European Journal of Sustainable Development (2023), **12**, 3, 364-376 ISSN: 2239-5938
Doi: 10.14207/ejsd.2023.v12n3p364

Assessing the Impact of the COVID-19 Pandemic on the Saudi Stock Market's Performance and Sustainability

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Abstract
The research investigates the immediate impact of the COVID-19 pandemic on the Saudi Stock Exchange (Tadawul) by analyzing the Tadawul All Share Index (TASI). Relying on a robust quantitative methodology, the study involved de-seasonalizing daily TASI 'Close' values using a 7-day moving average and employing ARIMA modeling to examine time-series characteristics for periods before and after the first reported case of COVID-19 in Saudi Arabia on March 2, 2020. The study spanned 115 days, with 56 days before and 59 days after the outbreak, resulting in a total of 115 observations. Advanced statistical tests, including a two-sample t-test and effect size calculation (Cohen's d), were conducted to statistically validate the differences in market performance. The findings revealed a significant decrease in TASI performance post-COVID-19, with increased market volatility. This data aligns with global observations of market disruptions during the pandemic and contributes to the understanding of crisis-induced market behaviors. Finally, the obtained results offer valuable insights into the complexities of stock market responses to global health emergencies while further underscoring the importance of considering external factors in market dynamics.

Keywords: Stock market; COVID-19; financial market; performance; Tadawul; mortality; Saudi Arabia.

1. Introduction

While over 90,000 cases of COVID-19 infection had been reported by 3rd March 2020, 3,100 deaths had occurred by this time across the globe. Despite the continuing stability of COVID 19 outbreak in some countries, such as China, the virus is spreading rampantly in other nations. The number of infected persons is a pertinent issue; nonetheless, the vast extent of disruption to economies from the instituted measures of containment forms a more severe concern (Selmi & Bouoiyour, 2020). The outbreak of this pandemic has resulted in different unprecedented changes in the global economy. As an immediate aftermath, the growing health concern prompted key international institutions to significantly lower their growth forecasts, which has been consequently followed by travel restrictions detrimentally impacting the manufacturing sector (Diop et al., 2021). From another standpoint, closures of both factories and office spaces contributed to supply chain disruptions, whereas sharply declining consumer spending trends effectively stalled the services industry (Komies et al., 2020). Under these circumstances, the pervasive spread of COVID-19 has predisposed all economic stakeholders, including consumers, suppliers, and financial intermediaries, to a large-scale crisis on an unprecedented scale.

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Exuberance and extreme responsiveness to change characterize stock markets. However, recent history insinuates that a prompt containment of an emergent malady would have modest economic effects, and thus, influence the stock market modestly. The outbreak of SARS virus in China in 2003, which was rapidly contained, leading to a stock market rise of 20 percent in the same year exemplifies this case (McKibbin & Fernando, 2020). Nevertheless, the COVID-19 presents quite a different scenario. The worldwide economy exhibits considerable fragility, and an extended pandemic emergence may aggravate the contemporary aging business cycle into a worldwide recession. COVID 19 exacerbates the anxiety over the global economic outlook since the stock indices have plunged.

The movement of the financial market indices reveals the anticipated impacts of COVID-19 on stock markets. Since the outbreak of this pandemic, financial markets continuously respond to daily developments about the disease across the globe (Mazur et al., 2021; Selmi & Bouoiyour, 2020). Specifically, stock markets have been illustrating the awareness of investors on unsystematic, industry-specific impacts. Hence, the stock exchange index is instrumental in indicating the rampant turbulence in financial markets.

Saudi Arabia's sole stock market exchange, Tadawul, has been a focal point in understanding the economic implications of the COVID-19 pandemic on the Middle Eastern country. As of June 16, 2020, Saudi Arabia reported over 140,000 COVID-19 cases and over 1,000 deaths, with its first case being recorded on March 2, 2020 (Algaissi, et al., 2020). Tadawul is the most significant capital market in the region encompassing North Africa and the Middle East. The estimation of the economic exposure of this stock market to the risk of COVID-19 invariably involves analyzing the Tawadul All Share Index (TASI). Specifically, TASI denotes a major stock market index that tracks the performance of all publicly listed firms on the Saudi Stock Exchange. The base value of this metric stands at 1,000 as initially set in 1985 (Saudi Arabia Stock Market, 2020).

