Impact of COVID-19 on the Saudi stock market: analysis of return, volatility and trading volume

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Abstract
The aim of this study is to investigate the effect of the coronavirus health crisis (COVID-19) on the performance of the Saudi stock market, the Tadawul. Prices of the Tadawul All-Shares Index (TASI) and all sector indices are collected from December 2019 to end of July 2020. Analysis of the pandemic on the return and volatility is carried out using the GARCH (1, 1) model. The results show that the pandemic has a positive impact on the mean returns of all indices except for the REITS sector, but the impact is mostly insignificant. Analysis of the pandemic on the volatility shows that the TASI itself experienced lower volatility during the pandemic period but the impact is insignificant, while out of 21 sectors only 9 experienced significant impacts on volatility. Out of the 9 sectors, 5 experienced significantly increased volatility, while 4 experienced significantly lower volatility. Analysis of the impact of trading volume on the volatility shows stronger investor sentiment influencing volatility for the sectors that experienced higher volatility only. This study provides further understanding of how various market participants around the world react to the COVID-19 pandemic and the need for portfolio diversification to reduce risk during crisis periods.

Keywords COVID-19 · GARCH model · Volatility · Market returns · Sentiments

Introduction
Over the past two decades, an increasing number of studies have studied the impact of major world events, such as financial/economic crises, terrorist attacks and medical emergencies; on financial markets around the world. The most recent major event that has become the centre of many studies is the 2019 coronavirus health crisis, also known as COVID-19. The outbreak of this crisis was announced by the World Health Organization (WHO) on 31 December 2019. By 20 February 2020, the WHO declared COVID-19 as a global emergency which quickly turned into a pandemic by 11 March 2020 (Ali et al. 2020). Studies conducted on the impact of various negative events note that global stock markets react negatively to these events. Accordingly, studies on the impact of COVID-19 on financial markets around the world predicted and also found that stock markets in USA, Europe and Asia plunged dramatically as a result of this crisis. The US stock market is reported to have hit the circuit breaker four times in ten days in March 2020, while stock markets in the UK and Japan dropped by more than 10 and 20%, respectively (Zhang et al. 2020). Despite this, the global markets have been resilient and the stock price collapse of March had reversed as a result of investors’ expectations of a resumption of economic growth towards the end of the year (Kane 2020).

According to Phan and Narayan (2020), markets are a function of government. Markets overreact when governments overreact and correct themselves when governments correct their reactions. Most studies on the effect of the COVID-19 pandemic carried out so far focused on either the major stock markets or the stock markets in countries where the government’s response to the pandemic was found to be severely lacking. The studies have mostly concluded that the pandemic has a negative impact on the stock market, with respect to the returns, and that the volatility in the markets have increased. This study aims to investigate the impact of COVID-19 on the stock exchange in Saudi Arabia via its impact on both returns and volatility. Saudi Arabia is one of the countries that did not implement a total lockdown in the country, but the Saudi government handled the
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A review of literature on the effects of epidemics/panemics on financial markets around the world is discussed next, and this is followed by the discussion of the data collection process, description of the data and measurement of the variables. Analysis is then conducted on the stock price data for the TASI and the sectoral indices and a discussion of the results follow. The final section concludes this study.

**Literature review**

Efficient Market Hypothesis (EMH) states that stock prices follow a random walk and are unpredictable (Fama 1970). However, global events in the past have shown that stock markets react to major events (Al-Awadhi et al. 2020). Past studies have shown that news and information trends can...
predict stock returns and volatility (Salisu and Vo 2020). Some studies argue that only bad news affects investment decisions (Akinchi and Chahrouh 2018; Cohen et al. 2018; Svensson 1999), while others show that both good and bad news affect investment decisions (Narayan 2019). In the past 2 to 3 years, a substantial number of studies have investigated the effects of various major events, such as the disasters, acts of terrorism and political events; on stock market returns and volatility (Bash and Alsaff 2019; Carter and Simkins 2004; Chen and Siems 2004; Kollias et al. 2011; Papakyriakou et al. 2019). With the outbreak of several infectious diseases around the world such as the Severe Acute Respiratory Syndrome (SARS) (2003), Middle East Respiratory Syndrome (2012), Ebola (largest outbreak in 2013) and especially the current health crisis, the Coronavirus Disease (COVID-19), there is renewed interest among academics in understanding the effect of health crises on the financial markets. The outbreaks of these diseases have been shown to adversely affect the economy, and although it is expected that financial markets will be adversely affected as well, research on the effect of these diseases on financial markets has remained inconclusive. Chen et al. (2007) and Chen et al. (2018) find that the SARS outbreak had significantly weakened stocks in the Taiwanese hotel industry and the regional stock markets in the Asian region, respectively, but Nippani and Washer (2004) find that the SARS outbreak had negative impacts on the stock markets of China and Vietnam but not on the markets of 6 other seriously affected countries. In their study of the Ebola outbreak, Ichev and Marinic (2018, p. 153) find that the effect of the outbreak was not the same across all industries and stocks. Instead, the effect was stronger for “small and more volatile stocks, stocks of specific industry, and for the stocks exposed to the intense media coverage”. Almost all studies agree that the volatility of the stock markets increases after the event of the disease outbreak.

The current health crisis, COVID-19, has received intense media coverage with economists warning of a major economic crisis as a result of the crisis. The financial press often compares the COVID-19 crisis with the Global Financial Crisis of 2008. It is therefore not surprising that financial markets around the world experienced large drops in values (Ali et al. 2020; Erdem 2020; Mishra et al. 2020; Salisu and Vo 2020; Zhang et al. 2020). He et al. (2020) equate the crisis to terrorist attacks and label the crisis as a Black Swan event—an event which is unpredictable and causes shock, fear and panic among investors; however, according to Goodell (2020), COVID-19 is foreseeable due to the possibility of numerous past real-world epidemics and health crises having become global pandemics.

A number of studies have been carried out on the effect of COVID-19 on the financial markets around the world (Ali-Awadhi et al. 2020; Ali et al. 2020; Bai et al. 2020; Corbet et al. 2021; Erdem 2020; Gormsen et al. 2020; Haroon and Rizvi 2020; Ichev and Marine 2018; Liu et al. 2020; Ngwakwe 2020; Sharif et al. 2020; Phan and Narayan 2020; Salisu and Vo 2020; Zhang et al. 2020), and accordingly, these studies present mixed results in terms of the impact of the pandemic on financial market returns. Salisu and Vo (2020) and Erdem (2020) find statistically significant negative impact of the pandemic on stock market returns. Al-Awadhi et al. (2020) confirm that the pandemic had negative effects on stock returns of companies listed on the Hang Seng Index and the China Stock Index, while Mishra et al. (2020) find that the stock returns of all indices in the Indian stock exchange were negative during the COVID-19 outbreak. Ngwakwe (2020), however, finds that while the Dow Jones Industrial Average experienced a reduction in the mean stock value during the pandemic period, the Chinese Stock Exchange Composite Index actually experienced an increase in value. No significant difference in mean stock value was detected for the S&P500 and the Euronet 100 indices. He et al. (2020) confirm that although the stock markets of China and other Asian countries experienced negative effects of the crisis in the early stages of the epidemic, the impact was limited and that COVID-19 had a negative impact on the stock markets in USA and Europe. Similarly, Ali et al. (2020) show that returns were lower in China in both the epidemic and pandemic period compared to that of stock markets in bigger economies such as the USA and the UK.

