



Do the stocks' returns and volatility matter under the COVID-19 pandemic? A Case Study of Pakistan Stock Exchange

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ABSTRACT

The catastrophe that the world is now facing in the form of COVID-19, has affected most of the world economies and financial markets as a result of lockdown, traveling restrictions, and social distances. The present study attempted to investigate the effects of COVID-19 on the stock returns of the Pakistan Stock Exchange. The data employed comprises daily prices of Pakistan Stock Exchange, the daily value of exchange rate over the period 01 January 2011 to 30 April 2021, and a dummy variable for COVID-19 which takes 1 for the period during COVID-19 and 0 for the period before. The data were sourced from the Karachi Stock Exchange website, National Institute of Health Sciences Pakistan, and State Bank of Pakistan. We applied the autoregressive conditional heteroskedastic (ARCH) and the associate generalized autoregressive conditionally heteroskedastic (GARCH) approaches to analyze the impact. Our findings revealed that a negative relationship exists between our variables of interest with mean returns and a positive relationship with the volatility of the KSE-100 index. This implies that the COVID-19 pandemic has affected the stock price and increases the volatility of the KSE-100 index, and further affects the financial system. The study recommends that an urgent and powerful response is needed on the part of the government, including strong measures to prevent a severe stock market crash in Pakistan in near future.



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1. Introduction

The global world has been hanged when the World Health Organization confirmed the outbreak of the pandemic diseases, called the Novel Coronavirus (nCovid-19), in Wuhan city of China¹. In the first five days of the epidemic, the death cases were recorded more than 1800, and more than 70,000 confirmed cases were recorded (Ilyas et al., 2020). The pandemic disease was spread around the globe in a very short period and affected the

¹WHO | What is a pandemic? (2020). WHO.

http://www.who.int/csr/disease/swineflu/frequently_asked_questions/pandemic/en/

production and general life of the people (He et al., 2020). The outbreak of the COVID-19 epidemic caused stock indexes to become unsettled, resulting in increased volatility (Engelhardt et al., 2021).

In Pakistan, the first two covid-19 cases were confirmed on 26th February 2020 and spread throughout the country (Ilyas et al., 2020). On 23rd December 2020, there are 462,814 confirmed cases with 37,905 active cases, 9557 death cases, and 415,352 recovery cases.²The Government of Pakistan officially implemented the lockdown to controlled the epidemic diseases as the safety measures suggested by the WHO (*Coronavirus*, n.d.). As the world limited the interaction, every country has sealed their borders for any kind of transpiration and as a result, created a huge gap between supply and demand. This pandemic highly targeted the financial markets, global economy and bears huge losses globally (Štifanić et al., 2020). The government of Pakistan has implemented proper preventive steps, such as providing relief to the community, small business owners, and lowering profit margins, all of which have a positive impact on the PSX (Maria et al., 2021). Pathak, (2021) concluded that covid19 has had a negative influence on the economy as a whole. Although it has a favorable influence on specific industries, the overall impact is seen as terrible and unfavorable.

In 2020, analysts expect Covid-19 to minimize global economic growth by 0.15% points, translating into around \$135 billion in delayed or unproduced goods and services. Three things influence the outcomes of this outbreak year how rapidly the virus spreads and how long it lasts; second, how many fear impacts travel, customer spending, manufacturing, and trade; third, what steps policymakers take to deter the spread of the virus and increase competitiveness (Hussain, 2020). Pakistan's economy and Pakistan stock exchange (PSX) are also highly affected by Covid-19 and the growth rate reduces to -0.4%.³ The Pakistan economy faces a loss of \$1.3 trillion due to Covid-19 (Shareef et al., 2020).

The Stock market price and the returns are imperfectly predictable in the short-run, cyclical and unpredictable in the long run because the stock prices become nonlinear and time-varying related behavior (Peters, 1994). Noise trading, a decision that is not based on fundamental data, which has no fundamental information of the market but they only follow the current market trend, changes as the market have good or bad news. These noise traders (individuals/firms) have a high impact on the volatility of the stock market because they have no basic approach to the market and make their investment decisions upon asymmetry information (Yu & Yuan, 2011). Due to the noise traders and speculators, the market appears to be excessively unpredictable. Optimistically, the stock market continues to provide investors with tremendous returns that will compensate for the increased uncertainty in the market. It is also a possible location for foreign diversification due to the relative segmentation of the stock market (Iqbal, 2012).

