# The stock volatility and contagion effect: Study from Pakistan

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## ABSTRACT

The notion of efficient market hypothesis has dominated the financial markets for an extended time which explicitly states the prices of the securities reflect all levels of information available. This fact was pursued by many of the rational investors, but in response to the global market crash, the concept of behavioral finance emerged, and the patterns changed. In a decision-making process, a relational, financial decision-maker must consider not only returns but also the variance and volatility of returns. The primary feature of this study examines the sentiments approach and random walk theory effects on the Pakistan stock market, in addition to this, forecast the volatility of Pakistan stock exchange index by using past index values, whether such noise traders are present in the Pakistan stock exchange. Furthermore, investigates the effect of the market index contagion factor, risk, return and volatility effect on Pakistan stock exchange using the Generalized Autoregressive Conditional Heteroscedasticity estimation models. These results propose that market index and volatility have an impact and an essential role in determining the dynamics on the stock returns.

In this study, quantitative methods have been adopted to investigate the research hypotheses. Time series data of stock indices from 2000-2018 is used to conduct this research. Augmented Dickey-Fuller test, Autoregressive Integrated Moving Average and Generalized Autoregressive Conditional Heteroscedasticity are the quantitative techniques used to measure the factors affecting the Pakistan stock market volatility, moreover, for contagion effect testing the correlation coefficient test and Generalized Autoregressive Conditional Heteroscedasticity with an exogenous model are engaged in US, UK and selected Asian countries. The analysis clearly shows that volatility trend is predictable based on historical trend as the variance equation of Generalized Autoregressive Conditional Heteroscedasticity has a significant positive impact. The analysis also revealed that leading stock exchange indices have a substantial impact on the Pakistan stock market. The study supports the argument for the international and national investors to hypothecate their strategies to minimize the risk. Besides of this strategy, formulators may also change the results of these acquirements to inform the macro and micro stage

policymaking. Moreover, this study is used to fill the gap between the volatility prediction and contagion factors which have a significant impact on the capital market.

**Keywords*:***
Market Risk, Market Index, Volatility, Contagion Approach, Random Walk Theory.

## INTRODUCTION

In the recent era, the globalization of financial markets reflects the fast growth in world portfolio investments. The most commonly used vehicles for global portfolio investments are mutual funds, closed finances, financial derivatives, shared funds and hedge funds. The studies about the relation among the performance of the industry, price of capital, financial leasing, financial variables, industry combining, and events came out with the learning that all these factors affect the stock market. Nonetheless, the past research on these areas does not consider the effect of recent phenomena in the financial market, namely; the irregularities in oil prices, the crisis in the United States and uncertainty in the political environment. The research on contagion effects and the transmission of achievement disaster has concluded that financial shocks to the occidental economies leave their mark on the emerging oriental economies.

The fundamental purposes of the study are to explore the factors that play the crucial role in the volatility of stock market of Pakistan and to identify whether there is any contagion effect in the stock market volatility of Pakistan in comparison to other stock markets, (i.e. selected Asian countries stock markets). Risk always exists in the international financial market and the business, financial institutions and investors should take cues from overall business sentiments to minimize their risks at a given level of returns. There are four factors that investors should consider achieving the optimal investment mix. Firstly, most of the financial markets became liberalized over time due to the reduction in governments involvement in the capital market, e.g. the measures are taken by the "European Union to integrate their capital markets". Secondly, the worldwide portfolio diversification helps the investors to actualize the advantages. Thirdly, Multi-National Corporations attained the benefits of raising new capital internationally. Fourthly, modern technology and better communication have made active stocks trading through modern-day technology which has reduced the throughput time of clearance and conflict resolutions (Eun & Resnick, 2010).

Moreover, Moosa (2004) states that the cross-border trade of import and export by international business firms were to be made. The adoption of the

four factors above will have a far-reaching impact on the liberalization and interconnectedness of the global economy (Eun & Resnick 2010). Khositkulporn (2013) Also studied the same impact and identified that the global liberalization could bring about an autocorrelation in financial markets. In an international financial market, the corporate investor, individuals and business originations get good results and make profits, when the higher development in capital funds should be viewed. For example, there is high, encouraging returns and opportunities in the emerging stock markets while investor investing from the cross border.

There is a high risk associated with the developing stock markets which correspond with the possibility of high potential returns. The sum of global equity returns collected from Jan 1988 to Dec 2006 showed that superior returns on starring year were 14.4 per cent for developing stock markets, whereas the global stock returns were 7.3% and Australia stock return was 11.9% (Warren & Radcliffe, 2008). Nonetheless, the returns of the global stock market are directly affected by global economic conditions. The global stock market returns are much less than the returns offered by the developing markets like the Asian market, which operate on a higher aggregate level of risk (Blanchard & Giavazzi, 2008). Therefore, if it is possible to create incredible improvement in developing stock markets returns, it creates an attraction for cross-border investors in favour of attractive optimistic returns after getting out from the economic depression.

A continues growth was observed in the returns of portfolios in the Asian stock market after the crisis hit in 1997, mainly because of the new initiatives taken by policymakers and researchers in the Asian stock market (International Finance Corporation 2000). Moreover, during the backlash of the Asian economic crisis in 1997, there were policy changes in economic as well as the capital market of Asia regarding developing stock market investments due to re-aligned currency values and unrestricted trade (Duca, Muellbauer, & Murphy, 2010; Murphy, 2009). Moreover, Murphy (2009) discussed that worldwide realized profit was generated from the developing economies of Asia in the world.

