisciplinary research suggests that an effective response to pandemic-induced financial turbulence must consider sociopolitical dimensions as well as technical economic metrics [7]. As such, combining event study analysis with GARCH modeling provides a robust framework to capture this duality.

Emerging research also highlights the psychological toll of prolonged volatility on market participants, with increased cognitive load potentially impairing rational decision-making. This aligns with insights from neurofinance, which suggest that stress-induced trading behavior may deviate significantly from established utility-maximizing frameworks [8]. Moreover, the lack of historical precedence for such a global health shock hindered the effectiveness of existing financial forecasting models, prompting calls for interdisciplinary resilience modeling.

3 Methodology

3.1 Data Collection and Sample Selection

The dataset consists of daily closing prices of four indices (S&P 500, China's CSI 300, United Kingdom's FTSE 100, Germany's DAX) from Yahoo Finance and Wind Database for the time period starting from December 1, 2019, and going to December 31, 2021. These are the representative indices for different kinds of economies and different health resource systems and control measures that allow for comparing those economies through different ways.

To ensure comparability, exchange rates and inflation-adjusted returns were normalized across regions. Additionally, the study excluded periods of low trading activity (such as national holidays) to avoid data distortion. Outliers and extreme returns were winsorized at the 1st and 99th percentile levels to reduce noise without affecting underlying trends.

3.2 Event Study Method

Five critical pandemic-related events were selected: WHO's PHEIC declaration (January 30, 2020), initial quarantine of Wuhan, China (January 23, 2020), United States declaring of a national emergency (March 13, 2020), European Union's imposition of border closure (March 17, 2020), Pfizer-BioNtech vaccine effectiveness announcement (November 9, 2020)

For each event, an 11-day event window (t-5 until t+5) was used to calculate abnormal returns as stated in the rates. The market model, which is tested for statistical significance through t-tests and after adjusting it in accordance with the Fama-French three-factor framework, determined the expected returns [9] .

Furthermore, the robustness of results was checked through alternative event windows (±3, ±7, and ±10 days), with supplementary comparison to CAPM-based expected returns. Cumulative abnormal returns (CARs) were also disaggregated by sector to reveal sector-specific sensitivity to pandemic news [10].

3.3 GARCH(1,1) Model

To improve reliability, Ljung-Box Q-statistics were used to test for autocorrelation in the residuals [11]. As for the ARCH-LM tests, they were run in order to determine whether heteroskedasticity was present or not before model fitting. Those steps guaranteed that the model assumptions properly fit and no inferences will be drawn from artifacts.

The methodology adopted in the study includes the lagged exogenous variables in the GARCH estimation and rolling window estimates of underlying consistency at different time intervals. Financial and epidemiological milestones such as gradual infection peaks and major international policies declared helped in selecting these event windows. Speaking of robustness, Monte Carlo simulations were executed in order to test the confidence intervals of CAR under modified assumption. Data integrity was maintained by aligning trading calendars across markets and converting all values into a consistent currency basis for comparability. These methodological steps enhance the reliability of the empirical findings.

To capture country-specific effects, dummy variables representing national-level pandemic severity and policy strictness indexes were included in the regressions. These variables were constructed from Oxford COVID-19 Government Response Tracker data and incorporated into extended GARCH-X models [12] . This innovation allowed the study to go beyond pure return series and incorporate real-world policy conditions as volatility influencers. Furthermore, impulse response analysis was conducted to examine how markets adjusted not just to initial events, but also to repeated waves of infection and policy adaptation.

4 Results

WHO declaration of PHEIC: All markets in this case had negative CARs, but the CSI 300 was the least affected, although it dropped by 2.1% and statistically significant ($p<0.05$). The S&P 500 has seen a 4.5% depreciation ($p<0.01$) while the DAX performed even worse, plummeting 5.8% ($p<0.01$).

Vaccine Announcement: From this positive CAR, it can be concluded that there were positive CARs in the United States (+0.32%, $p<0.05$) and Europe (+0.27%, $p<0.05$), while China's CSI 300 reacted with a negative market response (-0.09%, insignificant).

Wuhan Lockdown: The CSI 300 experienced a sharper drop of 3.3% ($p<0.05$), highlighting how early and direct exposure influenced domestic markets. In contrast, Western indices showed smaller but still significant declines.

EU Border Closures: DAX and FTSE 100 exhibited steep falls, consistent with investor concerns about intra-European supply chains and market integration.

US Emergency Declaration: The S&P 500 registered one of the largest drops among all events, emphasizing the role of U.S. economic leadership in global financial sentiment.