In the given context, this cross-sectional analysis incorporates a comprehensive quantitative methodology, encompassing de-seasonalization, ARIMA modeling, and advanced statistical tests. The chosen approach seeks to assess whether the emergence of COVID-19 influenced the performance of stocks on the Tadawul stock market. By comparing the average performance of TASI before and after the emergence of the COVID-19, the research aims to reveal whether a significant disparity in stock performance exists across these periods. The research question that guides the study is as follows: "What is the influence of COVID-19 on the performance of stock in Tadawul?" To adequately address this question, the study is grounded in the following hypotheses:

- H0: The means of TASI before and after the outbreak of COVID-19 pandemic in Saudi Arabia are equal.
- H1: The means of TASI before and after the outbreak of COVID-19 pandemic in Saudi Arabia are not equal.

2. Literature Review

2.1 Global Impact of COVID-19 on Stock Markets

Stock exchange markets form a critical component of the economy of any country. A considerable number of researchers have embarked on examining the influence of the COVID-19 pandemic on financial markets. Hence, a considerable number of

empirical work on this topic exist. According to Selmi & Bouoiyour (2020), COVID-19 is a detrimental threat to all sectors of the economy, including the stock markets. These researchers investigated the reaction of the stock price to the emergence of the COVID 19 pandemic. They employed an advanced event study methodology to evaluate the responses of the G7 (France, Germany, Italy, Canada, the United Kingdom, the United States, and Japan) stock markets to the rapid outbreak of the novel pandemic. Furthermore, this study employed the volatility spillover procedure of Diebold and Yilmaz's (2012) to approximate the level of risk of exportation associated with China to the G7 nations. As the advanced event study methodology involves analyzing the impact of specific events on the stock market by examining abnormal returns and the volatility spillover procedure assesses how fluctuations in one market can affect volatility in another, these methodologies are relevant to our study due to their potential to provide a framework for understanding market reactions to significant events like the COVID-19 pandemic (Ajmi et al., 2021). The findings revealed that all the stock markets of G7 countries are suffering subject to uncertainty emanating from the COVID -19 epidemic. Conversely, the reactions to the shock vary from nation to nation. Moreover, the study suggested the existence of difficulties in travel and trade disrupted the flow of services and goods, with cascading effects on industries whose supply chains heavily depend on Chinese supplies. This research considered China as the most significant volatility transmitter followed by USA, whereas Germany, Japan, Italy, and France were regarded as the likely volatility recipients of the current times. Therefore, COVID-19 has adversely affected the capital markets of the G7 countries.

2.2 Comparative Studies on Financial Markets During Pandemics

In another study by Sansa (2020), the author focused on investigating the impact of COVID-19 on the financial markets of only two countries, USA and China. The investigator affirms that this pandemic is severer than the great financial crisis of between 2007 and 2008. This study analyzed the influence of COVID-19 on the financial market of USA and China for the period between 1st March 2020 and 25th March 2020. It utilized a simple linear regression model. The data used was obtained from China COVID-19 Statistics Reports and the Trading Economics website. Shanghai Stock Exchange and New York Dow Jones served as the study samples for China and USA, respectively. While the COVID-19 confirmed cases for each country served as the independent variable, New York Dow Jones and Shanghai Stock Exchange represented the outcome variables of this research. The study findings revealed that a positive relationship between the number of confirmed cases of COVID-19 and the performance of the two capital markets, during the study period, exists. Thus, the outbreak of COVID-19 significantly influenced the financial markets of China and USA. Considering that these studies highlight the effects of COVID-19 on major markets like the USA and China, it is crucial to further consider how similar trends may manifest in emerging markets such as Saudi Arabia's TASI. A comparatively smaller economy could exhibit unique responses due to different market dynamics and investor behaviors.

