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The volatility of bank stock prices and macroeconomic fundamentals in the Pakistani context: an application of GARCH and EGARCH models

JEL Classification: *C58; C32; G21; O11*

Keywords: *bank stock return; OLS-HAC; GARCH; EGARCH*

Abstract

Research Background: The banking sector plays a crucial role in the world's economic development. This research paper evaluates the volatility spillover, symmetric, and asymmetric effects

between the macroeconomic fundamentals, i.e., market risks, interest rates, exchange rates, and bank stock returns, for the listed banks of Pakistan.
Purpose of the article: The main purpose of this study is to examine the volatility of Pakistani banking stock returns due to the influence of market risk, interest rates, and exchange rates. Pakistan is selected for the study because the volatility of its banking stock returns is strongly influential in achieving sustainable economic development.
Methods: By applying the OLS with the Heteroskedasticity and Autocorrelation Consistent (HAC) covariance matrix, the GARCH (1, 2), and the EGARCH (1, 1), analysis is conducted for the period from January 1, 2009 to December 31, 2019 using samples of 13 listed banks.
Findings & Value added: The ARCH parameter is significant in the OLS with the HAC covariance matrix estimation, which is a clear indication of the existence of heteroskedasticity in the squared residuals and the inaccuracy of the OLS with the HAC covariance matrix. The results of the OLS with the HAC covariance matrix suggest using the GARCH model family to accurately measure the volatility of bank stock prices. The results of the mean equation in the GARCH (1, 2) and EGARCH (1, 1) indicate the positive significance of market risk and the low significance of interest and exchange rates, confirming that market returns strongly affect the sensitivity of bank stock returns compared to interest and exchange rates. It should be noted that the ARCH (α) and GARCH (β) parameters of the variance equation fulfill the non-negative conditions of the GARCH model. Furthermore, the leverage parameter (λ) is found to be positively significant for all banks, and volatility is found to be influenced by positive shocks compared to negative shocks. Conclusively, it can be stated that market returns determine the dynamics of the conditional returns of bank stocks. Nevertheless, the interest and exchange rate volatilities determine the conditional bank stock returns' volatility.

Introduction

The economic development and financial institutions of a country are parallel and correlated with each other. Expanding financial institutions leads to high risk with high financial leverage. Banks as financial institutions play a vital role in providing liquidity to financial markets; however, operational problems and failures have the potential to crash the whole economy. Financial growth contributes to economic growth via different channels such as banks, insurance companies, saving schemes, finance development institutions, investment modes, stock markets, corporate brokerage, leasing, discount houses and microfinance institutions. These financial institutions, companies, and houses are capable of pooling and diversifying the determinants of risk to minimize the risk of financial transactions; furthermore, exploiting incentives can reduce the cost of financial intermediaries related to the scope and scale of the economy and increase the sense of saving and investment and the optimization (minimum input and maximum output) of economic resources. This research is keenly connected with the impacts and relationships of the leading financial institutions, i.e., the banking sector, with some specific macroeconomic fundamentals.

The banks of a country play a significant role in achieving sustainable economic growth. The banking sector positively contributes to 95% of the economic growth of Pakistan (Hussain *et al.,* 2011). Bank performance and economic growth are strongly connected (Ekinci, 2016). A significant role is played by the efficiency of the banking sector and credit channels to provide continued and low-cost funding for corporations. While conducting the intermediation function, banks hold and manage different types of risks such as market risk and interest rate change risk. Exchange rate change risk and these other risks affect the volatility of bank stock returns. The sensitivity of bank stock returns to interest rates and exchange rates can be assessed by using different models and hypotheses such as the ICAPM (Merton, 1973; Patnaik & Shah, 2004) and APT (Sweeney & Warga, 1986).

Financial analysts and economists agree that the sudden or unexpected fluctuations in interest rates and exchange rates directly influence the costs and returns of financial institutions' common stocks (Saunders & Yourougou, 1990; Kasman, 2011). The relationship of banks' stock returns and macroeconomic fundamentals is exemplified by a well-known theoretical stock evaluation method, which indicates that the present value is an approximation of the current equity share prices for all future cash flows, and macroeconomic variables are factors influencing cash inflows and the rate of return. Some macroeconomic fundamentals generally measure stock returns. For a specific period, the fluctuation of stock prices is called the stock return volatility. Some leading macroeconomic fundamentals such as the market risk, interest rate risk, and exchange rate risk vary and become the causes of bank stock return volatility. The upward trend in risk may urge investors to switch their investments from bank stocks to bonds, which are a less risky investment. Financial market liberalization facilitates banks' operations beyond their borders, and they become exposed to the factuality of interest rate risk due to financial market conditions. This situation eliminates the exploding effects of exchange and interest rates (Scott & Peterson, 1986; Gilkeson & Smith, 1992). The sensitivity of common bank stocks is volatile due to the variation in market interest rates (Sukcharoensin, 2013; Elyasiani *et al.,* 1992; Choi *et al*., 2019; Ahmad *et al.,* 2019).

Past examinations assessed the effects of the nearness of market risk and interest rates on banking stocks, which were not depicted by the returns in the available portfolio. A divergent market index model of bank security returns is evaluated and approved by Kane and Unal (1988), Booth and Officer (1985), Stone (1974b), and Merton (1973). The extent of development is emphatically affected by the codevelopment of bank stock returns, changes in interest rates, liabilities and nominal resources (Nor *et al.,* 2020, Flannery & James, 1984, 1981). However, Ekinci's (2016) exact discoveries demonstrate that credit risk adversely affects, the exchange rate (currency conversion scale) positively affects, the market positively affects and they altogether influence the bank stocks of Turkey while the interest rate has an insignificant effect. Different balance sheet activities and the execution of adequate risk management methods and techniques are coordinated to diminish the risk exposure of banking organizations due to changes in interest and exchange rates. Comprehensive empirical studies have strongly supported the existence of sensitivity among bank stock returns, exchange rate risk and interest rate risk (Kane & Unal, 1988; Sweeny & Warga, 1986). Bae (1990), and Fama and Schwert (1977) examined the explanatory power of a single factor model after the inclusion of an interest rate determinant. In contrast, Nelson and Foster (1995) and Chand *et al.* (2012) used the ARIMA-GARCH type model to prescribe the residuals' volatility attained under the best-fit model for time series data by using the daily closing prices of Pakistani banks, proving that the GARCH (1, 1) model is the best-fit model to capture volatility clustering compared to several other considered models.