The studies which investigate the impact on volatility unanimously agree that stock market volatility is increased during the pandemic period, i.e. it is a source of systematic risk (Sharif et al. 2020). Bai et al. (2020) find statistically significant positive impacts on the volatility of international stock markets. Ali et al. (2020) also find that volatility had increased from the epidemic to the pandemic period but the increase was greater in the USA, UK and European indices. They also find that gold experienced the least volatility. Corbet et al. (2021) find greater volatility in the cryptocurrency market. Zhang et al. (2020) confirm that the pandemic has caused global financial market risks to increase substantially due to the uncertainty of the pandemic and the economic losses associated with it but that the stock market reactions to the pandemic depend on the severity of the outbreak in the country. According to Phan and Narayan (2020), financial market’s reaction to the pandemic depends very much on the government’s reaction to the pandemic and its actions in dealing with it. When governments over-react, so do markets.

Prior studies have shown that changes in the conditional volatility of financial markets are influenced by changes in investor sentiment. Lee et al. (2002) find that financial market’s conditional volatility is negatively correlated with the changes in investor sentiment, implying that when
Investor sentiment is negative, volatility increases. Uygur and Tas (2012) and Uygur and Tas (2014) confirm this through their finding that investor sentiment positively influences conditional volatility of financial markets during high sentiment periods but the influence is negative during low sentiment periods. The reason for this relationship between investor sentiment and conditional volatility is the participation of noise traders. However, Verma and Verma (2006) find that positive sentiments have greater effects on stock market volatility compared to negative sentiments and that individuals rather than institutions have greater effects on stock returns. Baker and Wurgler (2007, p. 129) specify that while sentiments do affect stock returns, it is stocks of “low capitalization, younger, unprofitable, high volatility, non-dividend paying, growth companies, or stocks of firms in financial distress” that are more susceptible to investor sentiment.

**Data and measurement of variables**

In this study, the impact of the COVID-19 pandemic on the return and volatility of the Saudi stock exchange, the Tadawul, is studied. The Tadawul is the biggest stock market in the MENA region, representing 76% of the total market capitalization, and the third largest emerging market in the world. It is also the most liquid stock market in the MENA region, and it still enjoyed high levels of liquidity despite the COVID-19 crisis. It was upgraded to the status of an ‘Emerging Market’ by the MSCI in July 2019 and the initial public offering (IPO) of Saudi Aramco at the end of 2019 propelled it into the big league where it became one of the top global markets in the world (Fahy 2020).

Daily prices of the TASI and the 21 sectoral indices (energy; materials; capital goods; and professional services; transportation; consumer durables and apparel; consumer services; media and entertainment; retailing; food and staples retailing; food and beverages; healthcare equipment and services; pharma, biotech and life sciences; banks; diversified financials; insurance; software and services; telecommunication services; utilities; REITs; and Real Estate Management and Development) are collected for a 7-month period between 31 December 2019 and 28 July 2020 from the official website of the Tadawul stock exchange (www.tadawul.com.sa). Data are collected from 31 December 2019 as this was the date when the World Health Organization (WHO) was first notified of the cases of the ‘viral pneumonia’ in Wuhan, China, although it was only on 5 January 2020 that WHO issued its first disease outbreak news report. July 2020 is considered as the end of the sample period as the number of new cases had started declining by around the first week of July 2020.

The daily returns, \( R_t \), are calculated from the daily prices:

\[
R_t = \ln \left( \frac{P_t}{P_{t-1}} \right)
\]  

(1)

where \( P_t \) and \( P_{t-1} \) are the prices of the index at time \( t \) and \( t-1 \), respectively. For each index, the total of 145 prices are observed. The returns series are presented in graphical format in Fig. 2.

The graphs in Fig. 2 show that all the return series exhibit spikes of high and low returns at various points although some sectors exhibit greater volatility than others. Descriptive statistics for the daily returns of both the TASI and the sectoral indices are reported in Table 1.

The mean values show a negative returns for the TASI index (%0.08%) and most of the sectoral index returns except for consumer durable and apparel (0.03%), food and staples retailing (0.25%), food and beverages (0.14%), healthcare equipment and services (0.15%), pharma, biotech and life sciences (0.10%), diversified financials (0.00%), insurance (0.08%) and software and services (0.37%). The software and services; pharma, biotech and life sciences; and the media and entertainment sectors are the sectors with some of the highest returns (maximum values of 9.42, 9.52 and 9.46%, respectively) and the lowest returns (minimum values of −10.54, −10.22 and 10.43%, respectively). Accordingly, these sectors have some of the highest volatility of returns. The standard deviation values for all the indices are between 1 and 3% with the standard deviation of the TASI index being 1.83%. The standard deviation is the lowest for the REITs sector, while it is the highest for the software and services sector. The returns data series for the TASI index and all the sectoral indices, except for the telecommunications and services sector, are negatively skewed. The kurtosis values for all the returns series are greater than three; hence, a fat-tailed distribution is observed. Similarly, the Jarque–Bera statistics for the TASI and all the sectoral indices are greater than 69 indicating that all the data series are not normally distributed. The Ljung–Box test statistics for serial correlation of the returns series, Q(36), for the TASI and the sectoral indices indicates the absence of autocorrelation implying the independency of the current stock return on the prior stock returns. The significant values of the ARCH-LM test statistics for the TASI and the sectoral indices, except for the food and staples retail sector and the utilities sector, indicate the presence of heteroscedasticity (constant variance) in the return series. Therefore, the datasets suffer from the problem of heteroscedasticity but not from autocorrelation.

The mean return, mean volume and standard deviation (volatility) are calculated for the TASI and the sectoral indices for the period before the first case of COVID-19 was reported in Saudi Arabia and the period after. The first case of COVID-19 in Saudi Arabia was reported on 3 March.
2020. A dummy variable (COVID) is constructed whereby the value of ‘0’ is assigned to the variable for the period 31 December 2019 to 2 March 2020. From 3 March 2020 to 28 July 2020, the dummy variable assumes a value ‘1’. The significance of the difference in mean return and mean volume for the two periods is also tested using the 2-sample nonparametric Mann–Whitney test. The results are presented in Table 2.