In this study, we explain the volatility of stock returns and the heteroscedasticity in the meaning of conditional volatility in Pakistan's Stock Exchange. The main aim of the study is to check the applicability of random walk theory on Pakistan stock exchange. Moreover, the study also examines the Pakistan stock index returns volatility change over time and whether it is predictable or not. Many studies examine the predictability of stock returns from past values. Lo and MacKinlay (1988) and Poterba and Summers (1988) provided practical indication against the random walk hypothesis for stock

returns in the US Stock Markets. Zaldivar, Martinez, and Ingram (1999) Researched the stock exchange regarding long term memory.

There were numerous studies by the financial analysts on stock market returns in comparison with the conditional volatility of stock markets. Baillie and DeGennaro (1990) Examined the diminuendos of predictable stock returns and volatility in the US Stock Markets. Poon and Taylor (1992) Investigated the clustering effect in comparison to predictability and tenacity in conditionally volatile UK Stock Markets. Findings reveal from both the studies that conditional volatility with second moments plays a crucial role in various financial stock activities. There was at least one or more than one factor regarding stock pricing that played a crucial role in expected returns. In all the portfolio diversification and risk hedging strategies, one should always consider its ability to predict variance and covariance. Therefore, a study on different economic, institutional and microstructural structures like Pakistan stock market, becomes appealing to academics and experts. The study on Pakistan stock returns predictability adds sufficient evidence for further research for policymakers and global investors.

The significant gap that is identified is whether the technical analysis provides enough information to predict future returns in the Pakistani stock market. In addition to this, the element of contagion effect is also discussed thoroughly in the literature review, and it was identified that there is literature gap between understanding the effect and extent of contagion effect on Pakistani stock market.

### *Research Objectives of the Study*

For the literature review and problem statement, the following objectives have been designed for this study.

1) To investigate the existence of market efficiency in Pakistan stock exchange.
2) To investigate the stock prediction in Pakistan stock exchange through technical analysis.
3) To investigate the effect of leading stock market indices on the Pakistan stock exchange index.
4) To investigate the effect of selected Asian stock market indices on the Pakistan stock exchange index.

### *Research Questions of the Study*

In line with the above objectives, the following research question has been established.

- Do the daily returns of the KSE 100 index follow a random walk?
- Do the KSE 100 index returns are predictable through the historical index values?
- Does there exist any relationship between Pakistan stock exchange and other leading stock markets?
- Does there exist any interrelationship between Pakistan stock exchange and selected Asian countries stock markets?

To investigate the questions and to answer the statements an auto-regressive integrated moving average and generalized autoregressive conditional heteroscedastic model was developed to tryout the factors affecting stock market volatility and compounding of knowledge within the contagion area by measuring the correlation coefficient using GARCH with exogenous factor model.

## LITERATURE REVIEW

The predictability of stock index value is the most fundamental question for each investor. The importance of this question emphasis the concept of volatility as the predictability of stock index values that will ultimately maximise the wealth of stockholder as well as the overall market. Due to this importance both academically and practically, the concept of volatility is one of the widely investigated areas of study in recent time. Meanwhile, the study of volatility has faced very controversial comments due to its highly diverse nature; multiple economic factors play an essential role in the movement of the stock market. Bollerslev, Xu, and Zhou (2015), In this paper the researchers established the relationship of variance risk premium, defined as the difference between the actual and risk impartial outlooks of the forward aggregate market variation which help to forecast market returns. By using model-free estimation procedure, they showed that this predictability might be endorsed to time variation in the part of the variance risk premium associated with the exclusive compensation demanded by the investor for bearing jump tail risk which was related with the idea that market fears play an essential role in understanding the return predictability.

They had found strong, distorted effects in the variance risk premium, which suggested that asymmetric-GARCH models were better to be used as compare to usual GARCH models for portfolio and risk management. Bansal et al., (2014) Showed the volatility movements had first-order implications for consumption dynamics and asset prices. The finding came out that volatility risks were persistent and strongly significant with discount rate news. The impervious had important associations for the return on aggregate wealth and

the cross-sectional difference in risk premium. There is a positive correlation between the stock return to investor investment and equity, while this correlation was questionably negative when volatility risk is ignored. Finding also revealed that volatility news was a valuable source of risk that affects the measurement and interpretation of underlying risk in the economy and financial markets.

They used three sources as determined variables of risk, which were cash flow, discount rate and volatility risks each carried out the separate risk premium. Mouna and Anis (2013), Research investigated the effect of the market index, interest rate and foreign exchange rate risk on Tunisian banks stock returns using the ordinary least square and GARCH models. The results showed that the exchange rate and the market index had an influence and a significant role in regulating the dynamics of the conditional bank stock return. On the other hand, they also revealed the fact that interest rate had no significance with the return in Tunisian banks. The findings further revealed that long term interest rate and exchange rate volatility were the significant determinants of the conditional bank stock return volatility. This paper provided a comprehensive analysis of the interest rate, foreign exchange rate and market risk. With the evidence of the hypothesis by using GARCH model, they analyzed that the exchange rate and the market index had a significant relationship and had an impact on the banking sector returns. Moreover, the effect of exchange rate volatility on bank stock returns volatility. The exchange rate volatility has a positive relationship with banks, while the effect of long-term interest rate volatility on the bank stock volatility was significant which reflects as an increase in the bank return volatility.