Chamberlain *et al.* (1997) and Choi *et al.* (1992) explained the exposure to the exchange rate and concluded that interest rate sensitivity has stronger evidence compared to exchange rate sensitivity. Common stock returns are indirectly influenced by unexpected inflation. Emerging countries' financial institutions are more often experienced with this sort of financial crisis (Choi *et al.,* 2019). Estimating the unpredictability of the interest rate and the exchange rate is significantly important for financial stability, banking policy formulation, and regulatory organizations. Many researches have further proven the effect of the interest rate and have unequivocally delineated the joint association of market risk volatility, interest rate volatility, exchange rate volatility, and bank stock returns. However, some previous studies only provide empirical evidence for developed markets.

Our research paper differs from the previous literature on the listed banking sector of Pakistan in several points. First, we used 65% of Pakistani listed banks as the sample of this study. Second, there is wide data coverage for 11 financial years from January 2009 to December 2019, which is broader than the coverage of the previous literature. Third, this is the first study that evaluates banking sector volatility after the worldwide 2007–2008 economic crisis, and it seeks to avoid outliers and achieve more accurate results. Fourth, despite the clear significance of a comprehensive correlation of MRK, INT and EX with bank stock returns, no research paper has investigated the comprehensive effects of these variables in Asian emerging markets or Pakistan. Although considerable literature is available on this issue, it is related to developed markets. Previous literature on Pakistan has mainly applied the OLS and GLS to bank stock returns and ignored GARCH type models. Fifth, this is the first study to estimate both symmetric and asymmetric relationships by using the OLS with the HAC covariance matrix estimation (Newey & West 1987), the GARCH (p,q) model, and the EGARCH (p,q) model for Pakistani banking stock returns. Additionally, this study seeks to identify the possible factors explaining the observed volatility of the banking sector using symmetric and asymmetric evaluation. Finally, the rolling window approach is employed to check the robustness.

The remainder of this paper is organized as follows. Sections 2, 3 & 4 consist of the data description and methodology, empirical results, and conclusion of the research, respectively.

Research methodology

Data description

This research comprises two data samples. The first data sample contains daily data for the group of 13 KSE listed trading commercial banks over the period of 11 years from January 2009 to December 2019 (2725 trading days) (available at https://www.psx.com.pk/). Total capatilization of KSE-100 index is 6272.467 (PKR Billion) in which 1285.73 (PKR Billion) contribution of banking sector it's approximately 20.50% of total capatilization (available at https://dps.psx.com.pk/sectors). The second data sample consists of macroeconomic variables, i.e., the market risk, interest rates and exchange rates, within the same time span (available at www.investing.com). The Pakistan Stock Exchange "100" index is used to measure the market risk. The Pakistani government bond one-year yield is considered as the proxy of the interest rate, and the exchange (Ex) rate is based on the PKR/US dollar exchange rate. The basic reason for the sample selection is the time specification. Trading commercial banks are merged and newly established; therefore, we cannot approach all registered banks. The 20 listed banks met the basic conditions and were initially selected for this study, but the serious issue of nontrading days was observed in the data. Olbryś (2018, 2019) explained emerging markets' nontrading problem. To alleviate this issue, we exclude the stocks that exhibited unusual nontrading days during the whole sample period above 272 zero in daily volume, which constituted approximately 10% of the 2725 trading days. 15 commercial banks were included in the database, two of which were excluded due to inconsistencies between macroeconomic fundamentals and bank stock prices. To avoid the different types of problems in data and ensure the accuracy of the results and direction of study, finally, 13 commercial banks met all requirements and qualified for the analysis. Table 1 lists the individual bank samples and the macroeconomic variables with names and abbreviations.

Methodology

First, the following formula calculates the return of all bank stock prices and macroeconomic variables:

$$r_t = log \left[\frac{P_t}{P_{t-1}}\right] \quad (1)$$

In equation 1, P_t is the current price variable with respect to time t, and P_{t-1} is the previous price variable at time t. Figure 1 shows the return series of all dependent and independent variables.

The OLS with the HAC covariance matrix estimator is used to determine the impacts of the macroeconomic factors, i.e., MRK, INT, and EX, on the sensitivity of bank stock returns. This empirical model is also used by (Kasman, 2011; Olbryś, 2018; 2019).

$$r_{t,i} = \beta_0 + \beta_1 MRK_t + \beta_2 INT_t + \beta_3 EX_t + \mu_t \quad (2)$$

$r_{t,i}$ represents the returns of individual bank stock prices at time *t*, MRK_t is the market risk return and reflects economy-wide aspects, INT_t is the interest rate and EX_t is the foreign exchange rate returns. β_0 is the intercept term, and the independent variables are represented by $\beta_1, \beta_2,$ and β_3. μ_t is a standard error term that is assumed to follow an i.i.d., i.e., in the likelihood hypothesis and measurements, a grouping or the other gathering of arbitrary factors is independent and identically distributed (i.i.d.) if every random variable has an indistinguishable likelihood dissemination from the other and all are mutually independent.