The mean returns for the TASI and all the sectoral indices are found to be higher during the pandemic period in Saudi Arabia (i.e. 2 March onwards) than before the pandemic. The difference in the mean returns is highly significant for the TASI and only some of the sectoral indices (energy, materials, capital goods, food and beverages, telecommunication services and utilities). Similarly, the mean volume is higher during the pandemic period compared to before the period for the TASI and all the sectoral indices, except for the energy and the REITS sector. Trading volume is viewed as a measure of investor sentiment (Uygur and Tas 2014). In most of the cases, the difference in mean volume is found to be highly significant. Higher volume means greater trading taking place and with returns being higher, this indicates more buy trades compared to sell trades. Therefore, it can be concluded that traders on the Tadawul stock exchange were more active in buying stocks during the pandemic period. According to Uygur and Tas (2012), investor sentiment has a significant positive effect on the conditional volatility of the stock markets during high sentiment periods. Accordingly, it is found that the volatility of returns is also higher during the pandemic period. Since volatility is calculated as the standard deviation of stock returns, there is only one value before and during the pandemic period and so, significance of the difference could not be assessed.

The Augmented Dickey–Fuller (ADF) test is used to test the stationarity of the data series in two forms—i.e. the test with intercept only and the test with trend and intercept. The results of the test conducted on the returns data series for TASI and the sectoral indices are reported in Table 3. The results indicate that the returns series for the TASI and the sectoral indices are stationary as the null hypothesis of a unit root can be rejected at the 1% level of significance. The data can thus be used for further analysis without the need for any transformation.

Next, the Wald–Wolfowitz Runs test (Wald and Wolfowitz 1940) test is applied out to assess whether the returns of the TASI index and the sectoral indices follow a random walk. The results in Table 4 show that in most cases...
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(Except for TASI, transportation, food and staples retailing, food and beverages, diversified financials and insurance), the null hypothesis of a random walk cannot be rejected at the 1% level.

Methodology and data analysis

The constant variance and normality assumptions of the ordinary least squares (OLS) regression technique are violated; hence, the OLS technique cannot be used as is. Alternate methods correcting for heteroscedasticity should be used to test the impact of COVID-19 on returns. However, for testing the effect on the volatility, the ARMA $(p, q)$-GARCH $(1, 1)$ model is used, whereby

$$R_t = \eta + \lambda_t D_{COVID}$$

where

$$\varepsilon_t | \Omega_{t-1} \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \theta_t D_{COVID}$$

The conditional variance $\sigma_t^2$ in equation (3) is modelled as a linear function of the last period’s squared errors (the ARCH term) and its own lagged-one conditional variance (the GARCH term); $\alpha_0$ is the constant intercept term, while the estimated parameters are represented by $\alpha_1$ and $\beta_1$ which capture the presence of heteroskedasticity in daily index return series. The COVID-19 period is represented by a dummy variable, $D_{COVID}$, which takes on the value of 1 if the day falls in the COVID-19 period and 0 otherwise.

Table 1 Descriptive statistics

|            | Mean  | Max  | Min  | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Q(36) stats | LM-test stats |
|------------|-------|------|------|-----------|----------|----------|-------------|-------------|---------------|
| TASI       | -0.08%| 6.83%| -8.69%| 1.83%     | -1.5507  | 10.8689  | 432.2077    | 38.268      | 32.194        |
| ENERGY     | -0.05%| 9.24%| -9.16%| 1.69%     | -0.2784  | 14.9459  | 864.0403    | 32.799      | 14.745        |
| MATERIALS  | -0.07%| 7.04%| -9.28%| 2.12%     | -1.3206  | 8.9497   | 256.0187    | 34.145      | 27.027        |
| CAP_GOODS  | -0.03%| 6.34%| -10.06%| 2.26%     | -1.8884  | 9.4941   | 340.9718    | 24.801      | 24.945        |
| COMM_PROD_SERVCS | -0.13%| 7.74%| -9.80%| 2.11%     | -1.4087  | 10.5372  | 391.1816    | 43.56       | 29.323        |
| TRANSPORTATION | -0.08%| 6.59%| -10.51%| 2.42%     | -1.5693  | 8.3177   | 230.3643    | 50.719      | 20.964        |
| CONS_DURABLES | 0.03% | 7.44%| -8.08%| 2.10%     | -0.9282  | 7.4925   | 142.7579    | 35.396      | 26.103        |
| CONS_SERVICES | -0.08%| 6.39%| -9.96%| 2.35%     | -1.5115  | 7.9974   | 206.0978    | 37.118      | 24.570        |
| MEDIA_ENTERTN | -0.18%| 9.46%| -10.43%| 2.70%     | -0.5726  | 6.1955   | 69.6155     | 37.856      | 45.940        |
| RETAILING  | -0.07%| 7.64%| -7.48%| 2.24%     | -0.6448  | 6.7537   | 95.1767     | 32.983      | 15.467        |
| FOOD_STAPLE_RET | 0.25% | 8.40%| -9.93%| 2.36%     | -0.2584  | 7.3667   | 116.8159    | 49.976      | 0.606         |
| FOOD_BEVERAGES | 0.14% | 8.71%| -8.37%| 1.87%     | -0.7757  | 10.4644  | 351.1677    | 41.498      | 42.563        |
| HEALTH_EQNSERV | 0.15% | 7.98%| -8.29%| 2.07%     | -0.3778  | 7.5840   | 130.4014    | 31.767      | 8.568         |
| PHARMA_BIOTECH | 0.10% | 9.52%| -10.22%| 2.32%     | -0.2493  | 10.1638  | 311.5600    | 35.503      | 14.124        |
| BANKS      | -0.15%| 5.62%| -9.36%| 2.00%     | -1.6790  | 9.7829   | 346.0971    | 42.828      | 25.214        |
| DIVERS_FINANCIALS | 0.00% | 7.10%| -9.52%| 1.99%     | -1.7019  | 10.9036  | 447.4030    | 27.028      | 17.145        |
| INSURANCE  | 0.08% | 6.87%| -8.79%| 2.03%     | -1.0369  | 8.8365   | 231.7874    | 34.56       | 16.489        |
| SOFTWARE_SERVCS | 0.37% | 9.42%| -10.54%| 2.93%     | -0.6071  | 6.2281   | 71.8655     | 44.398      | 12.293        |
| TELECOM_SERVCS | -0.01%| 7.57%| -6.39%| 1.66%     | 0.0010   | 8.2024   | 163.5193    | 56.344      | 34.266        |
| UTILITIES  | -0.16%| 5.76%| -7.64%| 1.83%     | -0.4522  | 6.3692   | 73.5238     | 63.877      | 1.919         |
| REITS      | -0.07%| 3.47%| -4.93%| 1.17%     | -1.4515  | 7.8967   | 195.7790    | 26.491      | 31.414        |
| REITS_MAN_DEV | -0.11%| 8.03%| -9.71%| 2.13%     | -1.3078  | 9.2932   | 280.6107    | 33.658      | 27.232        |
Table 2 Comparison of Mean returns, mean volume and standard deviation