Aboura and Wagner (2010), Came out with the conclusion that it was possible to examine the asymmetric volatility for daily equity returns of United State of America. For that purpose, they modelled market returns, implied market volatility, and test for asymmetry in high price and volatility changes. They are there finding entailed that there was significant extreme asymmetric volatility. The impact was concurrent and reliable with both hypotheses, which were tested in that paper. Furthermore, they drive aggregate asset pricing implications of extreme asymmetric volatility, indicating that under extreme feedback a one in a hundred trading day innovation to average sixtieth volatility relates to an expected market drop of about 2.5 per cent. Hanan et al., (2012), Studied the impact of terrorist blasts and attack news on the actual market return as well as the resulted volatility in the KSE is analyzed and described. To conduct this research, an old model "EGRACH" model of Engle and Ng (1992-93), used by the author.

Through this model, the impact of good and bad news is analyzed on the stock. The research shows that all such news has a very negative impact on the

returns of almost every sector of the country, besides this such news also increase the volatility of the stock market and a few big guns of the country utilized this news like a golden egg in their hand, Sajid et al., (2013). Some solid fact also indicated that the return of Oil and Gas Development Company and industry does not response a significant change in the response of such news as compared to the rest of the sector. In the last, the author explained that volatility asymmetry is negative in response to all the sectors, and it also includes KSE100 with leverage effect.

The author also explains that the image of Pakistan in the eye of the international investor is comparatively bad as other Asian markets. Due to the incident of September 11 in New York, the whole world has suffered from a great depression. The impact of this incident was not only on that time, but it has very long-lasting. Many countries suffer from this and Pakistan was also one of these countries that have suffered from the after effect of September 11. The Madrid and London bomb blast and series of attacked in 2004-05 in Pakistan create a very disappointing image of Pakistan in the international community Suleman (2012). Qayyum and Anwar (2011), Conducted the researcher to indicate the significance of the relation between the stock market and monetary policy. They applied Engle-Granger two steps procedure and the bivariate EGRACH methodology to conclude their research. They conclude a powerful and prominent relationship between both variable of the study.

Through the ARIMA modelling, including the fact of Box-Jenkins test, it had been observed several times in the stock market, and these tests helped to explain the stock market successfully and beneficial for future research. There is a very long and old discussion regarding does the news of dividend affect the market or not. There are many factors both internal as well as external that plays a vital role in the market returns as it is a macro-economic phenomenon, therefore, no hard and fast rule has been established so far concerning the effect of dividend announcement news on market returns. For the sake of this research,researcher took the sample of 131 KSE listed company of the last ten-year data (2001-2010). Correlation and ANOVA technique were used to analyze the collected data Khan & Khan, (2010).

### *Theoretical Framework*

By examining the eighteen years of study (2000-2018). It was realized that in the context of Pakistan, most research is conducted on the base of events study. Most authors focus on the political and terrorist events in the given time frame. Hanan, Noshina, Siddiqui, and Imran (2012), Studied the impact of terrorist blasts and attack news on the actual market return as well as the resulted volatility in the KSE is analyzed and described. In the modern world,

fundamental analysis and events are both studies in determining stock returns volatility. In Pakistan, very few researches have been conducted with technical analysis. In 2015, by the help of technical analysis, strong bases of volatility were defined. Bollerslev, Xu, and Zhou (2015) In this paper, the researchers, established the relationship of variance risk premium, defined as the difference between the actual and risk impartial outlooks of the forward aggregate market variation which help to forecast market returns.

In recent time, many, many studies in the emerged and developed economies are conducted with the support of technical analysis along with fundamental analysis. All the points mentioned above open the direction of research for us with respect of Pakistan stock returns volatility. This study is structured to analyze the Pakistan stock returns volatility by using technical analysis.

### *Research Hypotheses*

The following hypotheses were developed based on the previous work done by the researchers.

We focused on whether the return of Stock Exchange of Pakistan follows the random walk theory in Pakistan. Also, we examined whether stock return volatility changes over time and whether it is predictable. After more tests, the relationship between market risk and expected return. Many studies examine whether stock returns are predictable from the past. The hypothesis related to this is

***Hypothesis 1:*** *There exists normality in daily returns of the Pakistan Stock Exchange.*

***Hypothesis 2:*** *The daily returns of KSE100 index can be predicted through technical analysis.*

***Hypothesis 3:*** *The variation in return of the leading stock market indices has a significant effect on the Pakistan stock exchange returns.*

***Hypothesis 4:*** *The variation in return of the selected Asian countries stock market indices has a significant effect on the Pakistan stock exchange returns.*

## DATA AND METHODOLOGY

Daily basis data of stock indices is collected for 18 years. The period is selected from 2000 to 2018. The volatility effect is more expressively explained by using daily data. Data is collected from each selected country's official stock exchange website. Seven different countries including developed

economies (United State, United Kingdom & China), emerging economies (Hong Kong, Malaysia & Korea) and developing economies (Pakistan, India & Indonesia) have been incorporated for this study; 4,162 daily basis observations have been taken for each country. Stationarity of data is the underlying assumption for the time series data. Augmented Dickey-Fuller test is applied to check the stationarity of the data.

Once the stationarity assumption is satisfied, Autoregressive Integrated Moving Average is applied to check the predictability of the data. After ARIMA Autoregressive Conditional Heteroscedasticity and Generalized Autoregressive Conditional Heteroscedasticity test are applied to analyze the conditional variance effect on the predictability of the stock returns of all the indices which are incorporated in the study. Moreover, to check the contagion effect of the other selected economies on Pakistan stock exchange GARCH with exogenous factor is applied. All the analysis are performed based on the following models. All the models are research-specific and modified as per the requirement of the study.