The OLS with the HAC covariance matrix estimation is initially employed for individual bank stock returns (Newey & West, 1987). Due to the presence of the ARCH effect, the OLS with the HAC covariance matrix estimation may not be fully correct, which is why the Lagrange Multiplier (LM) test is used to assess the ARCH effect. The significance of the ARCH parameter by employing the OLS with the HAC covariance matrix estimation confirmed the existence of heteroskedasticity in the squared residuals, and the results of the OLS with the HAC covariance matrix became unstable. To overcome the instability of the OLS results with the HAC covariance matrix, the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) type process was introduced (Bollerslev *et al.,* 1992; Engle & Nelson, 1994; Shah *et al.,* 2019). As per the previous literature, the GARCH (p,q) (1,2) model is more suitable and guarantees the accuracy better than other models, so we also employed the GARCH (1,2) in this research (Bollerslev, 1986; Tasy, 2010). The selection and comparison criteria of GARCH type models are the Log Likelihood (LL), Akaike information Criterion (AIC) and Schwarz Information Criterion (SIC). The GARCH (1, 2) is defined as follows:

$$r_{i,t} = \gamma_0 + \gamma_1 MRK_t + \gamma_2 INT_t + \gamma_3 EX_t + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} = z_{i,t}\sqrt{h_{i,t}}\ \ z_{i,t} \sim N(0,1) \tag{3}$$

$$h_{i,t} = \alpha_{i,0} + \sum_{j=1}^{q} \alpha_{i,j}\varepsilon_{i,t-j}^2 + \sum_{l=1}^{p} b_{i,l}h_{i,t,l}$$

or (4)

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$$

In equation 4, $\alpha_{i,0} > 0;\ \alpha_{i,j} \geq 0;\ j = 1, \dots, q;\ q > 0;\ b_{i,l} = , \dots, p;$ and $p \geq 0$. However, $\varepsilon_{i,t}$ is an innovative addition in the linear regression with variance function V $(\varepsilon) = \sigma^2, h_{i,t}$. The variance equation can be simply defined as $\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$. The details of other parameters are the same as those defined before in Eq. 2. The variance equation includes the long-run average volatility α_0, the preceding period's volatility α_1 (ARCH) and the previous period's forecast β (GARCH) terms. The assumption of the GARCH (1,2) in the conditional variance is that α_0, α_1 & β should be positive to meet the non-negativity condition, and the sum of α_1 and β should also be $\alpha_1 + \beta \leq 1$ for the consistency to hold. The GARCH (p,q) model's parameters are estimated by the Maximum Likelihood (ML) or the Quasi-Maximum Likelihood (QML) method, which can help to make a suitable choice for the conditional distribution of innovation. If the estimation of the conditional mean is the primary focus of the researcher, then the appropriate description of the conditional variance is also important. A more efficient and accurate conditional mean can be estimated with the conditional variance description (Hamilton, 2008).

The exponential GARCH (1,1) model is used next to determine the leverage effect of macroeconomic fundamentals and bank stock returns. Nelson (1991) introduced the EGARCH (1,1) model to measure the impact of leverage on volatility. The mean equation is similar to the above equation. The following equations estimate the EGARCH (1, 1):

$$\ln(\sigma_t^2) = \alpha_0 + \frac{1+\beta_1 B+\cdots+\beta_{q-1}B^{q-1}}{1-\alpha_1 B-\cdots-\alpha_p B^p}.g(z_{t-1}) \quad (5)$$

$$\varepsilon_t = \sigma_t.z_t,$$

$$\varepsilon_t|F_{t-1} \sim N(0,\sigma_t), z_t \sim N(0,1)$$

$$g(z_t) = \theta.z_t + \gamma.[|z_t| - E(|z_t|)]$$

$$g(z_t) = \begin{Bmatrix} (\theta+\gamma).z_t - \gamma.E(|z_t|) if\ z_t \geq 0, \\ (\theta-\gamma).z_t - \gamma.E(|z_t|) if\ z_t < 0 \end{Bmatrix}$$

Since EGARCH (p,q)= EGARCH (1,1) is a simple case, Eq. (5) becomes:

$$(1-\alpha_1 B).\ln(\sigma_t^2) = (1-\alpha_1 B).\alpha_0 + g(z_{t-1})$$

The equation can be rewritten (the subscript of α_1 is omitted), and then:

$$\ln(\sigma_t^2) = \alpha_0^* + \alpha.\ln(\sigma_{t-1}^2) + g(z_{t-1})$$

$r_{t,i}$ represents the conditional variance, F_{t-1} represents the given past information, α_0 is a constant, the lag operator represented by B is $1+\beta_1 B+\cdots+\beta_{q-1}B^{q-1}$ and $1-\alpha_1 B-\cdots-\alpha_p B^p$ are the polynomials with outside unit circle zeros and no commonality between factors. The symbolic representation of $g(z_t)$ is a combination of the magnitude and sign of z_t, which accommodates the asymmetric relationship between bank stock returns and volatility, as Nelson (1991) mentioned regarding the relationship between stock returns and volatility. A summation of z_t and $[|z_t| - E(|z_t|)]$ makes $g(z_t)$ linear combinations with coefficients $\theta\ and\ \gamma$. The magnitude measurement scaled by the term is in brackets, and the lagged standardized innovations to volatility are symmetrically considered by coefficient γ. The coefficient θ is used to check the standardized shocks to asymmetric volatility. The effect of the values' signs can be measured by the term $\theta.z_t$ while $\{g(z_t)\}_{t=-\infty,\infty}$ is a random sequence that is i.i.d. with zero mean. The sign of λ represents the leverage effect. A $\lambda < 1$ and significant guarantees the existence of the leverage effect and negative shocks that have a greater impact on volatility compared to positive shocks; conversely, $\lambda > 1$ indicates the opposite.

$$r_{i,t} = \gamma_0 + \gamma_1 MRK_t + \gamma_2 INT_t + \gamma_3 EX_t + \varepsilon_{i,t} \qquad (6)$$

$$\ln(\sigma_{i,t}^2) = \alpha_{i,0}^* + \alpha_i . \ln(\sigma_{i,t}^2) + \theta . z_t + \gamma_i . [|z_t| - E(|z_t|)] \qquad (7)$$

The mean equation is similar to the above equation, as defined before, and equation 7 is used to calculate the EGARCH (1,1) model for individual bank i. Furthermore, the GARCH (p,q) model is used to examine whether the interest rate and the exchange rate volatility have any effect on an individual or portfolio of bank stock return volatilities. No exogenous variable is considered in the mean equation because the focus of this equation is to determine the variance equation or volatility. The volatilities of interest and exchange rates are evaluated by using INT_t^2 and EX_t^2, respectively.