| Sector                                      | Before                  | During                  | Mann–Whitney test stats | Before                  | During                  | Mann–Whitney test stats |
|---------------------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| TASI                                        |                         |                         |                         | Food and beverages      |                         |                         |
| Mean return                                 | −0.3008%                | 0.0147%                 | 0.019                   | −0.1565%                | 0.2677%                 | 0.034                   |
| Mean volume                                 | 160,800,294             | 270,652,882             | 0                       | 6,728,233               | 11,930,594              | 0                       |
| Volatility                                  | 1.07%                   | 2.07%                   |                         | 1.03%                   | 2.12%                   |                         |
| Energy                                      |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.2153%                | 0.0167%                 | 0.046                   | −0.0369%                | 0.2253%                 | 0.428                   |
| Mean volume                                 | 14,364,599              | 13,824,905              | 0.111                   | 2,397,064               | 4,246,943               | 0                       |
| Volatility                                  | 0.85%                   | 1.95%                   |                         | 1.28%                   |                         | 2.34%                   |
| Materials                                   |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.4187%                | 0.0848%                 | 0.004                   | 0.0331%                 | 0.1243%                 | 0.396                   |
| Mean volume                                 | 34,795,049              | 69,517,631              | 0                       | 112,734                 | 396,996                 | 0                       |
| Volatility                                  | 1.33%                   | 2.38%                   |                         | 1.14%                   |                         | 2.68%                   |
| Capital goods                               |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.1733%                | 0.0265%                 | 0.047                   | −0.3166%                | 0.0845%                 | 0.093                   |
| Mean volume                                 | 6,090,359               | 8,476,612               | 0.111                   | 27,819,218              | 46,793,060              | 0                       |
| Volatility                                  | 1.35%                   | 2.56%                   |                         | 1.22%                   |                         | 2.26%                   |
| Commercial and professional services        |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.3730%                | −0.0236%                | 0.025                   | −0.0940%                | 0.0350%                 | 0.248                   |
| Mean volume                                 | 1,109,395               | 1,650,770               | 0                       | 3,190,869               | 3,243,190               | 0.321                   |
| Volatility                                  | 1.36%                   | 2.36%                   |                         | 1.46%                   |                         | 2.18%                   |
| Transportation                              |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.2334%                | −0.0065%                | 0.173                   | −0.2169%                | 0.2092%                 | 0.066                   |
| Mean volume                                 | 3,309,995               | 5,038,090               | 0                       | 14,957,621              | 23,658,662              | 0                       |
| Volatility                                  | 1.61%                   | 2.71%                   |                         | 1.22%                   |                         | 2.28%                   |
| Consumer durables and apparels              |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.1617%                | 0.1136%                 | 0.393                   | 0.3503%                 | 0.3768%                 | 0.653                   |
| Mean volume                                 | 3,756,795               | 4,221,300               | 0.897                   | 317,069                 | 2,153,340               | 0                       |
| Volatility                                  | 1.54%                   | 2.30%                   |                         | 2.47%                   |                         | 3.13%                   |
| Consumer services                           |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.1602%                | −0.0385%                | 0.443                   | −0.4799%                | 0.1922%                 | 0.004                   |
| Mean volume                                 | 5,176,784               | 15,311,785              | 0                       | 6,312,796               | 8,564,506               | 0                       |
| Volatility                                  | 1.59%                   | 2.63%                   |                         | 1.29%                   |                         | 1.76%                   |
| Media and entertainment                     |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.3562%                | −0.1013%                | 0.404                   | −0.4626%                | −0.0334%                | 0.05                    |
| Mean volume                                 | 636,267                 | 921,725                 | 0.115                   | 1,160,484               | 2,497,279               | 0                       |
| Volatility                                  | 2.06%                   | 2.94%                   |                         | 1.29%                   |                         | 2.01%                   |
| Retailing                                   |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.1206%                | −0.0493%                | 0.308                   | −0.0715%                | −0.0655%                | 0.489                   |
| Mean volume                                 | 2,699,196               | 6,052,387               | 0                       | 5,691,226               | 5,044,864               | 0.072                   |
| Volatility                                  | 1.07%                   | 2.60%                   |                         | 0.74%                   |                         | 1.31%                   |
| Food and staples retailing                  |                         |                         |                         |                         |                         |                         |
| Mean return                                 | −0.0050%                | 0.3662%                 | 0.3                     | −0.1142%                | −0.1098%                | 0.618                   |
| Mean volume                                 | 499,352                 | 1,600,528               | 0                       | 19,916,806              | 35,709,059              | 0                       |
| Volatility                                  | 1.61%                   | 2.62%                   |                         | 1.46%                   |                         | 2.37%                   |
Table 3 Unit root test

| Series                   | ADF test (with intercept only) | ADF test (with trend and intercept) |
|--------------------------|---------------------------------|-------------------------------------|
|                          | \(t\)-Stat | Prob. | \(t\)-Stat | Prob. |
| TASI                     | -11.645 0 | -11.74 0 | -11.745 0 | -11.75 0 |
| ENERGY                   | -10.985 0 | -11.115 0 | -10.985 0 | -11.011 0 |
| MATERIALS                | -11.388 0 | -11.501 0 | -11.388 0 | -11.485 0 |
| CAP_GOODS                | -10.882 0 | -11.013 0 | -10.882 0 | -11.021 0 |
| COMM_PROD_SERVCS        | -10.542 0 | -10.675 0 | -10.542 0 | -10.681 0 |
| TRANSPORTATION           | -3.5421 0.0082 | -3.627 0.0311 | -3.5421 0.0082 | -3.627 0.0311 |
| CONS_DURABLES            | -12.877 0 | -12.992 0 | -12.877 0 | -12.992 0 |
| CONS_SERVICES            | -11.153 0 | -11.201 0 | -11.153 0 | -11.201 0 |
| MEDIA_ENTERTN           | -13.588 0 | -13.586 0 | -13.588 0 | -13.586 0 |
| RETAILING                | -11.879 0 | -11.916 0 | -11.879 0 | -11.916 0 |
| FOOD_STAPLE_RET         | -10.101 0 | -10.081 0 | -10.101 0 | -10.081 0 |
| FOOD_BEVERAGES          | -11.284 0 | -11.3 0 | -11.284 0 | -11.3 0 |
| HEALTH_EQNSERV          | -12.868 0 | -13.109 0 | -12.868 0 | -13.109 0 |
| PHARMA_BIOTECH          | -10.574 0 | -10.571 0 | -10.574 0 | -10.571 0 |
| BANKS                    | -11.219 0 | -11.287 0 | -11.219 0 | -11.287 0 |
| DIVERS_FINANCIALS       | -11.726 0 | -11.754 0 | -11.726 0 | -11.754 0 |
| INSURANCE                | -11.429 0 | -11.536 0 | -11.429 0 | -11.536 0 |
| SOFTWARE_SERVCS         | -10.831 0 | -10.887 0 | -10.831 0 | -10.887 0 |
| TELECOM_SERVCS          | -12.02 0 | -12.093 0 | -12.02 0 | -12.093 0 |
| UTILITIES               | -12.301 0 | -12.313 0 | -12.301 0 | -12.313 0 |
| REITS                    | -11.866 0 | -11.9 0 | -11.866 0 | -11.9 0 |
| REITS_MAN_DEV           | -9.7173 0 | -9.7902 0 | -9.7173 0 | -9.7902 0 |