Dickey-Fuller General Model

$$KSEy_t = KSEy_{t-1} + u_t$$

ARIMA General Model

$$KSEy_t = a_0 + a_1 r KSEy_{t-1} + \beta_1 r KSE\varepsilon_{t-1} + v_t$$

ARCH and GARCH Model

$$KSEh_t = a_0 + \sum_{i=1}^{q} a_i r KSE\varepsilon^2_{t-i} + \sum_{j=0}^{p} \gamma_j r KSEh_{t-j} + v_t$$

GARCH with Exogenous Factor Model

$$KSEh_t = a_0 + \sum_{i=1}^{q} a_i r KSE\varepsilon^2_{t-i} + \sum_{j=0}^{p} \gamma_j r KSEh_{t-j} + \delta X + v_t$$

**Table 1: Variables Explanation**

| Variable Names | Abbreviation | Measurement |
|---|---|---|
| **Dependent variable** | | |
| Pakistan Stock Exchange | PSX | Take the Index data of Pakistan Stock Exchange. |
| **Independent variables** | | |
| Returns of Pakistan Stock Exchange | Re-PSX$_{(t-i)}$ | Take the returns of Pakistan stock index data. |

| Contagion Variables | | |
|---|---|---|
| Returns of United State Stock Index | Re-S&P $500_{(t-i)}$ | Take the returns of Standard & Poor stock index data. |
| Returns of United Kingdom Stock Index | Re-$LSE_{(t-i)}$ | Take the returns of London stock index data. |
| Returns of China Stock Index | Re-$SSE_{(t-i)}$ | Take the returns of Shanghai stock index data. |
| Returns of Hong Kong Stock Index | Re-$HKEX_{(t-i)}$ | Take the returns of Hong Kong stock index data. |
| Returns of Korea stock Index | Re-$KRX_{(t-i)}$ | Take the returns of Korea stock index data. |
| Returns of India Stock Index | Re-$BSE_{(t-i)}$ | Take the returns of Bombay stock index data. |
| Returns of Indonesia Stock Index | Re-$IDX_{(t-i)}$ | Take the returns of Indonesia stock index data. |
| Returns of Malaysia Stock Index | Re-$KLSE_{(t-i)}$ | Take the returns of Kuala Lumpur stock index data. |

Pakistan Stock Exchange index is taken as a dependent variable because the main purpose of the study is to look after the predictability of stock returns over the past values. Stock index data is collected from the official website of Pakistan stock exchange. Returns of Pakistan Stock Exchange index are taken as an independent variable to check the predictability of stock index volatility. Returns are collected by taking the natural log of stock index data. United States, United Kingdom and selected Asian countries are taken to be as contagion variables. The purpose of this is to overlook the Bi-sectional effect of these countries stock moments to Pakistan stock index. We take the first difference of their index values.

## RESULTS AND DISCUSSION

### *Descriptive Statistics Test Results and Discussion*

Table 2 reports the descriptive statistics of Pakistan, United State, United Kingdom and selected Asian countries stock market indices for the period of 2000-2018. The statistics show a different level of the index. The highest level of volatility in the indexes found in Pakistan stock exchange index, which results that Pakistan stock market is much riskier as compared to other stock markets. There is many reasons both macro and micro level. The most important reason is the political instability and threats of terrorism. As per the global political index, the average score of the political stability index is -2.09, whereas the minimum value of this index is -2.50. Due to this

instability, the inflow of foreign direct investment is low than those countries that have political stability. Other than political instability, another major reason behind that is the culture of family-owned businesses.

**Table 2: Descriptive Statistics of Stock Indices**

| | Obs | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| **KSE100** | 4192 | 11570.88 | 9227.37 | 1457.07 | 36228.88 |
| **S&P500** | 4192 | 1332.36 | 322.84 | 676.53 | 2130.82 |
| **LSE** | 4192 | 5574.60 | 866.70 | 3287 | 7104 |
| **SSE** | 4192 | 2311.80 | 926.23 | 1011.50 | 6092.06 |
| **HKEX** | 4192 | 18079.99 | 5046.45 | 8409.01 | 31638.22 |
| **KLSE** | 4192 | 1185.03 | 404.19 | 428.86 | 5218.86 |
| **BSE** | 4192 | 2676.40 | 1002.48 | 1831.86 | 5218.86 |
| **KRX** | 4192 | 1396.36 | 539.62 | 468.76 | 2228.96 |
| **IDX** | 4192 | 2306.24 | 1659.69 | 337.47 | 5523.29 |

For inferential analysis, take the log returns of Pakistan stock index value by using the following formula.

$$\mathbf{lnR = log}\left(\frac{\boldsymbol{Current\ value}}{\boldsymbol{Perivous\ Value}}\right)$$

After taking log-returns of the index value, the movement of the values was studied through (two-way line) graph. The graph shows the relationship between Pakistan stock exchange returns (on Y-axis) and the selected period from 2000-2018 (X-axis). For the further time series analysis, the element of volatility must exist in the available index values. Graph 1 is extracted to identify the existence of volatility in values. The fluctuated movement of the graph clearly shows the high magnitude of volatility in the selected values and correlation does not seem to be existing.