2.3 Short-Term and Long-Term Market Reactions to Pandemics

Inherently, the effects of COVID-19 on stock markets are likened to those of the 2003 SARS epidemic, which resulted in significant economic and social losses. Liu et al. (2020) conducted a study to examine the short-term impacts of COVID -19 pandemic on twenty-one leading stock market indices. This research considered indices in countries that have been enormously affected by the epidemic, including Singapore, USA, Japan, Germany, Korea, UK, India, Russia, Korea, Australia, Taiwan, Thailand, and Italy. Investing.com website and China Stock Market & Accounting Research database served as the data sources for this analysis. The data comprised daily closing process of these indices for the period between 21st February 2019 and 18th March, 2020. The bench index employed din calculating the returns of composite indices of the stock markets involved. The investigators adopted the event study approach and panel fixed effect regressions techniques to analyze data. The outcomes revealed that the influence of this disease is substantial and had a direct influence on the global stock markets. Furthermore, they indicated that the performance of the stock markets in the affected countries and regions declined immediately upon the outbreak of COVID-19. Remarkably, Asian countries suffered more adverse abnormal returns compares to other nations. COVID-19 was noted to intensify the pessimism of investors regarding future returns and fears of uncertainties. Hence, it negatively affected the financial markets of these countries.

2.4 National Responses to Market Crises

Finally, Alber (2020), examined the influence of the spread of COVID-19 on stock markets of the six worst markets, as per the number of cumulative cases. The countries involved encompassed Italy, China, USA, Spain, Germany, and France. The data was collected daily from 1st March, 22 to 10th April, 2020. While the independent variables in this study included relative COVID-19 cumulative cases, relative cumulative COVID-19 deaths, relative new COVID-19 cases, and relative new COVID-19 deaths, the stock market return represented the explained variable. The data was obtained from markets.businessinsider.com website and worldometers.com website. The study employed the traditional approach to examine the influence of informational content on the returns of stock markets. Additionally, the correlational analysis was conducted to reveal the interconnectedness between the spread of COVID-19 and stock market index. The study findings indicated that stock market returns were more sensitive to confirmed COVID-19 cases than deaths. Moreover, the sensitivity of stock market returns on COVID-19 cumulative indicators was found to be higher compared to new cases. Notably, the analysis showed that the adverse effects of the transmission of COVID-19 on capital market return for Germany, France, Spain, and China exist. Nonetheless, the negative influence of this pandemic was not confirmed for the USA and Italy. Thus, the research yielded mixed results regarding the impact of the spread of COVID-19 on stock market return. The influence of COVID-19 on these varied stock markets underlies a global trend of economic disruption. By specifically analyzing TASI, our study extends this narrative and contributes to a more comprehensive understanding of the pandemic's impact across diverse economic contexts.

The outbreak of COVID-19 is a global crisis. It has hurt the global economy vastly, thereby forming an attractive area of research to facilitate the formulation of policies that would

guide the economy to prevent further disruption, as well as assist in the recovery from the economic ruin. Recent studies employing ARIMA modeling and t-tests in market analysis, similar to our methodology, have partially demonstrated how these statistical methods can adequately reflect market dynamics during external shocks (Katoch and Sidhu, 2021; Yagoub and Eledum, 2021). These observations parallel our approach in analyzing TASI and can help to situate our study within the broader academic context of financial market research. Temporal and contextual consistency characterizes the findings of these studies, which show that COVID-19 is detrimental to the stock market, as well as the entire global economy.

3. Methodology

The current scholarly study adopted quantitative methodology, which entails collecting, categorizing, synthesizing, analyzing, as well as interpreting quantitative data. While this technique facilitates the realization of factual data needed to address a research question by concentrating on quantifiable economic behavior aspects, it provides for the numerical calculation of statistics that depict information regarding the subject under study. Thus, the methodological choice assisted in evaluating the link between TASI performance and the outbreak of the COVID-19 Pandemic in early 2020. This research utilized a cross-sectional design driven by the study's objectives and data availability. Cross-sectional analysis represents an observational design framework that supports the measurement of the outcomes and exposures in the study subjects simultaneously (Hemed & Tanzania, 2015; Setia, 2016). For these reasons, it is deemed to be optimal for the current research as the cross-sectional methodology also accounts for the determination of the number of subjects affected by a condition, as well as establishment of whether the frequency of the incident differs across groups or population attributes.

The study target, which marks the whole set of research observations showing identical observable attributes that interest the researcher, is the Tadawul stock exchange market. The main TASI index forms the population of this analysis due to its predisposition to the risk of calamities. In this context, the preliminary sample constituted daily observations of 160 days, which comprised 80 days before and 80 days after the report of the first COVID 19 incident in Saudi Arabia. Considering that the first case of COVID-19 in the Middle-Eastern country was reported on March 2, 2020, then December 13, 2019 marks eighty days prior to, whereas May 21, 2020 indicates eighty days after the base-day. The trading days of the Saudi Arabia stock market include a single session, Sunday through Thursday, excluding official holidays (Trading Cycles and Times, 2020). Hence, the closed days reduced the number of observations of this study to 115. The following financial database websites served as the data sources for this study: tadawul.com, tradingeconomics.com, and tradingview.com.