Table 5 presents the estimates of the GARCH (1, 1) model for the TASI and sectoral indices. The estimates of the mean equation are reported in Panel A, while the estimates of the conditional variance equation modelled as a GARCH process are reported in Panel B. Panel C reports the goodness-of-fit statistics using the Akaike Information Criteria (AIC) and the Schwarz Information Criteria (SIC).

The results in Panel A show that the returns of the TASI and all the sectors indices (except for the REITs sector) are positively affected by the COVID-19 pandemic. However, only the returns of the TASI and the TELECOM_SERVCS sector are significantly affected by the pandemic although the significance level is weak at the 10% level. The rest of the sectors are not significantly affected by the pandemic.

In terms of volatility, the results in Panel B show that the COVID-19 pandemic has an insignificant negative effect on the volatility of the TASI. For the sectoral indices, the impact is mixed, i.e. some sectors are significantly affected but some are not and the impact is positive in some sectors but negative in some. Among the sectors that have experienced significant increase in volatility are the ENERGY (1%), FOOD_STAPLE_RET (10%), FOOD_BEVERAGES (5%), HEALTH_EQNSERV (5%) and PHARMA_BIO-TECH (1%) sectors, while those that experienced significant decrease in volatility are the MATERIALS (5%), BANKS (10%), TELECOM_SERVCS (10%) and UTILITIES (5%) sectors.

Further analysis is carried out on the TASI and the sectoral indices identified in the previous analysis (ENERGY, FOOD_STAPLE_RET, FOOD_BEVERAGES, HEALTH_EQNSERV, PHARMA_BIOTECH, MATERIALS, BANKS, TELECOM_SERVCS and UTILITIES) to observe whether there is any difference in the effect of investor sentiment (as proxied via trading volume) on the volatility during the COVID-19 pandemic period. The GARCH (1, 1) model is used for this analysis with the following returns and volatility equations:

\[ R_t = c + \varepsilon_t \]  
\[ \sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \theta_1 \Delta \text{Sent}_{t-1} \]

where \( \Delta \text{Sent}_{t-1} \) represents the change in investor sentiment, proxied by the change in trading volume. The analysis is conducted on the entire period and also only on the COVID-19 period. The results of the analysis are presented in Table 6.

The results in Table 6 show that investor sentiment has a positive impact on the volatility of the various sectors except for the TASI, FOOD_BEVERAGES and MATERIALS sectors where volatility decreased as a result of increased investor sentiment. In addition, a clear difference is observed between the sectors that experienced an increase in volatility during the COVID-19 period and those that experienced a decrease in volatility (from Table 5). For the sectoral indices that experienced significant increase in volatility during the pandemic period (see Table 5), ENERGY, FOOD_STAPLE_RET, FOOD_BEVERAGES, HEALTH_EQNSERV and PHARMA_BIO-TECH exhibit stronger effect of investor sentiment on the volatility, i.e. the coefficient for \( \Delta \text{Sent}_{t-1} \) is larger during the COVID-19 period compared to the overall period. Additionally, the effect is found to be highly significant (at the 1% level) for all the sectors. On the other hand, the impact of investor sentiment on the volatility is found to be weaker (with lower coefficient value of \( \Delta \text{Sent}_{t-1} \)) for the sectors that experienced a significant decrease in volatility (see Table 5). Aside from the effect being weaker, it also found that investor sentiment does not have any significant effect on the volatility of returns in these sectors during the pandemic period. An exception is the TASI which experienced a decrease in volatility during the pandemic period but the decrease was insignificant (see Table 5). In this case, investor sentiment has a highly significant impact on the volatility of the TASI index during the entire period and also during the COVID period. As per those sectors that experienced decrease in volatility, the impact...
of investor sentiment on the volatility of the TASI is found to be weaker (in terms of coefficient value) on the volatility of the returns of TASI.

**Discussion of results**

Analysis of the mean returns of the TASI and the sectoral indices indicates higher values during the COVID-19 pandemic than before the period. Stock returns being higher during the pandemic period in Saudi confirms the findings of Ngakwe et al. (2020) for the Chinese stock markets and contradicts the findings of previous studies which found negative returns in various stock markets during the pandemic period (Al-Awadhi et al. 2020; Mishra et al. 2020; Salisu and Vo 2020; Erdem 2020). However, it is also noted that the difference in the means of the two periods is mostly found to be insignificant. Further investigation using the GARCH (1, 1) model confirms that while mean returns are higher during the COVID-19 period but that the pandemic did not have a significant impact on the returns of the TASI or the sectoral indices.

On the other hand, the descriptive statistics shows that consistent with previous studies (Ali et al. 2020; Bai et al. 2020; Corbet et al. 2021; Sharif et al 2020; Zhang et al. 2020), volatility is found to be higher during the pandemic period. The pandemic has increased uncertainty, and therefore, global financial market risks have increased (Zhang et al. 2020). Further investigation using the GARCH (1, 1) model indicates that the increase in volatility is only evident in some sectors. The sectors affected are some of the largest sectors in the Saudi stock market. The materials and financial sector represent the largest part of the market, followed by the Telecommunications, consumer staples and utilities sector¹. The sectors that have experienced increased volatility as a result of the pandemic are as expected as these sectors are the ones most affected by the pandemic. The energy sector was severely affected by the pandemic due to lockdowns around the globe, coupled with the oil price war between Saudi Arabia and Russia. The pandemic being a health-related issue did cause a significant increase in the volatility of the health related sectors, as these sectors are crucial to the proper handling of the crisis. Volatility was also increased in the food sector (Food and Beverages; and Food and Staples Retailing) due to the uncertainty about