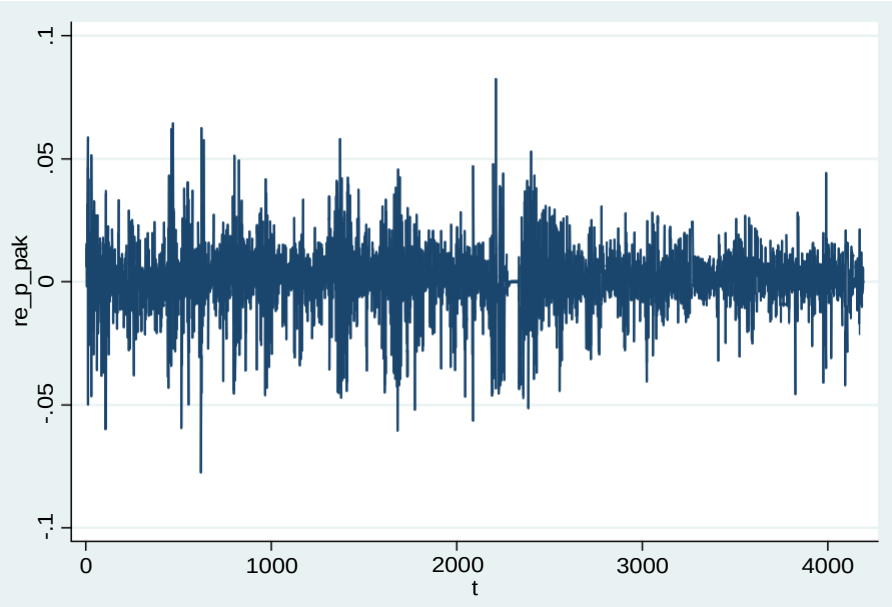


**Figure 1: Time Series Graph of Pakistan Stock Index Values**

***Unit Root Test Results and Discussion***

To check the data has unit root or not, Augmented Dickey-Fuller model instead of Dickey-Fuller is applied. The reason for preferring augmented dickey-fuller over dickey-fuller is to eliminate the problem of autocorrelation. Under augmented dickey-fuller test to check the stationarity assumption has applied on the level as well as on first difference by using three different models (Constant, Trend and None) on data. Table 3 reveals that data does not have the unit root as it shows absolute critical value 3.410 is less than the t-statistic value 60.298 at 5% level of significance

**Table 3: Stationarity Assumptions ADF Analysis**

| Variables | Constant Model | | Trend Model | | Non-Model | |
|---|---|---|---|---|---|---|
| | Critical Value | T-stat | Critical Value | T-stat | Critical Value | T-stat |
| Re-KSE (level) | 2.86 | 60.24 | 3.41 | 60.28 | 1.95 | 60.13 |
| Re-KSE (1st Diff) | 2.86 | 41.90 | 3.41 | 41.09 | 1.95 | 41.75 |

***ARIMA Test Results and Discussion***

To check the volatility of the data ARCH and GARCH are considered as best estimators. However, to proceed further, we must go for the ARIMA model which is the combinations of Autoregression and moving average. From Table 4 it can be viewed that the value of AIC (Akaike information

criterion) and BIC (Bayesian information criterion) confirm that ARIMA (0, 0, 1) model is considered as best fit as its moving averages which is the best definition of ARIMA.

ARIMA factor is calculated by the following method

ARIMA Model

$$KSEy_t = a_0 + a_1 Re\_KSEy_{t-1} + \beta_1 Re\_KSE\varepsilon_{t-1} + v_t$$

Further from Table 2 that MA shows significant results at 5% level. Moreover, results also confirm that we are not facing any kind problem relating to generalizability.

**Table 4: Autoregressive Integrated Moving Average Test**

| Re-KSE | | Coefficients | Std. Error | Z | P>t |
|---|---|---|---|---|---|
| Constant | | 0.00 | 0.00 | 3.23 | 0.01** |
| ARMA | | | | | |
| | MA | | | | |
| | L1 | 0.06 | 0.00 | 6.63 | 0.00*** |
| Sigma | | 0.01 | 0.00 | 148.59 | 0.00*** |

Note: Number of Observations = 4184; chi2 - wald = 43.91**; Prob>F = 0.000***; Bayesian Information Criterion = -24214.88; * 10%* , ** 5%, *** 1% level of Significance

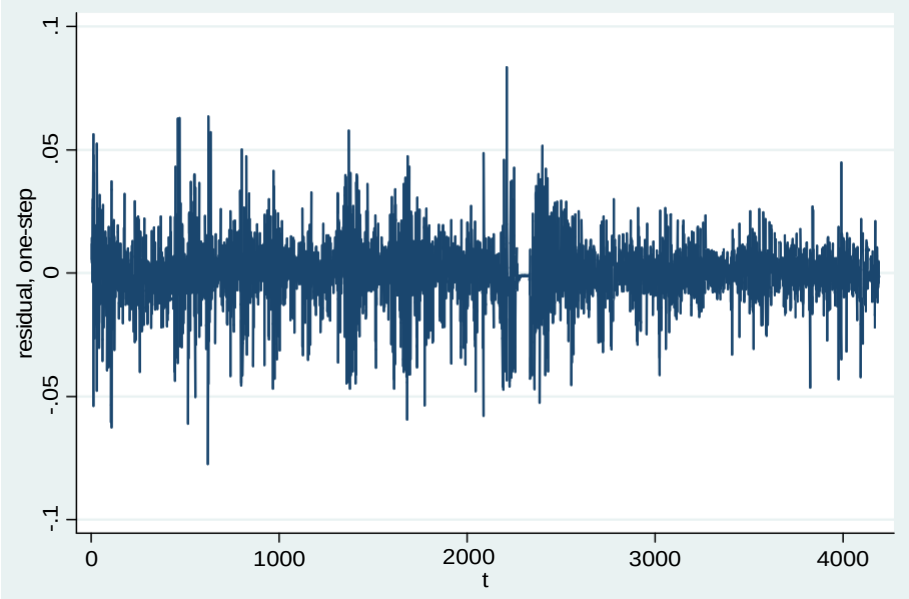


**Figure 2: Time Series Graph of Residuals of Pakistan Stock Exchange Index Values**

Given the literature review, before applying ARCH and GRACH models, the data should fulfil the stationarity assumption. Graph 2 ultimately strengthens the argument of the same trend as discussed in graph 1.