In regard to data analysis methods employed for the research, a comprehensive quantitative approach was considered to analyze the impact of the COVID-19 pandemic on the Saudi Stock Market. First, a 7-day moving average de-seasonalization was applied to the daily TASI 'Close' values to address the effects of weekly fluctuations and provide a clear perspective on underlying trends. Second, two ARIMA models with empirically justified parameters were fitted to the deseasonalized data for the purpose of examining

time-series characteristics for both pre- and post-COVID periods (Alfaki and Masih, 2015). The inclusion of ARIMA modeling informed by ACF and PACF tests helped in identifying and quantifying patterns in market behavior. Third, a two-sample t-test was additionally conducted to statistically validate the difference in market performance between the two periods, with a consequent Cohen's d test and rolling statistics. Altogether, these methods, being grounded in time-series analysis and inferential statistics, provided a robust framework for analyzing and interpreting market dynamics in response to the COVID-19 crisis. All graphics and calculations in this study were accomplished using a Python environment supplemented with the Matplotlib and Pandas libraries.

4. Data Analysis and Results

The study involved a meticulous analysis of the Tadawul All Share Index (TASI) performance during the initial stages of the COVID-19 pandemic, specifically covering the period from December 13, 2019, to May 21, 2020. According to the chosen methodology, this timeframe was further dichotomized into two distinct phases: the pre-COVID-19 period, covering dates from December 13, 2019 to March 1, 2020; and the post-COVID-19 period, spanning from March 2, 2020 to May 21, 2020. While the pre-COVID period included 56 observations, the post-COVID period encompassed 59 distinct data points.

4.1 De-seasonalization Process

Due to the importance of accounting for seasonal fluctuations in stock market data and considering short-term fluctuations, we employed a 7-day period de-seasonalization technique to the TASI 'Close' values. Allowing to further refine the raw dataset, this approach enabled a more accurate analysis of underlying trends. Figures 1 and 2 visually demonstrate the TASI performance trends both before and after the shocks introduced by COVID-19, with the latter showcasing the de-seasonalized data to provide a clearer view of the underlying market movements.