| Table 4 Runs Test |
|-------------------|
| **Series** | **Returns>Mean** | **Returns<Mean** | **Total no of runs** | **Expected runs Z-value** |
| TASI | 85 | 60 | 61 | 71.345 | −1.777*** |
| ENERGY | 72 | 73 | 69 | 73.497 | −0.749 |
| MATERIALS | 82 | 63 | 67 | 72.255 | −0.891 |
| CAP_GOODS | 88 | 57 | 67 | 70.186 | −0.557 |
| COMM_PROD_SERVCS | 81 | 64 | 63 | 72.503 | −1.606* |
| TRANSPORTATION | 82 | 63 | 62 | 72.255 | −1.739*** |
| CONS_DURABLES | 81 | 64 | 76 | 72.503 | 0.723 |
| CONS_SERVICES | 87 | 58 | 70 | 70.6 | 0.459 |
| MEDIA_ENTERTN | 83 | 62 | 73 | 71.979 | 0.174 |
| RETAILING | 79 | 66 | 67 | 72.917 | −0.994 |
| FOOD_STAPLE_RET | 68 | 77 | 63 | 73.221 | −1.710*** |
| FOOD_BEVERAGES | 78 | 67 | 63 | 73.083 | −1.690*** |
| HEALTH_EQNSERV | 78 | 67 | 72 | 73.083 | −0.182 |
| PHARMA_BIOTECH | 75 | 70 | 74 | 73.414 | 0.098 |
| BANKS | 80 | 65 | 67 | 72.724 | −0.964 |
| DIVERS_FINANCIALS | 87 | 58 | 61 | 70.6 | −1.667*** |
| INSURANCE | 75 | 70 | 63 | 73.414 | −1.738*** |
| SOFTWARE_SERVCS | 68 | 77 | 69 | 73.221 | −0.706 |
| TELECOM_SERVCS | 70 | 75 | 69 | 73.414 | −0.737 |
| UTILITIES | 78 | 67 | 72 | 73.083 | −0.182 |
| REITS | 78 | 67 | 67 | 73.083 | −1.020 |
| REITS_MAN_DEV | 83 | 62 | 60 | 71.979 | −2.040*** |

*indicates significance at 10%  
**indicates significance at 5% levels, respectively

¹ Tadawul Listing Guide 2019
the food supply as a result of the disruptions in the supply chain due to lockdowns, especially since Saudi Arabia is a net importer of agri-food and seafood products and it imports nearly 80% of its food requirements (Taha 2014). On the other hand, some sectoral indices (materials, banks, telecommunication services and utilities) experienced

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Table 5  Estimates of the GARCH (1, 1) models for the TASI and sectoral Indices

| Panel A: Mean equation | Panel B: Conditional variance equation | Panel C: Goodness of fit |
|------------------------|---------------------------------------|-------------------------|
| \( c \) | \( D_{\text{COVID}} \) | \( a_0 \) | \( a_1 \) (ARCH) | \( \beta_1 \) (GARCH) | \( D_{\text{COVID}} \) | AIC | SIC |
|---|---|---|---|---|---|---|---|
| TASI | \(-0.0025^*\) | \(0.0028\) | \(9.67 \times 10^{-6}\) | \(0.3255^*\) | \(0.7549^*\) | \(-1.06 \times 10^{-5}\) | \(-5.736\) | \(-5.613\) |
| ENERGY | \(-0.0024^{**}\) | \(0.0038\) | \(5.87 \times 10^{-5}\) | \(0.4209^*\) | \(0.0174\) | \(0.00014^*\) | \(-5.653\) | \(-5.530\) |
| MATERIALS | \(-0.0029^*\) | \(0.0038\) | \(1.47 \times 10^{-5}\) | \(0.2169^*\) | \(0.804^*\) | \(-1.41 \times 10^{-5}\) | \(-5.293\) | \(-5.170\) |
| CAP_GOODS | \(-0.0005\) | \(0.0019\) | \(2.01 \times 10^{-5}\) | \(0.3312^*\) | \(0.702^*\) | \(-2.50 \times 10^{-6}\) | \(-5.048\) | \(-4.925\) |
| COMM_PROD_SERVCS | \(-0.0008\) | \(0.0019\) | \(8.80 \times 10^{-6}\) | \(0.1730^*\) | \(0.849^*\) | \(-5.28 \times 10^{-6}\) | \(-5.099\) | \(-4.976\) |
| TRANSPORTATION | \(-0.0004\) | \(0.0018\) | \(1.85 \times 10^{-5}\) | \(0.3184^*\) | \(0.732^*\) | \(-1.06 \times 10^{-6}\) | \(-4.996\) | \(-4.873\) |
| CONS_DURABLES | \(-0.0006\) | \(0.0028\) | \(2.22 \times 10^{-5}\) | \(0.2597^*\) | \(0.747^*\) | \(-9.52 \times 10^{-6}\) | \(-5.169\) | \(-5.046\) |
| CONS_SERVICES | \(-0.0005\) | \(0.0019\) | \(5.39 \times 10^{-6}\) | \(0.3154^*\) | \(0.745^*\) | \(2.86 \times 10^{-6}\) | \(-5.011\) | \(-4.888\) |
| MEDIA_ENTERTN | \(-0.0036\) | \(0.0016\) | \(5.44 \times 10^{-6}\) | \(0.2299^*\) | \(0.629^*\) | \(5.03 \times 10^{-5}\) | \(-4.570\) | \(-4.447\) |
| RETAILING | \(-0.0010\) | \(0.0024\) | \(5.45 \times 10^{-6}\) | \(0.2422^*\) | \(0.790^*\) | \(1.65 \times 10^{-7}\) | \(-5.205\) | \(-5.082\) |
| FOOD_STAPLE_RET | \(-0.0017\) | \(0.0019\) | \(1.24 \times 10^{-5}\) | \(0.3054^*\) | \(0.699^*\) | \(3.54 \times 10^{-5}\) | \(-4.795\) | \(-4.672\) |
| FOOD_BEVERAGES | \(-0.0015\) | \(0.0035\) | \(3.60 \times 10^{-5}\) | \(0.2020^*\) | \(0.557^*\) | \(5.50 \times 10^{-5}\) | \(-5.411\) | \(-5.288\) |
| HEALTH_EQNSERV | \(-4.56 \times 10^{-6}\) | \(0.0013\) | \(2.44 \times 10^{-5}\) | \(0.3399^*\) | \(0.587^*\) | \(4.86 \times 10^{-6}\) | \(-5.116\) | \(-4.992\) |
| PHARMA_BIOTECH | \(-0.0008\) | \(0.0004\) | \(0.0002^*\) | \(0.1337\) | \(-0.351\) | \(0.0006^*\) | \(-4.922\) | \(-4.798\) |
| BANKS | \(-0.0021\) | \(0.0027\) | \(1.75 \times 10^{-5}\) | \(0.2684^*\) | \(0.777^*\) | \(-1.85 \times 10^{-5}\) | \(-5.408\) | \(-5.285\) |
| DIVERS_FINANCIALS | \(-0.0005\) | \(0.0017\) | \(8.56 \times 10^{-5}\) | \(0.1845\) | \(0.726^*\) | \(9.19 \times 10^{-6}\) | \(-5.136\) | \(-5.013\) |
| INSURANCE | \(-0.0015\) | \(0.0017\) | \(1.47 \times 10^{-5}\) | \(0.4022^*\) | \(0.708^*\) | \(-1.13 \times 10^{-5}\) | \(-5.264\) | \(-5.141\) |
| SOFTWARE_SERVCS | \(-0.0005\) | \(0.0031\) | \(0.0001\) | \(0.6138\) | \(0.636^*\) | \(5.85 \times 10^{-5}\) | \(-4.546\) | \(-4.402\) |
| TELECOM_SERVCS | \(-0.0045^*\) | \(0.0048^*\) | \(1.50 \times 10^{-5}\) | \(0.0937^*\) | \(0.878^*\) | \(-1.34 \times 10^{-5}\) | \(-5.638\) | \(-5.515\) |
| UTILITIES | \(-0.0024\) | \(0.0019\) | \(8.64 \times 10^{-6}\) | \(0.1413^*\) | \(0.859^*\) | \(-8.77 \times 10^{-6}\) | \(-5.506\) | \(-5.382\) |
| REITS | \(-0.0003\) | \(0.0008\) | \(7.72 \times 10^{-6}\) | \(0.3798^*\) | \(0.619^*\) | \(3.55 \times 10^{-7}\) | \(-6.424\) | \(-6.301\) |
| REITS_MAN_DEV | \(-0.0013\) | \(0.0016\) | \(1.19 \times 10^{-5}\) | \(0.3960^*\) | \(0.647^*\) | \(5.53 \times 10^{-6}\) | \(-5.288\) | \(-5.165\) |