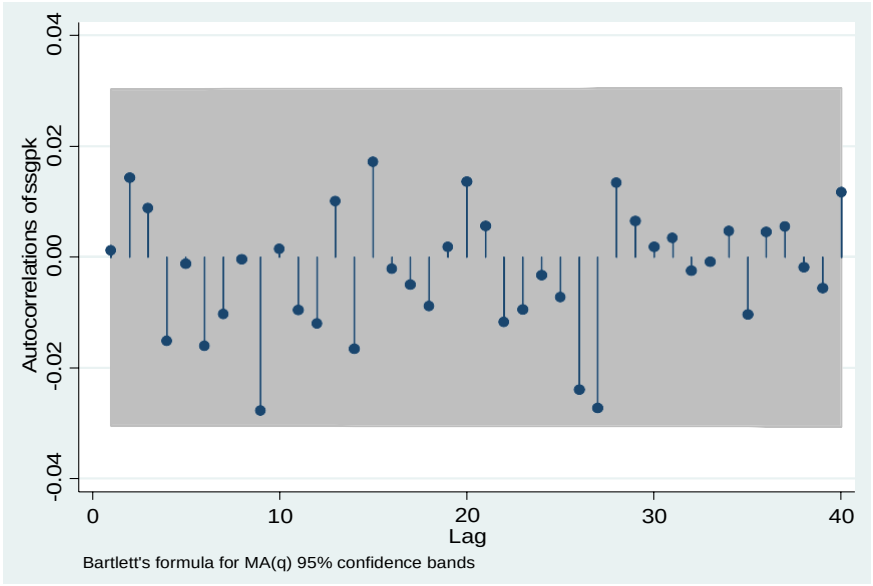


**Figure 3: Autocorrelation Graph**

Graph 3 represents the autocorrelation between the Pakistan stock exchange index values to its very next value. As from the above graph, it is clear that no value is beyond the shaded area, there from the returns values data fulfil the assumption of autocorrelation and for further analysis.

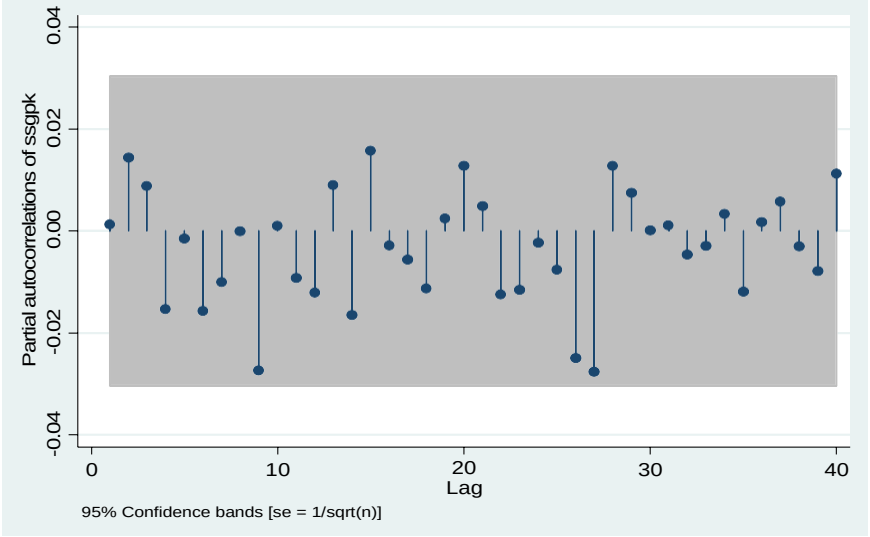


**Figure 4: Partial Autocorrelation Graph**

Partial Autocorrelation graph shows the correlation between lags values of the data set. The lag difference came from the same ARIMA model criteria. As from the above graph, no value is beyond the shaded area, there from the returns values data fulfil the assumption of partial autocorrelation and for further analysis.

### *ARCH and GARCH Test Results and Discussion*

Data in which there is no equal distribution of variance in the error terms, or variance of the error term may be high for some point in time from other data is commonly called heteroscedasticity problem. When there is a discussion about heteroscedasticity problem and the primary purpose of the study is to forecast and analyze the size of the error of the model, the standard test uses are ARCH & GARCH models. The purpose of these models is to provide volatility measure. It is commonly used for decision making regarding risk analysis, portfolio management and derivatives. All these factors are calculated by the following method.

ARCH and GARCH Equations

$$KSEh_t = a_0 + \sum_{i=1}^{q} a_i r KSE\varepsilon^2_{t-i} + \sum_{j=0}^{p} \gamma_j r KSEh_{t-j} + v_t$$

The study is about to forecast and predict the Pakistan stock index volatility, for that ARCH model was first incorporated in the study. Because using ARCG, the mean equation of the model can be derived. Whereas the variance part of the model could be assessed with the help of GARCH. ARCH predicts past trends of the data, whereas GARCH estimates the volatility of the data with the help of residuals.