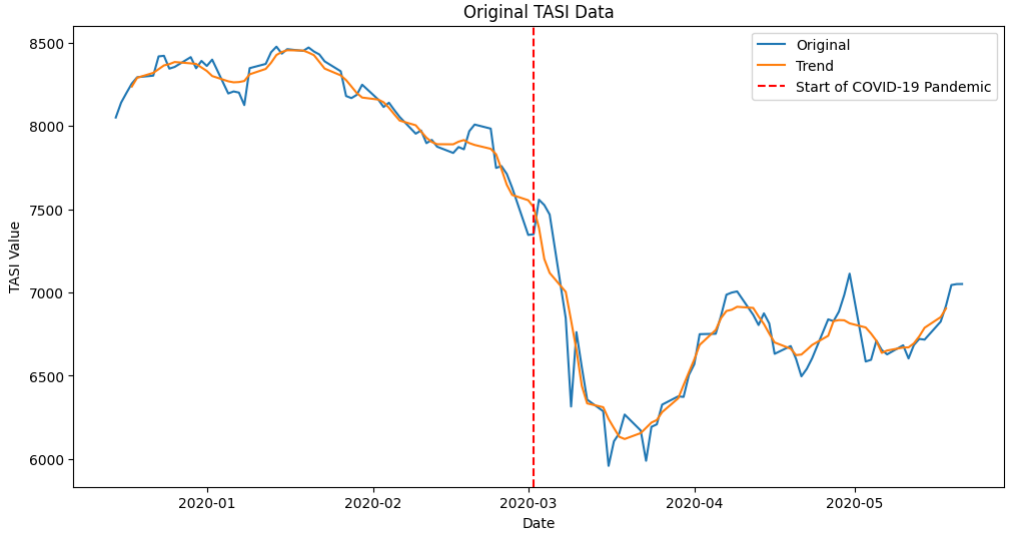

Figure 1. Original TASI Performance Trends Pre- and Post-COVID-19

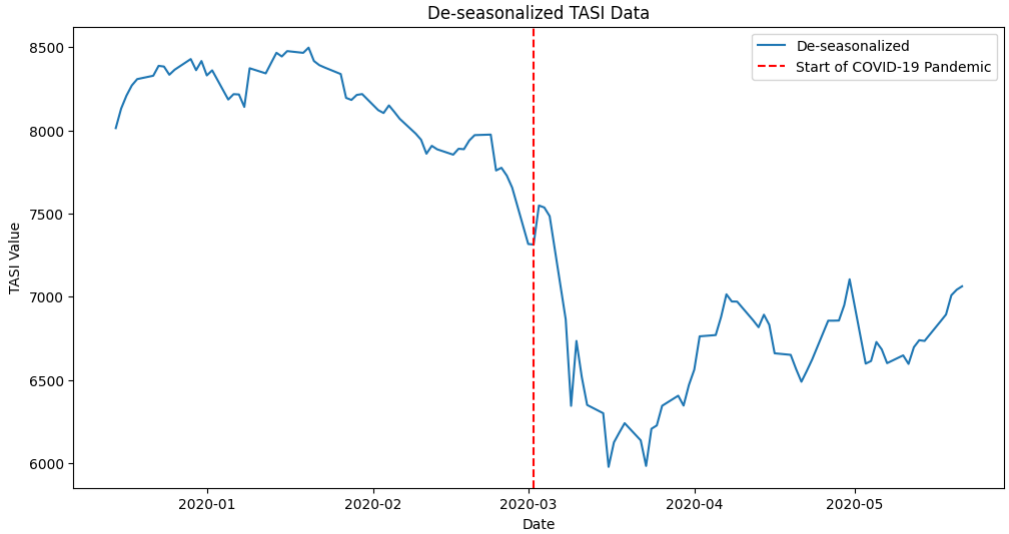

Figure 2. De-seasonalized TASI Performance Trends Pre- and Post-COVID-19

4.2 ARIMA Models for De-seasonalized Data

Based on the preliminary results of ACF and PACF tests to determine the differencing order and autoregressive term, we applied the ARIMA model to both pre- and post-COVID data sets. The pre-COVID data exhibited a Log Likelihood of -329.328, AIC of 666.657, and BIC of 674.758. On the other hand, the post-COVID data showed a Log Likelihood of -386.980, AIC of 781.960, and BIC of 790.270. These models resulted in the following distinct patterns for each phase: the pre-COVID data showed stability

and a strong autoregressive influence, whereas the post-COVID data revealed a lower constant value due to the pandemic's likely impact on TASI performance.

4.3 Two-Sample T-Test Results

Regarding the two-sample T-test, it revealed a T-statistic of 25.617 and a P-value of 7.01e-49. This result is statistically significant and underscored a pronounced difference in TASI levels between the pre- and post-COVID periods. The extremely low p-value provides an opportunity to decidedly reject the null hypothesis of no difference in means (Kim, 2015; Herzog, Francis, & Clarke, 2019). While the average rolling mean values were 8195.19 (pre-COVID) and 6633.62 (post-COVID), the average rolling standard deviations were 77.50 (pre-COVID) and 169.66 (post-COVID). Moreover, the Cohen's d value of 4.78 indicated a substantial effect size, an observation that highlights the significant divergence in TASI Close prices across the studied periods. The market dynamics are visually represented in Figure 3, where the Rolling Mean and Rolling Standard Deviation for the Pre-COVID and Post-COVID periods are depicted. These figures illustrate the market's shift in stability and volatility due to the tangible impact of the pandemic.