The stock market volatility occurs when there is an increase in the operation charges on assets transaction and as a result, the overall behavior of spot and futures markets changes when the noise traders invest in spot and futures markets (Verma & Verma, 2007). The action of noise traders in the speculative market affects volatility since their high degree of trust bias and self-esteem is the key cause of high market volatility. So, the conscientious investors would flee the market in those periods (Shleifer & Vishny, 2003).

² World Economic Outlook (October 2020) - Real GDP growth. (n.d.). Retrieved December 25, 2020

³ World Economic Outlook (October 2020) - Real GDP growth. (n.d.). Retrieved December 25, 2020

The noise traders altered for the overpricing that attached the moments of the greater market sentiment can also significantly decrease their volatility over those times, thus facilitating the induction of the noise traders to improve their actions in the price environment. This disparity in trading behavior can affect the level of trading, the mix of participants, and the exchange costs in the two markets.

There is a limited and growing literature on the stock market volatility response towards Covid-19 (Apergis & Apergis, 2020; Gu et al., 2020; Onali, 2020; Wang et al., 2020; Yar, 2020; Yilmazkuday, 2020). Apergis & Apergis, (2020) studied the stock market of China and concluded that the stock market returns negative but significantly affected by Covid-19 while the volatility of market returns are positive and significantly affected. Onali, (2020) has also worked on the stock market volatility response towards Covid-19 and founded the stock market returns significantly negative, and forecasted volatility is a significantly positive effect of Covid-19 in France and Italy. The Pakistan stock market only enhances with the recovery cases of Covid-19 and there is no impact of covid-19 confirm and death cases on the stock market (Yar, 2020).

The economic condition of a country is primarily dependent on the performance of the stock market, as the stock market is the main source of company financing. Investors are interested in stock market returns and different associated factors can affect the stock market return. Due to noise traders and speculators, the Pakistan Stock Market is highly volatile and as a result, the market offers a massive gain to investors by compensating for higher market volatility (Iqbal, 2012). In inefficient stock markets, the investments are information-based and as a result, the investor deviates, thus trigger stock market anomalies (Kumar & Lee, 2006). The different researchers studied that the Covid-19 have a high impact on stock market return globally but Yar, (2020) concluded that stock market return hasn't been influenced by Covid-19 cases and death. So, due to high sensitivity and financial constraints, we have conducted this study to find the impact of Covid-19 on the Pakistan Stock Exchange (PSX) and as well as internal and external shocks.

This study will tend to investigate the following two question; i) Do the Covid-19 impact the stock returns of KSE-100 of Pakistan Stock Exchange (PSX), ii) What will be the impact of local shock and international shock on the stock returns of KSE-100 of Pakistan Stock Exchange (PSX)? The study aims to find out the effects of Covid-19 on stock market returns of the Pakistan Stock Exchange (PSX) and as well as it will help rational investors instead of noise traders to specify the decision in investing in profitable stocks in the future. This study will help investors, in case of asymmetry information while for the policymakers, it will easy to make the right decision in such a devastating situation.

The present paper is organized in the following manner. Section I gives an introduction to the study and the literature review of the study is described in Section II. In Section III, we developed the methodology of the study. Furthermore, Section IV gives the results and discussion of the study; finally, Section-V provides the conclusion and findings of the study.

2. Literature Review

Numerous works of literature on the relationship between different macroeconomic variables and stock returns have been written but more precise attention is needed to explore the volatility and return of the stocks in presence of the COVID-19 pandemic. Pareek & Singh, (2020) analyzed the Covid-19 and its initial signaling effects on the stock market in India, using closing data of Sensex as a proxy for the stock market and Covid-19

data from the first week of March to the third week of March. Karl Pearson's correlation coefficient was applied to achieve the purpose of the study. The results showed that an increase in the reported cases of coronavirus-affected patients sends a negative financial signal to the stock market and the stock market has reacted negatively at a very initial level of the pandemic.