**Table 5: Autoregressive Conditional Heteroscedasticity**

| Re-KSE | | Coefficients | Std. Error | Z | P>t |
|---|---|---|---|---|---|
| Constant | | 0.00 | 0.00 | 7.93 | 0.00*** |
| ARMA | | | | | |
| | MA | | | | |
| | L1 | 0.06 | 0.01 | 4.77 | 0.00*** |
| ARCH | | | | | |
| | L1 | 0.37 | 0.02 | 17.15 | 0.000*** |
| | L2 | 0.25 | 0.01 | 13.27 | 0.000*** |

Note: Number of Observations = 4184; chi2 - wald = 22.76**; Prob>F = 0.000***;
L Jung- BOX Q statistics = 0.00**; * 10%, ** 5%, *** 1% level of significance

The study uses the Pakistan Stock returns as dependent variables and the mean and variance of the past information as independent variables to forecast the future stock trend. The ARCH model assumed that the variance of the

future returns has an equal-weighted average with past residuals. This assumption seems impractical. Table 5 reveals that alone ARCH model is not enough to get into the forecast of future index trend based on past values. Although the model is a good fit by seeing the value of P, which is (0.000**), Arch with two lags is tested, and both the lags have shown significant results. However, when autocorrelation of the model was checked by using Ljung Box test by using 5 lagged value (0.000**), it came out to be significant and supported the hypothesis that there is an autocorrelation in the ARCH model. Literature review supports that argument to precede future to GARCH when there is an autocorrelation problem in the ARCH model.

Earlier studies suggest that for the sake of best-fit GARCH model must capture all the dynamic aspects of the model of mean and variance. GARCH model consists of two parts, the first part of the model refers to autoregressive lags or ARCH part appears in the equation and the second part of the model refer to moving average lags which is normally called the GARCH term in the model. For this estimated residual should be serially uncorrelated and must not contain any element of conditional volatility. To avoid this, again applied LJung Box test to obtain a mean of zero and variance of unity. After performing the test, we can see that means are equal to zero and as prob> F = 0.8280 also satisfy the situation that the study should opt ARCH (1/2) and GARCH (1/1) to explain the pattern of data specifically for Pakistan.

**Table 6: Autoregressive Conditional Heteroscedasticity**

| **Re-KSE** | | **Coefficients** | | **Z** | **p>t** |
|---|---|---|---|---|---|
| Constant | | 0.00 | 0.00 | 6.14 | 0.00*** |
| ARMA | | | | | |
| | MA | | | | |
| | L1 | -0.80 | 0.06 | -13.19 | 0.00*** |
| ARCH | | | | | |
| | L1 | 0.25 | 0.01 | 15.7 | 0.000*** |
| | L2 | -0.08 | 0.02 | -4.82 | 0.000*** |
| GARCH | | | | | |
| | L1 | 0.80 | 0.00 | 83.01 | 0.000*** |
| Constant | | 5.58E | 4.93E | 11.31 | 0.000*** |

Note: Number of Observations = 4184; chi2 - wald = 8.60*; Prob>F = 0.00***;
L Jung- BOX Q statistics = 0.82**; * 10%, ** 5%, *** 1% level of significance

Mean equation part of the model shows significant results for both lag; however, L1 shows positive results as compared to L2, which creates a negative impact on the model. For the variance part of the model, results are almost like those extracted in mean model keeping the fact in mind that GARCH shows variations derived from the residuals, in this case, it creates a positive effect on the model.

The overall summary of Table 6 can be enumerated as volatility can be explained with the help of past values of the Pakistan stock exchange index. Empirical results of the current study also confirm the finding of earlier literature in this regard.

***GARCH with Exogenous Factor Test Results and Discussion***

This test is applied to check the Contagion effect of leading countries indices and selected Asian countries listed countries on Pakistan stock exchange index. Contagion effect which maintained above is calculated by the following method.

GARCH Equation with Exogenous Factor

$$KSEh_t = a_0 + \sum_{i=1}^{q} a_i r KSE\varepsilon^2_{t-i} + \sum_{j=0}^{p} \gamma_j r KSEh_{t-j} + \delta X + v_t$$

After volatility forecasting of Pakistan stock index, the second most crucial part of this study is to examine the contagion effect on Pakistan Stock index. The indices that are used to monitor the contagion effect on Pakistan stock exchange (bi-sectional) are US, UK and selected Asian countries. This would help to predict the effect of the stock indices volatility of those countries on Pakistan Stock market index. The study has applied ARCH in mean effect to determine the effect on intercept on the Pakistan stock index and for effect on slope used conditional variance effect. This is also known as Heteroscedasticity.

Table 6 results revealed that there is a significant impact (p-value = 0.000**) on Pakistan stock index intercept by US, UK, on the other hand there are no such evidence from the selected Asian countries listed countries stock markets except Malaysia stock index return who have an impact on Pakistan stock exchange, which has positive and significant in nature. Historical evidence had revealed that emerging market always take aftershocks of developed markets crisis. It also showed the interdependence of one equity market with other equity markets, Burdekin and Siklos (2012).