\*indicates significance at 1% level
\**indicates significance at 5% level
\*indicates significance at 10% level. Z-statistic values are in parenthesis
### Table 6  Estimates of the impact of investor sentiment on volatility

|                      | Increasing volatility | Decreasing volatility |
|----------------------|-----------------------|-----------------------|
|                      | TASI                  | ENERGY                | FOOD_STAPLES_RET | FOOD_BEVERAGES | HEALTH_EQNERSV | PHARMA_BIOTECH | MATERIALS | BANKS | TELECOM_SERVCS | UTILITIES |
|                      |                       |                       |                  |               |               |               |           |      |                |           |
| Panel A: Entire period | Mean equation         |                       |                   |               |               |               |           |      |                |           |
| $c$                  | 0.00014               | $-0.00127^{**}$       | 0.00050          | 0.00069       | $-0.00082$    | $-0.00072$    | $-0.00101$ | $-0.00146$ | $-0.00107$ | $-0.00139$ |
|                      | (0.2175)              | (-2.3109)             | (0.7403)         | (0.5311)      | (-0.5501)     | (-0.5319)     | (-0.2949) | (-1.355)  | (-1.3047)  | (-1.8797)  |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
| Conditional variance equation | $\alpha_0$ | 3.72*10^{-5}*** (6.749) | 2.56*10^{-5}*** (3.283) | 0.00019*** (3.776) | 2.56*10^{-5}*** (3.283) | 8.55*10^{-5}*** (8.283) | 0.00013*** (8.283) | 0.00028 (4.152) | 2.40*10^{-5}*** (1.952) | 3.45*10^{-5}*** (2.298) | 5.62*10^{-6}*** (6.315) |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
|                      | $\alpha_1$ (ARCH) | 0.3224*** (4.439)    | 0.1951*** (2.899) | 0.3687** (2.444) | 0.1789** (2.368) | 0.1843** (2.030) | 0.1993* (1.864) | 0.1372 (1.352) | 0.1805*** (3.1755) | 0.1350*** (2.5003) |           |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
|                      | $\beta_1$ (GARCH)  | 0.4835*** (17.655)   | 0.5020*** (5.096) | 0.2315* (1.936) | 0.7096*** (6.717) | 0.1547*** (8.256) | 0.3029** (1.977) | 0.5466** (2.034) | 0.6672** (8.636) | 0.6072*** (5.912) | 0.8561*** (34.901) |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
| $\Delta$Sent         | 0.00029*** (6.604)   | 0.00016*** (8.230)   | 0.00043*** (6.570) | $-8.67*10^{-5}$** (7.732) | 0.00036*** (5.056) | 0.00024** (2.371) | 0.00025*** (6.095) | 0.00019*** (4.521) | 5.18*10^{-5}*** (4.229) |           |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
| Panel B: COVID-19 period | Mean equation         |                       |                   |               |               |               |           |      |                |           |
| $c$                  | $-0.00064$            | $-0.00083$            | 0.00049          | $-0.00297^*$  | 0.00181**     | $-0.00137$    | 0.00080    | 0.00094 | 0.00035         | $-0.00093$ |
|                      | (-0.3473)             | (-0.7224)             | (0.3080)         | (-1.8154)     | (2.526)       | (-0.5739)     | (0.4056)   | (0.899) | (0.330)         | (-1.127)   |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
| Conditional variance equation | $\alpha_0$ | 6.86*10^{-5}*** (3.044) | 3.40*10^{-5}*** (3.942) | 0.00021*** (6.260) | 0.00010*** (3.806) | 1.20*10^{-5} (3.9602) | 2.979 (2.979) | 0.00024*** (3.658) | $-2.26*10^{-6}$ (0.710) | $-9.25*10^{-7}$ (0.300) | $-4.50*10^{-6}$ (2.211) |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
|                      | $\alpha_1$ (ARCH) | 0.1944*** (2.027)    | 0.1860*** (3.317) | 0.2328          | 0.2299** (1.578) | 0.0307        | 0.0905      | 0.1448** (2.010) | 0.1921*** (3.670) | $-0.0610^{**}$ (1.382) | 0.0987*** (2.1057) |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
|                      | $\beta_1$ (GARCH)  | 0.5962*** (12.385)   | 0.4955*** (20.001) | 0.3064** (7.684) | 0.4819** (6.870) | 0.8220*** (22.960) | 0.2471*** (1.598) | 0.5403** (8.539) | 0.8057** (19.701) | 1.0177*** (145.515) | 0.8768*** (21.998) |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
| $\Delta$Sent         | $-2.19*10^{-5}***$   | $0.00020***$          | $0.00049***$     | $-0.00010$    | 0.00032***    | 0.00034***    | $-7.76*10^{-5}$ | $1.49*10^{-5}$ | $2.39*10^{-5}$ | $3.19*10^{-5}$ |           |
|                      | (-242.575)            | (5.2977)              | (5.217)          | (-20.227)     | (8.4838)      | (3.6237)      | (-0.5187)   | (0.6846) | (0.9182)        | (1.4701)   |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
| Number of observations |                      |                       |                   |               |               |               |           |      |                |           |
|                      | 145                   |                       |                   |               |               |               |           |      |                |           |
|                      |                       |                       |                   |               |               |               |           |      |                |           |
|                      |                       |                       |                   |               |               |               |           |      |                |           |