$$r_{t,i} = \gamma_0 + \varepsilon_t$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \theta_1 INT_t^2 + \theta_2 EX_t^2 \qquad (8)$$

Results and discussion

Descriptive summary

Table 2 shows the descriptive summary and ADF test for the individual bank stock returns and macroeconomic factors, i.e., $MRK, INT,$ and EX. The average values of banks range from -0.03 to 0.08, MRK is 0.0719, INT is 0.0093, and EX is 0.0107. The return distribution is positively skewed for all banks. The macroeconomic fundamentals have positive and negative skewnesses. MRK is negatively skewed while EX and INT are positively skewed. The fundamentally large value of the kurtosis with a normal distribution means that the data are leptokurtic and suddenly topped around the mean. The Jarque-Bera test is used to determine whether the macroeconomic fundamentals and bank stock returns are normally distributed. The Jarque-Bera test is positively significant at the 1% level, which reflects the non-normality of the data distribution. Since the results reject the hypothesis of a normal distribution, we take the logs of all series to convert them into normally distributed data series. The results of the ADF test show that the measurement of continuously compounded returns has removed the unit root from each data series (Dickey & Fuller, 1979; 1981; Jiménez-Rodríguez & Sánchez, 2012). The ADF test is significant at the 1% level in all continuous compounded return series.

The OLS with the HAC Covariance Matrix Estimation for Individual Banks

The OLS with the HAC covariance matrix estimation was applied to the bank stock returns and macroeconomic fundamentals. However, the OLS with the HAC estimation was not fully correct due to the presence of the ARCH effect in every individual bank stock return (Newey & West, 1987). If the autocorrelation or heteroskedasticity contains a squared residual, the null hypothesis will likely be rejected (Kasman, 2011; Elyasiani, 2003). The theoretical logic behind the no autocorrelation hypothesis is the similarity, repetition, noise, or missing lag values between series over time. Residual serial correlation exists for all banks individually. The OLS with the HAC covariance estimation seriously failed to support residual serial correlation, and the accuracy of the residual estimation is not more accurate and efficient due to the standard t and F-statistics. Therefore, the family of GARCH (p,q) models would have all be more reasonable for assessing this sort of data information.

Estimation of returns using the GARCH (1,2) Model

The GARCH (1,2) estimates of the restrictive return equation model can be seen in table 3. According to previous research, the GARCH (1,2) has a lower order and is employed the most (Tsay, 2010; Olbryś, 2018, 2019). The Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) also support the GARCH (1,2) model, which is why we have applied the GARCH (1,2) in our research. The parameter γ_1 is used to measure the impact of the market risk returns (MRK) of the bank stock returns. The parameter is positive and statistically significant for 9 out of 13 bank stock returns. The coefficients γ_2 and γ_3 of the mean equation represent the effects of INT and EX on bank stock returns, respectively. γ_2 shows a positive and significant relation with the conditional return in 3 cases, and γ_3 shows a positive and significant relation with the conditional return in 2 cases and a negative and significant relation with the conditional return in 1 out of 13 cases. These results agree with those of Kasman *et al.* (2011), Shanken (1990) and Ferson (1989). Second, the conditional mean equation is observed to be large in magnitude, and MRK is unequivocally significant for every individual bank. The facts and figures are taken from all banks, which are incorporated into the KSE-100 index. Clearly, MRK is found to explain a greater extent of the contingent or conditional bank stock returns. The extent of foreign money, foreign currency, designated resources, and liabilities in a bank's monetary records is influenced by the negative association with the foreign exchange rate, i.e., EX. A bank's balance sheet can be directly influenced by unanticipated changes due to the gains and losses from a position on foreign currencies. Regarding the contemporaneous state of a bank specifically tied to foreign trade, when foreign currency-denominated liabilities surpass foreign currency designated resources or assets, the local currency's devaluation may damage the bank's monetary records (Chance & Lane, 1980; Adler & Dumas, 1983; Chen & Chan, 1989). Banks' deterioration can decrease the return of a bank stock. The sensitivity of net interest income (NII) and other interest rates can negatively affect a bank's common stock. A sudden increase in interest rates will contrarily influence the balance sheet of the bank, and the normal span time of assets in a bank is longer than its liabilities. The intensification of nonfinancial borrowers' income might experience an immediate effect from the effect of an increased INT of the market on the bank monetary record. In the return generation process, the intercept (α_0) is positively significant for every individual bank, and this shows that there is a significant time-invariant segment. Both the ARCH and GARCH parameters (α & β) fulfill the non-negative condition. The results show the greater value of the GARCH parameter compared to the ARCH parameter, which is an indication that each stock return is highly sensitive to its own lagged value rather than to a news shock. The sum of $\alpha_1 + \beta \leq 1$ for the 13 cases. The volatility of bank stock returns has exceedingly persistent impacts, and the response of volatility degenerates at a minimal rate. The fitness of the model is confirmed by the ARCH LM test with no ARCH effect.

Estimation of returns using the exponential GARCH (EGARCH) model

The results of the EGARCH (1, 1) parameters of the restrictive return model are listed in table 4. The autoregressive coefficients γ_1, γ_2, and γ_3 experience mixed positive and negative significant results. The functionality of the conditional variance is based on the past conditional variance and past innovations. The coefficient α_1 is positive and significant for all individuals; the coefficient β_1 is significant in 9 (5 negative and 4 positive) cases out of 13; and except for JSBL, the coefficient λ is positive and significant for the remaining 12 cases.