Yousef & Shehadeh, (2020) investigated the impact of Covid-19 on gold price volatility, using GARCH and GJR-GARCH models for the period 2012-2020. Their findings found that an increase in gold prices corresponds to a rise in worldwide coronavirus infections, which may be linked to the virus's anxiety about future economic conditions, as well as the fact that gold is considered a secure investment in uncertain times. Furthermore, the Covid-19 has a strong positive influence on the conditional variance equation, meaning that the virus is also raising gold volatility.

To anticipate commodities and stock price movement during the COVID-19 pandemic, a forecasting model incorporating stationary wavelet transform and bidirectional long short-term memory networks was developed. The Covid-19 epidemic had a significant influence on energy costs and the stock market since the suggested method displays a decrease in the price of crude oil (Štifanić et al., 2020). Apergis & Apergis, (2020) studied the role of Covid-19 for Chinese stock returns, using a GARCHX model, spanning the period from January 22, 2020, to April 30, 2020. Total confirmed cases and total daily fatalities were employed as alternative approximations for the Covid-19 factor in this investigation. Covid-19 has a considerable negative influence on stock returns and their related volatility across both Covid-19 alternatives, according to the data. Covid-19 had a favorable and statistical significance influence on stock return volatility, according to the same research. Because when the Covid-19 outbreak measure was proxied by the total instances of fatalities, the detrimental impact of Covid-19 on stock returns was more obvious.

Bora & Basistha, (2021) used the GJR GARCH model to capture the volatility of the two stock markets in India BSE and NSE, the study covered the period September 3rd, 2019 to July 10th, 2020. The study's findings suggest that during pandemics, the stock market, particularly the BSE Sensex, becomes extremely volatile. On the other hand, the Covid-19 era had no substantial influence on NSE Nifty stock prices, and it was also determined that the coronavirus epidemic influenced stock prices and market volatility in the Indian stock market, as well as the financial market. Kotishwar, (2020) used the Vector Error Correction Model (VECM) and Cumulative Average Abnormal Returns Model (CAAR) to investigate the effect of the Covid-19 pandemic on the stock markets of different countries and concluded that the financial markets throughout the world have reacted favorably to the epidemic, indicating that investors are investing at all levels of the market. Moreover, Chaudhary et al., (2020) found that because the sum of the ARCH and GARCH coefficients is less than one, the Covid-19 coefficient in the conditional variance equation has a significant positive influence on conditional variance for all indices, indicating that the virus has increased volatility in these indices and markets are experiencing a mean-reverting procedure. Covid-19 has had a greater impact on European and American markets than on Asian markets, and Covid-19's health problem has effectively precipitated a financial catastrophe (Shehzad et al., 2020).

Covid19 has had a huge effect on global financial markets, influencing practically every industry in some manner. The covid19 had a negative influence on the economy as a whole. Even though it has a favorable influence on specific industries, the overall impact is seen as terrible and unfavorable (Pathak, 2021). The anticipated value of the Pakistan Stock Exchange has been calculated using the models for the COVID-19 and non-COVID scenarios reveals that the government's preventative measures enable the stock market to become

stable and sustain the needed growth that has been impeded (Maria et al., 2021). Rahman et al., (2021) found that the governments and regulatory agencies must create more objective and targeted rescue measures to restore investor confidence following a catastrophic occurrence and to show a large rise in the correlation between stock, sector, and market returns throughout the epidemic period. The most significant elements affecting individual investment decisions are market and personal considerations. Furthermore, investors are cautiously investing in the market during the COVID-19, relying on their expertise and broker recommendations (Sohail, et al., 2020).

Hussain, (2020) looked at the reaction of the Pakistan stock market to Covid-19. According to the researcher, the surge in the number of Covid-19 cases in Pakistan caused the KSE-100 index to plummet 1336.03 points or 4.68 percent, and to an intraday low of 27228.80 points. Moreover, compared to other businesses, the products and services and utility sectors are the only ones in Pakistan that did well, since the demand for amenities that aid domestic occupations has surged. Using a descriptive-analytical technique, the effects of the Covid-19 epidemic on micro, small, and medium-sized firms is high in Pakistan. From April 09, 2020, to April 21, 2020, data on 184 MSMEs was gathered. MSMEs have been badly impacted by the Covid-19 outbreak and lockdowns, according to the findings(Shafi et al., 2020).