*** indicates significance at 1% level
** indicates significance at 5% level
* indicates significance at 10% level. Z-statistic values are in parenthesis
reduced volatility. The telecommunication services sector experienced increased demand for services globally due to lockdowns as telecommunication has become an important mode of communication between people during the pandemic. Lockdowns also mean that individuals spent more time at home; hence, there is an increased demand for utilities. The banking and the materials sector are two of the heaviest sectors on the MSCI Tadawul 30 Index.

Contrary to prior studies that find higher volatility of the main indices around the world during the COVID-19 period, the TASI is found to have lower volatility during the pandemic period according to the GARCH (1, 1) model. This could be due to the time period of this study. Most prior studies were conducted from December 2019 to March 2020 when the pandemic had just been declared and the uncertainty regarding the pandemic was very high. Since the data for this study are taken until the end of July 2020 by which time the Saudi government had demonstrated its ability to handle the pandemic without causing panic among the population, there was no over-reaction to the pandemic in the Saudi financial market. Therefore, in the period from March 2020 to July 2020, the aggregate effect of COVID-19 on the TASI is a reduction in the volatility compared to the period before the pandemic. Alternatively, the decrease in the volatility of the TASI could be because the sectors that experienced decreases in volatility during the COVID-19 pandemic are also some of the biggest sectors in the Saudi market; hence, the impact of COVID-19 in these sectors is reflected in the TASI.

Higher trading volume during the pandemic period as observed in the descriptive statistics may mean that there is increased investor sentiment; hence, the increase in volatility could be a result of this increase in investor sentiment (Lee et al. 2002; Uygur and Tas 2014) during the pandemic period. However, while it is expected that negative sentiments may be felt among the investors during the pandemic period due to the increased risk in the market caused by the pandemic, this does not seem to be the case in this study as negative sentiments would trigger sell decisions, but the higher mean return indicates more buying during this period. The GARCH (1, 1) model relating change in sentiment to volatility shows that for the sectors that had experienced increased volatility during the pandemic, investor sentiment was stronger and the impact on volatility was significant. This may indicate the participation of noise traders in these sectors (Uygur and Tas 2014). However, for the sectors that experienced decrease in volatility during the COVID-19 period, sentiment had a weaker impact on volatility. In fact, change in sentiment is found to be insignificant in affecting volatility in these sectors. Based on the observations of the two different groups of sectors, it may be concluded that the increase or decrease in volatility may not only be because of the participation of noise traders, but it could be because of the uncertainties related to the particular sectors that influenced the volatility. For the TASI, it is found that investor sentiment had a negative impact on the volatility of the TASI during the COVID-19 period. Since the performance of the TASI may be influenced heavily by its top 5 constituents (‘top heavy’), the negative and weaker impact of sentiment on the volatility of the TASI could confirm the findings of Baker and Wurgler (2007) that stock of established, mature companies is not as susceptible to investor sentiment.

**Conclusion**

This study examines the impact of the COVID-19 pandemic on the return, volatility and volume of the Saudi stock market. Analysis is carried out on the Tadawul All-Shares Index (TASI) and the sector indices in the Tadawul market. Price data are collected for the TASI and the sectoral indices from 31 December 2019 to 28 July 2020. The time period is divided into two: from 31 December 2019 to 2 March 2020 for the period pre-COVID and from 3 March 2020 to 28 July 2020 for the period during the COVID-19 pandemic, as the first case of COVID in Saudi Arabia was announced on 2 March 2020. Analysis is carried out on the returns of the indices using both descriptive statistics and the GARCH (1, 1) model. The study finds that mean returns, volatility and trading volume are higher for the period during the COVID-19 pandemic. Investigation of the returns via the GARCH (1, 1) model shows that the COVID-19 pandemic has a positive impact on returns, but the impact is insignificant in most cases. This is contrary to what was found in most studies on the effect of the pandemic. On the other hand, volatility of the TASI is found to be negatively affected by the pandemic, but the effect on the volatility is found to be insignificant. Out of 21 sector indices, only 9 experienced significant impacts on the volatility and the impact was mixed. 5 experienced increased volatility, while 4 experienced decreased volatility. Further investigation on the TASI and the 9 sectoral indices is carried out by observing the effect of trading volume (sentiment) on the volatility, and it is found that for the indices that experienced increased volatility, the effect of sentiment on the volatility is significantly greater during the pandemic period, while for the indices that experienced decreased volatility, the effect is insignificant and weaker during the pandemic period.

The results of this study contribute to a further understanding of the reaction of various financial markets around the world to, not only the COVID-19 pandemic but to pandemics in general. Prior studies have been conducted on the countries most affected by the pandemic, and in most cases, it is found that the pandemic has significantly increased volatility in the stock markets. This study is focused on the Saudi stock market because of the Saudi government’s
handling of the crisis and the importance of the Tadawul stock exchange due to its recent upgrade to MSCI emerging markets status. The results of the study show that the impact of the COVID-19 pandemic may be different for different stock markets and for different sectors. The study warrants further analysis of the COVID-19 pandemic effect on other stock markets around the world, aside from the large stock markets and the stock markets of the countries that were most badly affected by the crisis. The different results found in this study highlight the importance of portfolio diversification across markets to reduce overall investment risk. Additionally, the study highlights that the impact of COVID-19 on the financial markets cannot be equated to the Global Financial Crisis of 2007/2008, at least until the impact of the pandemic is not felt on the economies of countries around the globe.

This study is limited to only the Saudi stock market, and hence, its implications are only for that stock market. Future studies could be carried out on all other stock markets around the world so that a clearer understanding of the pandemic on the stock markets can be attained. In addition, this study considers overall price and volume data without differentiating the activities and sentiments of retail and institutional investors, as these two groups of investors may adopt different trading strategies during the crisis and lockdown periods. Such a study would be especially important to both portfolio managers, retail investors and even regulators of stock markets so that market dynamics can be better understood. This study only considers data until end of July 2020, after which many countries started experiencing second and third waves of the pandemic. Hence, investigation could be carried out on markets around the world in these phases to observe if the market participants react differently in these phases given the ongoing threat of the pandemic.

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