Additionally, the positive significance of all λ coefficient values indicates that positive shocks or innovations intensively affect volatility compared to negative shocks. As Olbryś and Majewska (2017) and Olbryś

(2020) explained the three conditions and the themes of the equation, if $\delta_i = \theta_i / \lambda_i$ <0, then negative shocks or events have higher and stronger impacts than positive shocks on volatility. When the asymmetry effect is equal to zero as $\delta_i = 0$ ($\theta=0$, $\lambda_i = 0$) means, the magnitude of the term controls the volatility, which is comparatively low. The last conditional asymmetry effect is greater than zero and lower than 1, i.e., 0< $\delta_i = \theta_i / \lambda_i$ <1. This situation indicates that positive shocks or innovations would increase the volatility of bank stocks more than negative shocks or innovations. The results of this research support that positive innovations contribute to volatility more than negative innovations. The concerning details of our results are that α_1 and λ are positive and significant in most of the cases while β_1 is negative or positive and significant for 9 out of 13 cases. The positive coefficient λ banks have a significant leverage effect with a positive sign, which means that positive shocks are more affected than negative shocks, and a leverage effect does not exist (Nelson, 1991; Verma, 2016; Hahm, 2004; Hooy *et al.,* 2004).

The summation of both parameters (α & β) is more than one, which shows that the covariance is stationary for the conditional variance in all cases. The GARCH (β) value is greater than the ARCH (α) value, indicating that the past behavior of the variance σ^2 is stronger than that of the past squared error term ε_{t-1}^2 (Ekinci, 2016). The results of the corresponding coefficient $\delta_i = \theta_i / \lambda_i$ show that there are 5 negative and 8 positive indices. The negative index coefficients show that a negative impact results in higher volatility whereas the positive coefficients confirmed that the EGARCH model was the best fit but comparatively poor qualitatively (Black, 1976). The ARCH LM test confirmed the fitness of the model with no further ARCH effect, in line with (Salamat *et al.,* 2020).

Estimation of the volatility of bank stock returns and macroeconomic fundamentals with the GARCH (1,2) model

The results of bank stock return volatility considering the interest rate (INT) and exchange rate (EX) volatility are presented in table 5. The weak support for previous shocks of bank volatility is represented by a small and significant ARCH parameter α_1 whereas the robust evidence of previous surprises is represented by a larger and significant β (GARCH parameter). For α_1 and β_1, the proportion of the volatility that lasts is moderately high when INT and EX are incorporated. The impacts of INT volatility on bank stock return and MRK volatility indicate that the evaluation coefficient θ_1 is positive and significant for 8 banks. The proliferation of the volatility of bank stock returns is a short response to rising interest rate volatility. Their proficient holdings of derivative securities and corresponding durations of assets and liabilities have enabled the banks to withstand interest rate risk. As per the outcomes of Elyasiani and Mansur (2003), Pakistani financial institutions have been negligent in implementing effective risk management techniques and implementing derivative instruments. The parameter θ_2 is observed to be certain and significant in 7 out of 13 cases. Based on these results, an increase in EX increases bank stock return volatility. In the global banking context, foreign exchange rate risk was significant in the Pakistani bank context over the sample period (Choi *et al.,* 1992; Kasman *et al*., 2011; Wetmore & Brick, 1994; Ryan & Worthington, 2002). The exchange rate return volatility and the volatility of bank stock returns are positively related to each other.

Robustness analysis

The results of the rolling window analysis are presented in table 6. With the time period specified, the stability of the empirical results is examined. The sample period covered 11 years of data, which is quite a long sample period. This is why the robustness test is based on a 6-year rolling window approach (Olbryś, 2019). We utilized six-year time windows: Window 1: 01.01.2009-31.12.2014, Window 2: 01.01.2010-31.12.2015, Window 3: 01.01.2011-31.12.2016, Window 4:02.01.2012-30.12.2017, Window 5: 01.01. 2013-31.12.2018, and Window 6: 01.01.2014-31.12.2019.

The coefficients of the GARCH (1,2) are used to estimate the individual stocks within each window because the OLS with the HAC covariance matrix was not fully corrected due to having the ARCH effect. In total, 234 models are investigated individually, covering a large number in itself. The summarized results of the rolling window approach in table 6 show that 9, 8, 10, 9, 10, and 7 of the market risk coefficients are positive and significant; and 0, 0, 1, 1, 0, and 0 of the market risk coefficients are negative and significant in the six respectively windows. The table also shows that 3, 5, 2, 0, 0, and 0 of the interest rate coefficients and 1, 1, 1, 0, 2, and 0 of the exchange rate coefficients are positive and significant in the six respective rolling windows; and no negative and significant coefficients are observed for the interest rate and exchange rate in the six rolling windows. Moreover, the 6-year rolling window stability test clearly supports the hypothesis of the research that there is a relationship between bank stock returns and macroeconomic variables, especially market risk, which has a stronger impact than interest and exchange rates.

Conclusions

Recently, bank stock returns and volatility have become influenced by market risk, interest rates, and exchange rates, as well as free capital flows, fiscal policy, communication, trading, and technological development. Pakistan is a developing country similar to many other developing and emerging economies. Many variables influence the volatility of bank stock returns, but this research has covered only market risk, the interest rate, and the exchange rate. This paper explores the relationship between macroeconomic fundamentals and bank stock returns in Pakistan by employing the OLS with the HAC covariance matrix estimation model, the GARCH (1,2) estimation model, and the EGARCH (1,1) estimation model. The GARCH, rather than the OLS with the HAC covariance estimation, delivers more proficient coefficients because of the presence of the residual autocorrelation in the data information. The EGARCH (1, 1) assesses the impact of the leverage effect (negative or positive shocks) on the unpredictability of bank stock returns, as in the study of Kasman (2011). Moreover, the application of time-varying risk models is used to determine the effects of interest and exchange rate volatility on the bank stock return volatility generation process.

It is evident that market risk is a substantial variable that is more significant for the adjustment of economic conditions or market situations; furthermore, the results demonstrate that interest rate and exchange rate instabilities have significant and negative effects on the conditional bank stock return. This paper proposes that the market return is fundamentally important to assessing the dynamics of the conditional return of a bank stock. Besides, the conditional bank stock return volatility is strongly influenced by the exchange rate and interest rate volatility. The results of this examination suggest that the variance in the interest and exchange rate risks can delineate the discernible bank characteristics that are associated with contributing people. These parties need to address the risk and foreign exchange positions in their portfolios. This exploration is very significant for bank supervisors in building risk administrative methodologies for financial specialists and policymakers in assembling monetary-related arrangements or policies and monetary methodologies.