The individual investors in the Pakistani firms are excited to have the opportunity to put their knowledge and talents to good use in difficult situations to get better returns on their investments (Yousaf et al., 2020). Furthermore, overconfidence gives a positive boost for investors during uncertain times, allowing them to wrap up unexpected and tough operations and aid in trend predicting. Overconfident traders undervalue the dangers associated with active stock investing, resulting in a series of losses.

3. Data and Methodology

The current study aimed to investigate the effects of COVID-19 on stock returns of the Pakistan Stock Exchange. To achieve this goal, data on stock prices, exchange rate, and COVID-19 were collected from different sources and different econometrical methods were applied. The study covered the period from 1st January 2011 to 30th April 2021 including both the period before and during the COVID-19 pandemic.

The data for the daily closing value of the KSE-100 index has been obtained from the Karachi Stock Exchange website. The return was calculated using the formula under;

$$R_t = \ln P_t - \ln P_{t-1} \quad (1)$$

Where R_t denotes the return at time t , \ln is the natural log, P_t is the current daily stock price at time t , and P_{t-1} is the previous daily stock price at time t . The data for our second explanatory variable exchange rate has been collected from the State Bank of Pakistan. The first confirmed positive case has been reported on 26 February 2020; a dummy variable was used to capture the effect of COVID-19. We assigned 1 for the period from 26th February 2020 onward and 0 for the rest of the period.

Since the investors' attitude not only to expected returns but also to risk, this fact requires a model that can deal with the volatility (variance) of the series (Asteriou & Hall 2007). Therefore, this study utilizes the ARCH/GARCH models presented by (Bollerslev, 1986; Engle, 1982). Under the conventional econometric analysis (Classical linear regression assumptions) views the variance of the disturbance terms as constant over time.

However, some of the economy but most of the financial time series follow the volatility clustering. The data of the stocks market, in particular, follow this behavior where the periods of unusually high volatility followed by more tranquil periods of low volatility in the series. As described by Asteriou & Hall (2007) "wild' and 'calm' periods as some financial analysts like to call them".

For the successful estimation of the ARCH/GARCH model, there should be two pre-conditions that must be fulfilled. The first pre-condition is volatility clustering. Under this condition, the periods of high volatility in the series are followed by periods of high volatility, while the periods of low volatility are followed by periods of low volatility for a prolonged period. The second pre-condition is the presence of ARCH effects in the residuals. To check whether the data exhibit ARCH effects or not, the LM test for autoregressive conditional heteroscedasticity is used.

$$Y_t = \alpha + \beta' X_t + u_t \quad (2)$$

Here, Y_t denotes the KSE-100 returns X_t is the explanatory variable, i.e., lagged of KSE-100 returns and u_t is the error-term. We can only run the ARCH/GARCH model if this model has volatility clustering and ARCH effects. We would then run equation (2) and obtain the residual; the residual of the mean model will be plotted in a graph.

$$\hat{u}_t^2 = \gamma_0 + \gamma_1 \hat{u}_{t-1}^2 + \dots + \gamma_q \hat{u}_{t-q}^2 + w_t \quad (3)$$

Null hypothesis no ARCH effect, if the chi-square probability is less than 5% in which we can reject the null hypothesis. If these conditions were satisfied, meaning that our mean model has clustering volatility as well as the ARCH effect, we have the validity to run the ARCH and GARCH models. The general form of the GARCH (p,q) model as specified by Asteriou & Hall (2007), can be stated under;

$$Y_t = \alpha + \beta' X_t + u \quad \text{Mean Equation} \quad (4)$$

And $u_t | \Omega_t \sim iidN(0, h_t)$

$$h_t = \gamma_0 + \sum_{i=1}^p \delta_i h_{t-i} + \sum_{j=1}^q \gamma_j u_{t-j}^2 \quad \text{Variance Equation} \quad (5)$$