Substantial heterogeneity in market responses was evident not only between countries but also across sectors. Technology and healthcare stocks generally demonstrated stronger recoveries following positive vaccine news, while tourism, energy, and retail sectors exhibited prolonged negative CARs. Notably, markets in China showed quicker rebounds following lockdown announcements due to aggressive containment measures and state interventions. In contrast, European indices lagged, reflecting investor concerns about fragmented fiscal responses. GARCH parameters remained stable across sub-periods but indicated more persistent shocks in nations with slower vaccine rollouts or erratic policy frameworks.

One notable result was the temporal divergence in volatility normalization. For instance, while the U.S. and Chinese markets stabilized by Q2 2021, several European markets displayed persistent fluctuations well into Q4. This could be attributed to the decentralized nature of European fiscal response mechanisms and difficulties in synchronizing public health policy across EU member states. Additionally, Chinese equities showed earlier signs of recovery due to strong retail participation and confidence in governmental pandemic control.

5 Discussion

The synthetic method shows two main principles. Firstly, during the pandemic period, different events brought about the short-term market reactions that are fully consistent with behavioral finance theories, which highlight the roles of investor sentiment as well as the asymmetry of information. Like the WHO's PHEIC announcement leading to the dramatic selling of assets, especially in net export-oriented economies like Germany. Secondly, the GARCH-conclusive results remained constant with the "volatility feedback" hypothesis in which an increase of uncertainty pushes the markets to instability for longer.

Perhaps the underlying downturn of the Chinese market can be attributed to the rigorous measures and fiscal stimulus adopted by the government, which kept investor confidence high afterward. On the contrary, the US and EU markets fell due to the fact that their policy measures hit the consumer-centered sectors hard and were initiated slowly. Such a finding highlights the effects of institutional support on financial stability.

Moreover, the prolonged uncertainty revealed a lack of harmonized global coordination in handling financial volatility during health crises. The countries applied coherent monetary and fiscal measures made the volatility measures to return quickly to their levels. This implies that an area of potential future research will be in the role of global governance structures during the pandemic.

Through this finding, we reinforce the argument that the policy predictability plays an integral part in easing the market fears in time of health crisis. For the countries that were able to convey unequivocal plans on how and when they would deploy monetary stimuli, the financial markets showed mean reversal more rapidly on average. In contrast, the erratic and delayed actions hiked volatility. This behavior is consistent with prospect theory, which states that individuals marginalize losses to a great extent in economically uncertain circumstances. Furthermore, there was a contagion effect, which occurred because of the character of intercontinental and intercountry trade. Global markets operate in a complex switching mechanism where even one butterfly flap can trigger a hurricane, therefore understanding contagion of one financial hub upon another is worth exploring, not only for future crises but also for future recovery.

From a policy standpoint, the findings underscore the importance of flexible regulatory mechanisms capable of responding to non-economic shocks. Traditional monetary tools, such as interest rate cuts, proved insufficient in isolation. Instead, multi-pronged responses that combined health infrastructure investment with targeted financial relief were more effective in containing both pandemic spread and investor panic. The results also invite a reevaluation of financial stability mandates to include responsiveness to global health threats.

6 Conclusion

This study endeavors to explore an extensive analysis on COVID-19 pandemic's causing of global stock market turbulence by taking advantage of event study methods combined with GARCH. The key findings reinforce that the pandemic leads to the significant short-run disruption and long-run volatility persistence as emerging markets exhibit many risks. Through this, the research adds to the academic debate by demonstrating the effectiveness of hybrid methodologies for the market in capturing complex dynamics. The policy proposals are pitched as anticipative strategies, with such measures as increased control over the system and multilateral interactions in order to stabilize financial systems during crises.

Future research can also focus on the macroeconomic variables, such as GDP growth, unemployment rates, or specific sector vulnerability. In addition, behavioral aspects like risk aversion, media sentiment, and trust in government may be modeled to understand heterogeneous investor responses. Multi-factor modeling incorporating both fundamental and sentiment variables could further advance understanding of pandemic-induced volatility.

Given the rising likelihood of systemic risks stemming from non-financial domains—be it health, climate, or geopolitics—this paper highlights the urgent need for integrating real-time risk analytics into financial regulatory frameworks. Even behavioral factors that underpin an acceptable risk should be understood. Behavioral triggers are equally important. The forthcoming research may be equipped with machine learning, which will increase the forecasting ability and agent-based modeling, which will reflect different behavior of investors with uncertainty. This will broaden the understanding of not only the likely unpredictable market reactions but also the level of economically resilient structures under crises.

Lastly, the findings advocate for the inception of international data-transmitting systems and early warning systems in order to determine and disable financial contagion from global health events. The approach of collective platforms that consist of public health professionals, dividends regulations and institutional investors can serve as a basis for the resilient capital markets. The essential transition to the integrated risk management strategies with the growing frequency of complex, nonlinear global disturbances must be acknowledged as the coming decades are associated with such events keep on increasing.

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