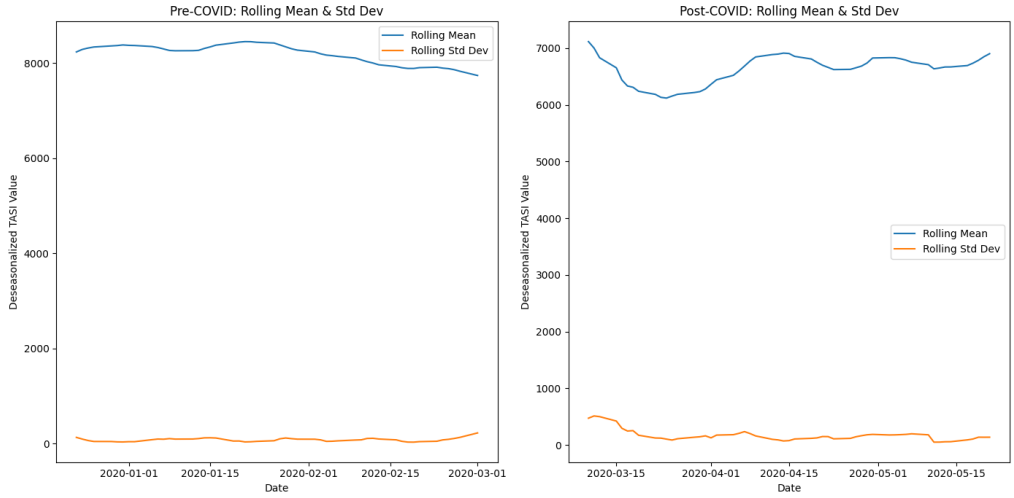

Figure 3. Rolling Statistics of Tadawul Stock Market Pre- and Post-COVID-19

4.4 Analysis of Market Dynamics

When considered together, the combination of employed statistical tests elucidates the Saudi Stock Market's dynamics during the pandemic as compared to the equal pre-pandemic period. In addition to observations listed in previous sections, a pronounced increase in the rolling standard deviation post-COVID (from 77.50 to 169.66) signifies heightened market volatility as it reflects investor uncertainty and reactivity to global events. As mentioned previously, the noticeable contrast in market conditions is quantitatively reflected by the two-sample t-test, characterized by a significant mean difference (T-statistic: 25.617; P-value: 7.01e-49) and a substantial effect size (Cohen's d: 4.78). In combination with ARIMA model findings, these results present a comprehensive

image of a market affected by unprecedented challenges due to the pandemic. The integrated overview of key statistical metrics pertaining to the Tadawul Stock Market's response to COVID-19 is summarized in Table 1.

Table 1. Comprehensive Statistical Analysis of Tadawul Stock Market Pre- and Post-COVID-19

Method	**Pre-COVID Period**	**Post-COVID Period**
Period Covered	13 Dec 2019 - 01 Mar 2020	02 Mar 2020 - 21 May 2020
Number of Observations	56	59
ARIMA Model Fit Metrics		
- Log Likelihood	-329.328	-386.980
- AIC	666.657	781.960
- BIC	674.758	790.270
Rolling Mean (7-day)	8195.19	6633.62
Rolling Std Dev (7-day)	77.50	169.66
T-Test for Mean Difference		
- T-Statistic	25.617	
- P-Value	7.01e-49	
Effect Size (Cohen's d)	4.78	
General Observations	Stable trend with strong AR influence	Lower constant value, indicating a decrease in TASI performance

5. Discussions and Findings

The findings of this study align with current literature, emphasizing the significant impact of major global events, such as the COVID-19 pandemic, on financial markets. Our analysis underscores the sudden shift in the Tadawul Stock Market's performance, a pattern that has also been observed in markets worldwide during the pandemic (Brodeur

et al., 2021; Maital and Barzani, 2020). Additionally, the marked decrease in TASI performance post-COVID, as evidenced by the ARIMA model results and the significant p-value from the t-test ($p < 0.05$), is consistent with global trends indicating pandemic-induced economic disruptions (Liu et al., 2020). The resulting fall in performance may be attributed to the influence of information regarding the impact of calamities on market operations (Khan et al., 2021). Consequently, investors turn pessimistic about the future outcomes, which are coupled by uncertainties. Thus, the outbreak of the COVID-19 pandemic resulted in a drop in the mean performance of shares in the Saudi Stock Exchange.