Here, Y_t is the dependent variable in the mean equation, α is constant in the mean equation, u_t is the error term, h_t is the current volatility, γ_0 is the constant in the variance equation, h_{t-i} is the GARCH term and u_{t-j}^2 is ARCH term. Equation (5) is GARCH (1,1) and can be rewritten as under:

$$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 u_{t-1}^2 \quad (6)$$

This equation can easily be estimated as it has only three parameters γ_0, γ_1 , and δ . To obtain the effects of COVID-19 on stock returns of Pakistan, a dummy variable of COVID-19 has been incorporated in which 0 was assigned to represent the period during the COVID-19 pandemic and 1 before the period to detect external shocks. We also introduced another variable exchange rate to detect the external shocks too. The model with the exchange rate and COVID-19 can be written below:

$$h_t = \gamma_0 + \sum_{i=1}^p \delta_i h_{t-i} + \sum_{j=1}^q \gamma_j u_{t-j}^2 + \sum_{k=1}^m u_k X_k \quad (7)$$

Here, X_k is a set of explanatory variables that have an international shock or external influence on the KSE-100 index. Therefore, positive and statistically significant coefficients of the exchange rate and COVID-19 would imply the increase of volatility of Pakistan stock returns.

4. Empirical Findings and Discussion

This section of the study explores the impact of the COVID-19 pandemic on the KSE-100 index returns. The study utilized daily data of stock returns of the KSE-100 index for a period from January 01, 2011, to April 30, 2021. As the financial data are exposed to higher volatility, so an investor may be interested to know the risk associated with holding an asset. Therefore, a more efficient estimator can be obtained if the problem of heteroskedasticity in the errors is handled accurately (Bollerslev, 1986; Taylor, 2006). To properly handle this issue the widely used models are Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized ARCH (GARCH) developed by Engle, (1982) and respectively Bollerslev, (1986)⁴. The study flinches its empirical analysis by providing the summary statistics of the variables of interest in Table 1 while Table 2 presents the diagnostic test for confirmation of the ARCH effect in the data. The result of a baseline model is presented in Table 3. In addition to this, Table 4 shows the results of the mean equation where we utilized three different models. The results obtained from the GARCH model that incorporates the explanatory variables in both mean and variance equations are also presented in Table 5.

4.1 Summary Statistics

The daily adjusted closing prices of stocks have a mean value of 30876 with a standard deviation of 11366. It implies that the average value of stock prices has greater volatility. The mean value of stock returns is 0.0004 with a standard deviation of 0.0087 which also confirms the presence of random walk in KSE-100 index stock returns. The mean value, standard deviation, 25th and 50th percentiles for Stock return (RKSE) and lagged Stock return (LRKSE) are the same. The COVID-19 is a dummy variable that takes only 0 and 1 values, so, the three percentiles presented in Table No. 1 are the same. The exchange rate has a mean value of 112.53 with a standard deviation of 23.48 which stats high volatility in the exchange rate.

Table 1
Summary Statistics

Variables	Mean	SD	P25	P50	P75
KSE	30876	11366	21789	33229	40271
RKSE	.00038	.00875	-.00172	0	.00302
LRKSE	.00038	.00875	-.00172	0	.00299
COVID-19	.92320	.26630	1	1	1
EXR	112.53	23.48	98.45	104.75	116.05

Note: Table 1 represents the summary statistics of the main variables. The variable KSE is the adjusted closing prices of the KSE-100 index. RKSE and LRKSE are the returns and one-period lag stock returns of the KSE-100 index respectively. The presence of the pandemic is captured by the dummy variable COVID-19 which takes the value 0 for the period in which the pandemic was present and 1 for the rest of the period. The last variable in the above table is the exchange rate. For each variable, we have presented mean, standard deviation, 25th, 50th, and 75th percentiles.

⁴ For more understanding see for example (Bollerslev, Chou, & Kroner, 1992) and (Bollerslev, Engle, & Nelson, 1994).