Therefore, this examination assesses some strategy suggestions and gives valuable data to portfolio administrative personnel locally and globally by determining the nature of the effect of interest rates and exchange rates on bank stock returns, as in Kasman *et al*. (2011). Speculators and investors certainly follow monetary policies to determine their investments and the organization of their portfolios if the exchange and interest rate risks associated with bank stock returns fluctuate, which allow financial specialists to better determine the structure of their investments. Managers should also follow monetary policies to establish accurate and adequate strategies to overcome the risks. Finally, policymakers form monetary policies by considering the conditions of the banking system because a stable and sound banking system is important for the economic growth of a country.

The future direction of this research can be to explore the bank stock returns of emerging stock markets using different variables. A comparison can be made between the developed banking sector (developed countries' banking systems) and developing banking sectors (developing countries' banking systems). The component of bank stock volatility can be explored by utilizing principal component analysis (PCA).

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Annex

Table 1. Sample and Data Source

Name of Bank	**Abbreviation**
Allied Bank Limited	(ABL)
Askari Bank Limited	(AKBL)
Bank Alfalah Limited	(BAFL)
Bank Islami Pakistan Limited	(BIPL)
The Bank Of Punjab	(BOP)
Faysal Bank Limited	(FABL)
Habib Bank Limited	(HBL)
JS Bank Limited	(JSBL)
Muslim Commercial Bank Limited	(MCB)
Meezan Bank Limited	(MEBL)
Silk bank Limited	(SILK)
Summit Bank Limited	(SMBPL)
Soneri Bank Limited	(SONA)
Macroeconomic Fundamentals	
Market Risk	(MRK)
Interest Rate	(INT)
Exchange Rate	(EX)

Table 2. Descriptive Statistics and Augmented Dickey-Fuller Test

	Mean	**Max.**	**Min.**	**SD**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**ADF**
ABL	0.0633%	0.2148	-0.0634	0.0174	0.9110	12.7414	11147.3000*	-49.3833***
AKBL	0.0357%	0.1006	-0.0882	0.0207	0.2992	5.3502	667.5452*	-47.0408***
BAFL	0.0530%	0.0966	-0.1168	0.0208	0.0865	5.6082	775.5035*	-50.6796***
BIPL	0.0122%	0.3124	-0.2568	0.0312	0.5834	12.6259	10671.1700*	-56.2558***
BOP	0.0018%	0.1783	-0.1407	0.0298	0.3941	5.9971	1090.0340*	-46.8385***
FABL	0.0614%	0.1826	-0.1652	0.0244	0.4214	6.6295	1575.7800*	-48.4451***
HBL	0.0563%	0.0753	-0.0999	0.0183	0.2099	4.6237	319.2528*	-45.3045***
JSBL	-0.0051%	1.6594	-1.6052	0.0764	0.6116	224.4729	5567372.0000*	-20.9909***
MCB	0.0419%	0.0578	-0.0664	0.0182	0.1114	4.1693	160.8170*	-45.3603***
MEBL	0.0781%	0.0825	-0.1089	0.0204	0.1444	4.9824	455.5027*	-52.6296***
SILK	-0.0342%	0.2480	-0.1661	0.0332	1.5711	12.9365	12326.9000*	-30.6022***
SMBPL	0.0357%	0.1006	-0.0882	0.0207	0.2992	5.3502	667.5452*	-47.0408***
SONA	0.0237%	0.1865	-0.1185	0.0272	0.6268	6.8226	1836.8390*	-60.6338***
MRK.	0.0719%	0.0530	-0.0513	0.0106	-0.1694	5.5309	740.0513*	-45.6842***
INT.	0.0093%	0.2607	-0.2123	0.0137	2.6475	143.9534	2258183.0000*	-18.1413***
EX.	0.0107%	0.0371	-0.0211	0.0023	1.7491	52.9967	285101.0000*	-61.231***

Note: ***,**,*indicates 1%, 5% and 10% level of significance respectively.

Table 3. Estimation of return using Generalized ARCH (GARCH) Model

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	*LL*	**LM-ARCH Test**
ABL	2.47E-04	0.0277	-0.0003	-0.0680	2.58E-05***	0.1821***	0.5368***	7404.5040	0.1885
	2.91E-04	0.0283	0.0169	0.1547	2.73E-06	0.0142	0.0366		[0.6642]
AKBL	1.21E-04	0.2635***	0.0026	-0.1570	2.82E-05***	0.1158***	0.4189***	6894.3300	2.0473
	3.54E-04	0.0331	0.0329	0.1497	3.78E-06	0.0124	0.1116		[0.1293]
BAFL	-2.99E-05	0.9510***	-0.0015	0.0727	1.93E-05***	0.1292***	0.3869***	7247.7500	0.0508
	2.94E-04	0.0299	0.0255	0.1310	2.88E-06	0.0133	0.1263		[0.8218]
BIPL	3.68E-04	0.0476	0.0669**	-0.1197	1.49E-05***	0.0877***	0.6922***	5831.7750	0.5095
	5.12E-04	0.0467	0.0340	0.2191	1.93E-06	0.0063	0.0601		[0.4754]
BOP	-1.10E-03**	1.4423***	0.0194	-0.3000*	4.56E-05***	0.1408***	0.6044***	6461.2500	3.6859
	4.34E-04	0.0354	0.0289	0.1782	3.96E-06	0.0109	0.0486		[0.0550]
FABL	-3.35E-04	0.9627***	-0.0149	-0.1804	3.91E-05***	0.1447***	0.4788***	6787.6260	1.3135
	(3.51E-04)	(0.0336)	(0.0278)	(0.1816)	(4.02E-06)	(0.0144)	(0.0741)		[0.2552]
HBL	1.69E-04	0.0041	0.0182	0.1078	9.93E-06***	0.1069***	0.4993***	7272.7100	2.2004
	(3.06E-04)	(0.0298)	(0.0245)	(0.1688)	(1.48E-06)	(0.0128)	(0.1185)		[0.1381]
JSBL	-6.16E-05	0.0827*	0.0208	-0.1776	6.61E-05***	0.1389***	0.0723	5069.2010	0.0854
	(6.36E-04)	(0.0480)	(0.0607)	(0.3691)	(7.87E-06)	(0.0190)	(0.1145)		[0.7701]
MCB	-4.00E-04*	1.1069***	0.0295**	0.2389**	9.58E-06***	0.0950***	0.2531	8031.5240	0.7319
	(2.26E-04)	(0.0225)	(0.0124)	(0.1015)	(2.21E-06)	(0.0188)	(0.2162)		[0.3924]
MEBL	5.50E-04	0.2515***	-0.0253	-0.2367	6.92E-05***	0.1861***	0.2872***	6943.3760	0.0002
	(3.46E-04)	(0.0299)	(0.0237)	(0.1508)	(9.43E-06)	(0.0211)	(0.0894)		[0.9877]
SILK	-5.23E-04	0.0279	0.0142*	0.4408***	1.43E-04***	0.1771***	0.4467***	5661.0450	0.0841
	(5.49E-04)	(0.0480)	(0.0509)	(0.2264)	(8.33E-06)	(0.0135)	(0.0425)		[0.7718]
SMBPL	1.21E-04	0.2635***	0.0026	-0.1570	2.82E-05***	0.1158***	0.4189***	6894.3300	3.5547
	(3.54E-04)	(0.0331)	(0.0329)	(0.1497)	(3.78E-06)	(0.0124)	(0.1116)		[0.0595]
SONA	-3.83E-04	0.6012***	-0.0062	0.0188	7.10E-05***	0.2262***	0.4911***	6275.6040	0.2286
	(3.97E-04)	(0.0333)	(0.0348)	(0.1748)	(6.96E-06)	(0.0174)	(0.0423)		[0.6326]