The results are also consistent with other research focusing on different regions and markets. According to Abiad et al., (2020), Akbulaev et al. (2020), and Liu et al. (2020), the emergence and spread of COVID-19 has influenced stock markets from various countries and regions adversely, thereby triggering massive economic losses. In regard to the short-term impacts highlighted in the work by Liu et al. (2020), they provide a useful comparison for our study's findings on TASI, where we observed significant changes in performance and volatility as an indication of a common pattern of market responses. Furthermore, the obtained results partially support the analysis of the influence of the spread of COVID-19 on stock markets of the countries that had registered the highest number of COVID-19 cases and deaths in the world (Chowdhury et al., 2022; Fernandez-Perez et al., 2021). Our analysis specifically indicates a substantial impact on the Saudi Stock Market (Tadawul), as evidenced by a marked decrease in the TASI performance post the COVID-19 outbreak. The average performance of the Saudi Stock Exchange before the confirmation of any COVID-19 case was significantly higher compared to the period following the outbreak. This drop in performance is statistically significant (P-value: 7.01e-49), supporting the hypothesis that the pandemic has negatively affected the market. According to a study by Alber (2020), the adverse influence of COVID-19 prevalence was notable in some states, including Germany, France, Spain, and China, but was not evident in others, such as the USA and Italy. Therefore, there is sufficient evidence to conclude that the outbreak of COVID-19 has had a detrimental impact on the stock markets across the globe.

6. Contributions of the Study

From another perspective, the study's utilization of a comprehensive quantitative approach, including de-seasonalization, ARIMA modeling, and statistical tests such as the two-sample t-test and Cohen's d calculation, adds to the existing body of research by providing a nuanced understanding of the pandemic's effects on a major Middle Eastern stock market. This methodological approach not only affirms the pandemic's immediate impacts but also highlights the heightened market volatility and investor sensitivity, reflecting global financial trends during this period (McKibbin & Fernando, 2020). Moreover, the research contributes to literature by showcasing the effectiveness of the employed analytical methods in researching complex market dynamics during unprecedented global events. The application of de-seasonalization and time-series analysis, frequently downplayed in current literature, offers new insights into the intricate patterns of market behavior in crisis conditions, thus enriching the theoretical understanding of stock market responses to global health emergencies.

7. Limitations of the Study

It is important to acknowledge the limitations of this study. While the focus has been primarily on the impact of the COVID-19 pandemic on Saudi Arabia's stock exchange, other external factors could also influence TASI performance to a varying degree. Among these confounding factors are global economic trends, oil prices, political events, and regional conflicts that concurrently affect both local and global market dynamics. Being limited to a specific timeframe, the study's scope may not accurately capture long-term market trends or delayed implications of the pandemic. In this context, future research could expand on these aspects to provide a more comprehensive understanding of the myriad of factors influencing TASI performance.

8. Conclusion

The COVID-19 pandemic remained a matter of concern across the globe for several years. In addition to having multiple detrimental impacts on entire economic sectors, the pandemic has considerably hurt the performance of stock markets across the world. Upon the confirmation of the first incident of COVID-19 in Saudi Arabia on 2nd March, 2020, the TASI index began to drop substantially. The notable decrease in TASI performance post-COVID-19, validated through ARIMA models, t-tests, and effect size calculations, aligns with global observations of market disruptions during major crises (Abiad et al., 2020; Akbulaev et al., 2020). The heightened market volatility and investor sensitivity, as reflected in the increased rolling standard deviation, are also consistent with trends seen in other international financial markets during similar periods of global uncertainty (Ahmad et al., 2020).

9. Implications of the Study

This study's comprehensive analysis of the Saudi Stock Market during the COVID-19 pandemic contributes to the existing body of financial literature. Emphasizing the critical impact of external shocks that are not inherently economic in their nature, our findings echo previous research on crisis-induced market behaviors (Rayburn et al., 2022). The application of advanced statistical techniques in this study not only demonstrates the immediate effects of COVID-19 but also offers a methodological framework for analyzing market responses to similar future events. Overall, the evidence confirms that adverse impacts of COVID-19 and other global shocks on stock markets are likely to result in long-term deteriorations of the economies worldwide. Based on the findings of this research, the institution of more stringent and well-informed measures for countering the crisis event and mitigating its effects is strongly recommended, alongside the adoption of various means of bolstering the economies. Furthermore, policymakers and stakeholders should focus on developing preventive strategies that would shield the economies from such disruptions, in case of any other similar incidents in the future.

10. Recommendations

Altogether, the research lays a foundation for furthering knowledge in this domain. To expand upon the knowledge foundation, future investigators are recommended to incorporate other potential influencers of market performance, such as political events or oil price fluctuations. Another possibility of examining influence on stock market performance by certain groups justifies future studies that would account for demographic aspects, such as education level, gender, the type of investor, and experience in the stock market. While new research could account for a longer timeframe to capture long-term market trends and delayed effects of global crises, the examination of other stock markets in similar contexts could offer valuable comparative insights.

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