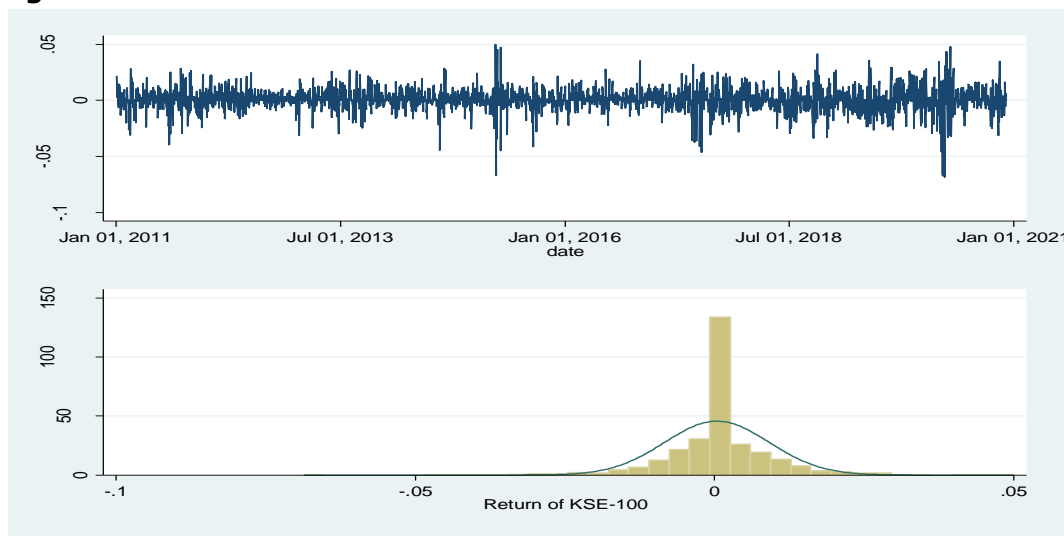
4.2 Diagnostic Tests for Checking of ARCH effect:

Following previous research of Asteriou & Price, (2001), we also verified the presence of the ARCH effect in our series first by plotting the series and secondly by applying the diagnostic test.

4.2.1. Visualization of ARCH effect:

The suggested ARCH/GARCH models are appropriate if the data have an ARCH effect. To confirm whether the selected data set of stock returns have an ARCH effect we first plotted the stock returns and visualized the volatility clustering. From Figure 1 below it can be seen that high period volatility is followed by another high period volatility and low period volatility is followed by another period of high volatility. Further, we also checked for normality in the data and found the returns of the KSE-100 index are non-normal. The lower part of Figure 1 indicates that the series is leptokurtic. There are a huge number of observations around the mean value and relatively large numbers of observations are away from the average value. The tails are skewed and the center of the histogram has a high peak.

Figure 1: Visualization of ARCH effect



4.2.2. Tests for Autoregressive Conditional Heteroskedasticity:

To estimate the GARCH model it is necessary to check whether the series satisfies the two conditions or not. The first condition of the presence of volatility clustering is fulfilled in the above section after visualization of the ARCH effect. Therefore, now to check the ARCH effect in the residuals of the model, we applied the LM test after the OLS estimation. The test was applied under the null hypothesis of constant variance or no ARCH effect. If the variance equation of the ARCH model is correctly specified there would be no ARCH effect remain in the residuals Engle, (1982). The results obtained are presented in Table 2 where the value of the chi-square test is highly significant. We, therefore, reject the null hypothesis and verified the presence of Autoregressive Conditional Heteroskedasticity (ARCH) which directs us to the use of the GARCH model is appropriate.

Table 2
Tests for Autoregressive Conditional Heteroskedasticity (ARCH)

LM Test		
Lags (p)	Chi2	p-value
1	160.42	0.0000

4.3 Baseline Models Results

4.3.1 ARCH/GARCH

Table 3 provides the results of the baseline models. We estimated the baseline models to verify the appropriation of the ARCH/GARCH model and compare the results; after we introduced the explanatory variables in mean and variance equations. Model-1 is the simple AR (1) process for stock return (RKSE) which is estimated using the OLS regression. The positive and statistically significant coefficient of lagged stock return (LRKSE) suggests that the current period average returns of the KSE-100 index are positively affected by lagged period returns. We estimate ARCH (1, 1) and provide the results under model-2. To reach convergence it took only ten iterations in estimating the model.