**Table 7: Autoregressive Conditional Heteroscedasticity**

| Re-KSE | Coefficients | | Z | p>t |
|---|---|---|---|---|
| Re-S&P | -0.00 | 0.02 | -0.36 | 0.00** |
| Re-LSE | 0.00 | 0.01 | 0.52 | 0.04** |
| Re-HKEX | 0.24 | 0.01 | 0.52 | 0.05** |
| Re-SSE | 0.01 | 0.00 | 1.09 | 0.27** |
| Re-BSE | -0.00 | 0.01 | -0.52 | -0.52 |
| Re-KRX | 0.00 | 0.01 | 0.25 | 0.80 |
| Re-KLSE | 0.05 | 0.01 | 3.07 | 0.00** |
| Re-INX | 0.01 | 0.00 | 8.09 | 0.00 |
| Constant | | | | |
| ARMA | | | | |
| MA | | | | |
| L1 | 0.045 | 0.01 | 2.62 | 0.00*** |
| ARCH | | | | |
| L1 | 0.25 | 0.01 | 13.9 | 0.000*** |
| L2 | -0.09 | 0.01 | -4.9 | 0.000*** |
| GARCH | | | | |
| L1 | 0.81 | 0.00 | 81.59 | 0.000*** |
| Constant | 5.29E | 5.12E | 10.34 | 0.000*** |

Note: Number of observations = 4184; chi2 - wald = 56.55*;
Prob>F = 0.00***; * 10%, ** 5%, *** 1% level of significance

The results of contagion effects reveal that there exists strong effect of leading stock exchange indices on Pakistan stock market on the slope as well. The results in Table 7 illustrate P value = 0.000** that in the high volatility period of leading countries US & UK, the effect seems on Pakistan stock Exchange momentum may a case of political crisis, economic pressure or devaluation of their financial assets or some common interest among these countries with Pakistan.

The evidence was quite similar to the study of (Burdekin & Siklos, 2012). Their study comes with the point of view that financial shocks come from leading stock exchanges, i.e. US, UK may impact Asian Pacific region financial markets because of the dollar-dominated region. Karunanayake, Valadkhani, and O'Brien (2010) Reported that developing financial market always taken impact positive/negative from developed financial markets. Sakthivel, Bodkhe, and Kamaiah (2012)Came with the view that the US stock market affect developed and developing stock markets.

The study also examines the contagion effect of countries listed in selected Asian countries. The finding concludes that there is an impact on Pakistan stock exchange by some of the emerging countries stock movements, but its magnitude is the least important. The results were explained by Batten and

Szilagyi (2011) and Das (2012). Their studies indicate that in developing countries, the stock markets prevent volatility transmission across countries. However, this study supports the literature, that Pakistan stock market seems to be less effective by contagion factor. This argument is supported by Batten and Szilagyi (2011), who argued that developing countries work on their financial system and implement some financial strategies to overcome the contagion effect from the same regions.

## CONCLUSION

The study was conducted to understand the significant variables that caused volatility in Pakistan's stock exchange. The analysis was conducted on historical indices and results showed a significant impact of historical values on Pakistan's stock index volatility. This is clear that complete volatility cannot be predicted based on historical values due to the sensitivity upon other macro variables like political instability and terrorism. The past literature also supports this argument, especially in the case of Pakistan. Pakistan market is very volatile to both domestic and international events. Khan and Khan (2011) study the variables behind predicting the trend, and as per his results, dividend policies do have some impact on future trend, but the magnitude of this impact is minimal.

This study was further enhanced in 2012 when Suleman studied the same phenomenon using the historical data of KSE 100 index. His primary focus was on terrorism and its impact on Pakistan's stock exchange. He studied the aftershocks of London bombs attacks 2004-2005. As per his results, those attacks had a severe impact on the stock market of Pakistan, which created high volatility in the market. His research also shows that Pakistan economy is sensitive to international events as well.

Hanan et al., (2012) defined two variables of volatility; political instability and terrorism, which caused the outflow of foreign direct investment which again damaged the sentiment of the investors and created high volatility in the stock market. According to Sajjad et al., (2013), the market responds more quickly to rumours spreading in the market as compared to its past trend. This shows that historical values can be used for predicting the future trend of a stock index, but the overall forecasting cannot be done on the basis of past values.

The results of GARCH with exogenous factor clearly shows that contagion effect does exist in the Pakistan stock market. The contagion effect of leading stock markets has a significant impact on the Pakistan stock market as compared to selected Asian countries. The contagion effect of the US stock market has a significant impact on the Pakistan stock market mainly due to

dollar-denominated region. The past literature also supports this argument, as explained by (Burdekin & Siklos, 2012). Their study comes with the point of view that financial shocks come from leading stock exchanges, i.e. US, UK may impact Asia Pacific region financial markets because of the dollar-denominated region. Karunanayake et al. (2010), Reported that developing financial market always takes impact positive/negative from developed financial markets. Sakthivel et al. (2012), Came with the view that the US stock market effect developed and developing stock markets.

The result from the predictability of stock returns shows that the past movement of Pakistan stock index values may have a direct effect on Pakistan stock index volatility. Including the contagion effect of some other major stock markets. Pakistan stock market is not so strong and developed, so it is elementary to depress the sentiments of the investor by any secondary reason, which creates unnecessary volatility in the stock market. The literature supports the argument that the stock markets are affected by global events such as political turmoil, uncertainty in the developed stock market, economic pressures and natural disaster. Whenever there is research on the equity market, one thing is evident in the fact that volatility and contagion factors always stand as the most important consideration for financial intuition, policymakers and investors.

Based on this study, some suggestions can be offered to overcome the surprise element of unexpected market volatility. Use the average cost of an asset as a benchmark on a monthly or quarterly basis rather than the current market value. It is a good strategy when the market is facing high volatility. Open the barriers for foreign investors as it also helps to control the high volatile market and to make it stable. However, it is not a sustainable long-term strategy. The regularity body, like the security exchange commission of Pakistan should make strategies to monitor the stock market and should research to avoid the artificial bubbles in the stock market of Pakistan. The need of the hour is to work seriously and develop the derivative market in Pakistan. It also helps investors from the high volatile market by using third-party protection.

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