Note: Standard error is given in Parentheses and probability values in brackets.
***,**,*indicates 1%, 5% and 10% level of significance respectively

Table 4. Estimation of Return with Exponential GARCH (EGARCH) Model

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	λ	*LL*	*LM-ARCH Test*	$\delta_i = \theta_i / \lambda_i$
ABL	0.0005*	0.0564**	-0.0035	-0.0578	-1.0394***	0.3613***	0.0350***	0.9059***	7384.0520	0.1119	0.04>0
	(0.0003)	(0.0222)	(0.0172)	(0.1363)	(0.0657)	(0.0142)	(0.0118)	(0.0077)		[0.7380]	
AKBL	-0.0002	0.2804***	0.0097	-0.1810	-0.5742***	0.1947***	-0.0336***	0.9452***	6889.4770	1.2957	- 0.04<0
	(0.0003)	(0.0301)	(0.0306)	(0.1476)	(0.0590)	(0.0144)	(0.0098)	(0.0069)		[0.1957]	
BAFL	-0.0002***	0.9370	0.0040	0.0682	-0.5390***	0.2064***	-0.0255**	0.9529***	7256.5000	0.5994	- 0.03<0
	(0.0003)	(0.0289)	(0.0227)	(0.1307)	(0.0566)	(0.0128)	(0.0114)	(0.0064)		[0.4389]	
BIPL	0.0000	0.1013**	0.0678**	0.2403	-0.0747	0.0634***	-0.0152***	0.9957***	5778.3190	3.1615	- 0.02<0
	(0.0005)	(0.0459)	(0.0321)	(0.2206)	(0.0048)	(0.0034)	(0.0039)	(0.0008)		[0.0755]	
BOP	-0.0007*	1.4528***	0.0216	-0.3129**	-0.5982***	0.2103***	0.0176**	0.9408***	6436.6520	1.7720	0.02>0
	(0.0004)	(0.0359)	(0.0284)	(0.1462)	(0.0335)	(0.0109)	(0.0090)	(0.0044)		[0.0605]	
FABL	-0.0002	0.9805***	-0.0212	-0.2343	-0.8203***	0.2367***	0.0234**	0.9167***	6772.8300	1.4131	0.03>0
	(0.0004)	(0.0326)	(0.0261)	(0.1628)	(0.0694)	(0.0143)	(0.0100)	(0.0083)		[0.0528]	
HBL	0.0002	0.0273	0.0103	0.0728	-0.3221***	0.1409***	-0.0125*	0.9734***	7266.6410	1.4667	- 0.01<0
	(0.0003)	(0.0277)	(0.0241)	(0.1589)	(0.0267)	(0.0115)	(0.0075)	(0.0028)		0.1088	
JSBL	-0.0003	0.3611***	0.0144	-0.2044	-5.1476***	0.0100***	0.0100***	0.0100	3170.0050	0.2118	1.00>0
	(0.0018)	(0.1316)	(0.3148)	(0.5232)	(0.4994)	(0.0013)	(0.0010)	(0.0963)		[0.6454]	
MCB	-0.0004***	1.1120***	0.0271**	0.2192**	-0.5203***	0.1633***	0.0017	0.9546***	8027.3980	1.5850	0.02>0
	(0.0002)	(0.0224)	(0.0122)	(0.1028)	(0.0640)	(0.0157)	(0.0114)	(0.0066)		[0.1608]	

\

Table 4. Continued

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β_1	λ	*LL*	*LM-ARCH Test*	$\delta_i = \theta_i / \lambda_i$
MEBL	0.0005	0.2614***	-0.0324	-0.2306**	-1.4406***	0.3024***	0.0132	0.8466***	6935.4480	1.5044	0.02>0
	(0.0003)	(0.0298)	(0.0226)	(0.1399)	(0.1682)	(0.0252)	(0.0170)	(0.0199)		[0.2201]	
SILK	-0.0010**	0.0837**	0.0305	0.3253	-1.3277***	0.3203***	0.0083	0.8410***	5646.4400	0.2520	0.01>0
	(0.0005)	(0.0405)	(0.0499)	(0.2252)	(0.0657)	(0.0156)	(0.0114)	(0.0086)		[0.6157]	
SMBPL	-0.0002	0.2803***	0.0097	-0.1808	-0.5739***	0.1947***	-0.0336***	0.9452***	6889.4770	1.5878	-
	(0.0003)	(0.0301)	(0.0306)	(0.1476)	(0.0590)	(0.0144)	(0.0098)	(0.0069)		[0.0880]	0.04<0
SONA	-0.0006	0.5831***	-0.0019	0.0438	-1.2783***	0.3936***	0.0129	0.8660***	6271.3680	1.1532	0.01>0
	(0.0004)	(0.0335)	(0.0301)	(0.1720)	(0.1061)	(0.0235)	(0.0134)	(0.0132)		[0.2830]	

Note: Standard error is given in Parentheses and probability values in brackets.
***,**,*indicates 1%, 5% and 10% level of significance respectively.