Table 3: Results from the baseline model

	(Model-1)	(Model-2)	(Model-3)
Lrkse	0.0517** (3.11)	0.0657** (3.12)	0.0789*** (4.40)
Constant	0.000356* (2.45)	0.000343* (2.44)	0.000674*** (5.22)
ARCH			
L.arch		0.154*** (12.32)	0.0778*** (18.66)
L.garch			0.894*** (172.71)
Constants		0.0000634*** (85.18)	0.00000221*** (11.09)
<i>N</i>	3618	3618	3618

Note: *t* statistics are in parentheses and * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ represents significance levels at 5%, 1% and 0.1% respectively. All the three models are estimated for a total of number of 3618 observations. **Lrkse** is the lagged period stocks returns.

The positive significant value of ARCH (1, 1) indicating its consistency with the claim presented in Table 2. We also checked for higher-order ARCH effects, where we found the effect is significant up to six lags while at 7th lag the coefficients become negative and some are statistically insignificant. Similarly, it also took 362 iterations to reach convergence. For some reason, we did not provide the results here. To overcome this problem Bollerslev, (1986) provided the GARCH model that adds up the lagged conditional variance with the autoregressive terms. We, therefore, estimated the GARCH (1, 1) model and provided the results under model-3.

4.3.2 Generalized Autoregressive Conditional Heteroskedasticity (GARCH):

As the GARCH specification has mean and variance equations to capture the mean behavior and volatility of a series respectively. We, therefore, estimated the GARCH (1,1) model where we introduce our variables of interest in the first two models separately, and next, we combine both the explanatory variables in a single model and presented the results under column 4 of Table 4.

Table 4
GARCH estimates of KSE Returns with explanatory variables in Mean

	(Model-1)	(Model-2)	(Model-3)
Lrkse	0.0785*** (4.37)	0.0789*** (4.40)	0.0779*** (4.34)
Covid_19	-0.000684* (-1.24)		-0.00159* (-2.27)
Exr		-0.00000262** (-0.44)	-0.0000151* (-2.01)
Constant	0.00132* (2.47)	0.000955* (1.44)	0.00381** (2.82)
ARCH			
L.arch	0.0780*** (18.63)	0.0778*** (18.67)	0.0783*** (18.70)
L.garch	0.894*** (172.07)	0.894*** (172.79)	0.893*** (171.34)
Constant	0.00000222*** (11.09)	0.00000221*** (11.09)	0.00000224*** (11.11)
N	3618	3618	3618

Note: t statistics are in parentheses and * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ represents significance levels at 5%, 1% and 0.1% respectively. All three models are estimated for a total number of 3618 observations. **Lrkse** is the lagged period stocks returns, **Exr** is used for exchange rate, and **Covid_19** represent the pandemic.

First, the variance equation shows the significance of the estimation in all three models. This indicates that the GARCH models estimated are parsimonious (Engle, 2001). Besides the appropriation of the model, Table 4 also describes the impact of the exchange rate and COVID-19 on KSE-100 index stock returns. In particular, taking into consideration the magnitudes of both the explanatory variables the impact of COVID-19 is more prominent.

Keeping in mind the investor's attitude towards average returns of the asset, we included the COVID dummy and exchange rate separately in the mean equation of model-1 and model-2 in Table 4. Thenceforth, included both of these variables in a single model where the results are shown in column 4. Interestingly, in all three models, we found the coefficients of both COVID-19 and exchange rate negative and statistically significant. The negative coefficient of the covid-19 and exchange rate suggests that the average prices of the stock prices in the KSE-100 index are inversely affected by both of the explanatory variables exchange rate and COVID-19. The results obtained are in line with Agrawal et al., (2010). They revealed a negative relationship between exchange rate and Indian Stock Market returns.

According to the investors Asteriou & Hall, (2007) are not only interested in average stock returns but also interested in the risk associated with those stocks. Therefore, the variance equation of the GARCH model has a greater value. To capture the risk associated with stock returns of the KSE-100 index due to COVID-19 and exchange rate, these are quantified both separately and together. Particularly, we introduced the COVID-19 dummy in the variance equation alone. We found the model is statistically significant and the COVID-19 has a positive sign and significant at the 1% level. This implies that the volatility of the stock returns increased due to COVID-19. Our results are in line with Mazur et al., (2021) and Onali, (2020).

Agrawal et al., (2010) concluded that the exchange rate has a negative relation with stock return and we used the exchange rate as an explanatory variable to find how much the stock return affected as an international shock. The result shows a positive coefficient for the exchange rate which is significant at 0.01%. This again implies that the exchange rate

as an international shock increases the volatility of the KSE-100 index. To find the combined effect of the explanatory variables we next introduce both COVID-19 and exchange rate in a single model.

Table 5
GARCH estimates of KSE Returns with explanatory variables of variance

	(Model-1)	(Model-2)	(Model-3)	(Model-4)
Lrkse	0.0788*** (4.40)	0.0789*** (4.39)	0.0793*** (4.42)	0.0783*** (4.35)
Exr				-0.0000153** (-1.81)
Covid_19				-0.00155* (-2.01)
Constants	0.000672*** (5.21)	0.000664*** (5.17)	0.000671*** (5.24)	0.00379* (2.52)
HET				
Covid_19	0.214** (-1.34)		0.644*** (3.55)	0.655*** (3.59)
Exr		0.00971*** (6.54)	0.0143*** (7.99)	0.0142*** (7.96)
Constants	-12.81*** (-72.86)	-13.90*** (-77.40)	-14.98*** (-44.20)	-14.98*** (-44.14)
ARCH				
L.arch	0.0777*** (18.64)	0.0784*** (17.85)	0.0793*** (17.72)	0.0801*** (17.71)
L.garch	0.894*** (172.97)	0.885*** (148.09)	0.883*** (144.31)	0.882*** (143.36)
N	3618	3618	3618	3618

Note: *t* statistics are in parentheses and * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ represents significance levels at 5%, 1% and 0.1% respectively. All four models are estimated for a total the number of 3618 observations. **Lrkse** is the lagged period stocks returns, **Exr** is used for the exchange rate, and **Covid_19** represents the pandemic.

The finding provided in Table 5, column 4, indicates that both explanatory variables are significant and positive. The results obtained in column 4 are consistent with the findings of columns 2 and 4 but contrary to the findings of Yar, (2020). For further confirmation and abstract analysis, we also include both of our interest variables in the mean and variance equation at the same time. The results presented in column 5 of Table 5 are statistically significant. The results clearly show the negative association of our interest variables with mean returns and the positive association with the volatility of the KSE-100 index returns. In particular, the results obtained in this study are in line with the findings of Apergis & Apergis, (2020), where they introduce daily confirm COVID cases and death cases in the GARCH framework. More specifically they found a negative association of both the explanatory variables on the average returns and a significantly positive effect on the volatility of the China Stock Market.

5. Conclusion and Policy Recommendations

The major aim of the current study is to investigate the effects of the COVID-19 pandemic on the stock returns of Pakistan from 1st January 2011 to 30th April 2021. The study applied the ARCH and GARCH models to achieve the stated objective. The findings from ARCH and GARCH models showed that the dummy variable of COVID-19 in the variance equation as a measure of external shocks found to be statistically significant with a positive sign; this indicates that volatility of the stocks returns increased due to COVID-19. The exchange rate as a second measure of external shocks affecting Pakistan stock returns

showed a positive and significant value, this indicates that the exchange rate increases the volatility of the KSE-100 index.

The overall findings of the study show that a negative relationship exists between our variables of interest with mean returns and a positive relationship with a volatility of the KSE-100 index. This implies that the COVID-19 pandemic has affected the stock price and increases the volatility of the KSE-100 index, and further affects the financial system. The study observed that the Pakistan Stock Exchange markets have positively reacted to the COVID-19 pandemic, therefore we recommend that an urgent and powerful response is needed from the part of the government, including strong measures to prevent a severe stock market crash in Pakistan in near future.

The present study is limited to the Pakistan Stocks Exchange and the adoption of the ARCH and GARCH model. The future study may consider other econometrics models from ARCH-family such as exponential generalized autoregressive conditional heteroskedastic (EGARCH) which include leverage effects.

Conflict of Interests/Disclosures

The authors declared no potential conflicts of interest w.r.t the research, authorship and/or publication of this article.

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