Table 5. Estimation the bank Stock return, exchange rate, and interest rate volatility with GARCH (1,2) model

	γ	α_0	α_1	β_1	θ_1	θ_2	*LL*	*LM-ARCH Test*
ABL	1.79E-04	2.83E-05***	0.1814***	0.5737***	0.0044***	-0.0004***	7408.7020	0.1800
	2.87E-04	2.67E-06	0.0143	0.0295	0.0017	0.0002		[0.6714]
AKBL	2.23E-04	2.76E-05***	0.1114***	0.4219***	-0.0014***	0.0012	6872.0620	1.2764
	3.58E-04	3.74E-06	0.0120	0.1090	0.0023	0.0004		[0.2712]
BAFL	5.63E-04*	2.32E-05***	0.1045***	0.2527**	-0.0050***	0.0017***	6929.3910	0.0398
	3.40E-04	3.38E-06	0.0118	0.1023	0.0016	0.0004		[0.8418]
BIPL	3.94E-04	1.48E-05***	0.0881***	0.6975***	0.0002	-0.0001	5829.6580	0.4644
	5.12E-04	1.96E-06	0.0064	0.0571	0.0014	0.0008		[0.4956]
BOP	-5.79E-05	6.26E-05***	0.1541***	0.4582***	-0.0157	0.0014**	5976.4140	1.0849
	5.25E-04	6.13E-06	0.0136	0.0730	0.0035	0.0007		[0.2977]
FABL	1.78E-04	4.59E-05***	0.1344***	0.3990***	0.0039*	0.0010*	6498.6740	1.9038
	3.90E-04	5.95E-06	0.0154	0.1060	0.0021	0.0006		[0.0904]
HBL	7.06E-05	1.30E-05***	0.1295***	0.5577***	0.0036***	0.0006***	7272.4750	1.7170
	2.98E-04	1.55E-06	0.0122	0.0700	0.0008	0.0002		[0.1902]
JSBL	6.09E-05	6.89E-05***	0.1505***	0.1384	0.0090	-0.0026***	5070.5510	0.0457
	6.27E-04	7.04E-06	0.0166	0.0997	0.0063	0.0007		[0.8308]
MCB	4.55E-04	1.77E-05***	0.1205***	0.1842	-0.0028***	0.0002	7286.7600	0.2542
	3.06E-04	3.40E-06	0.0207	0.1651	0.0015	0.0002		[0.6142]

Table 5. Continued

	γ	α_0	α_1	β_1	θ_1	θ_2	*LL*	*LM-ARCH Test*
MEBL	7.25E-04**	6.41E-05	0.1834	0.2539***	0.0006***	0.0000***	6918.0070	0.0442
	3.44E-04	8.36E-06	0.0209	0.0984	0.0030	0.0006		[0.8336]
SILK	-4.57E-04	1.48E-04***	0.1800***	0.5272***	0.0141***	-0.0018	5659.8450	0.0705
	5.42E-04	8.09E-06	0.0137	0.0288	0.0036	0.0013		[0.7907]
SMBPL	2.23E-04	2.76E-05***	0.1114***	0.4219***	-0.0014	0.0012	6872.0620	1.2764
	3.58E-04	3.74E-06	0.0120	0.1090	0.0023	0.0004		[0.2712]
SONA	-5.82E-06	7.65E-05***	0.2006***	0.4417***	-0.0036	-0.0004	6187.7160	0.0112
	4.32E-04	7.14E-06	0.0173	0.0484	0.0024	0.0009		[0.9157]

Note: Standard error is given in Parentheses and probability values in brackets.
***,**,*indicates 1%, 5% and 10% level of significance respectively.

Table 6. The Rolling-Window results of testing for Macroeconomic Fundamentals Impact's on Bank Stock Return

Coefficients	**The positive/negative proportion and statistically significant slope coefficients**						
	Significance Level	**Window-1**	**Window-2**	**Window-3**	**Window-4**	**Window-5**	**Window-6**
Market Risk	1%	8/0	8/0	6/0	7/0	7/0	6/0
	5%	0/0	0/0	3/1	2/1	2/0	1/0
	10%	1/0	0/0	1/0	0/0	1/0	0/0
	Total	9/0	8/0	10/1	9/1	10/0	7/0
Interest Rate	1%	1/0	2/0	0/0	0/0	0/0	0/0
	5%	1/0	2/0	0/0	0/0	0/0	0/0
	10%	1/0	1/0	2/0	0/0	0/0	0/0
	Total	3/0	5/0	2/0	0/0	0/0	0/0
Exchange Rate	1%	0/0	1/0	0/0	0/0	0/0	0/0
	5%	1/0	0/0	0/0	0/0	2/0	0/0
	10%	0/0	0/0	1/0	0/0	0/0	0/0
	Total	1/0	1/0	1/0	0/0	2/0	0/0

Notes: Notation like in table-6. Window 1: 01.01.2009-31.12.2014; Window 2: 01.01.2010-31.12.2015; Window 3: 01.01.2011-31.12.2016; Window 4:01.01.2012-31.12.2017; Window 5: 01.01. 2013-31.12.2018; Window 6: 01.01.2014-31.12.2019

Figure 1. Return Series of all Variables

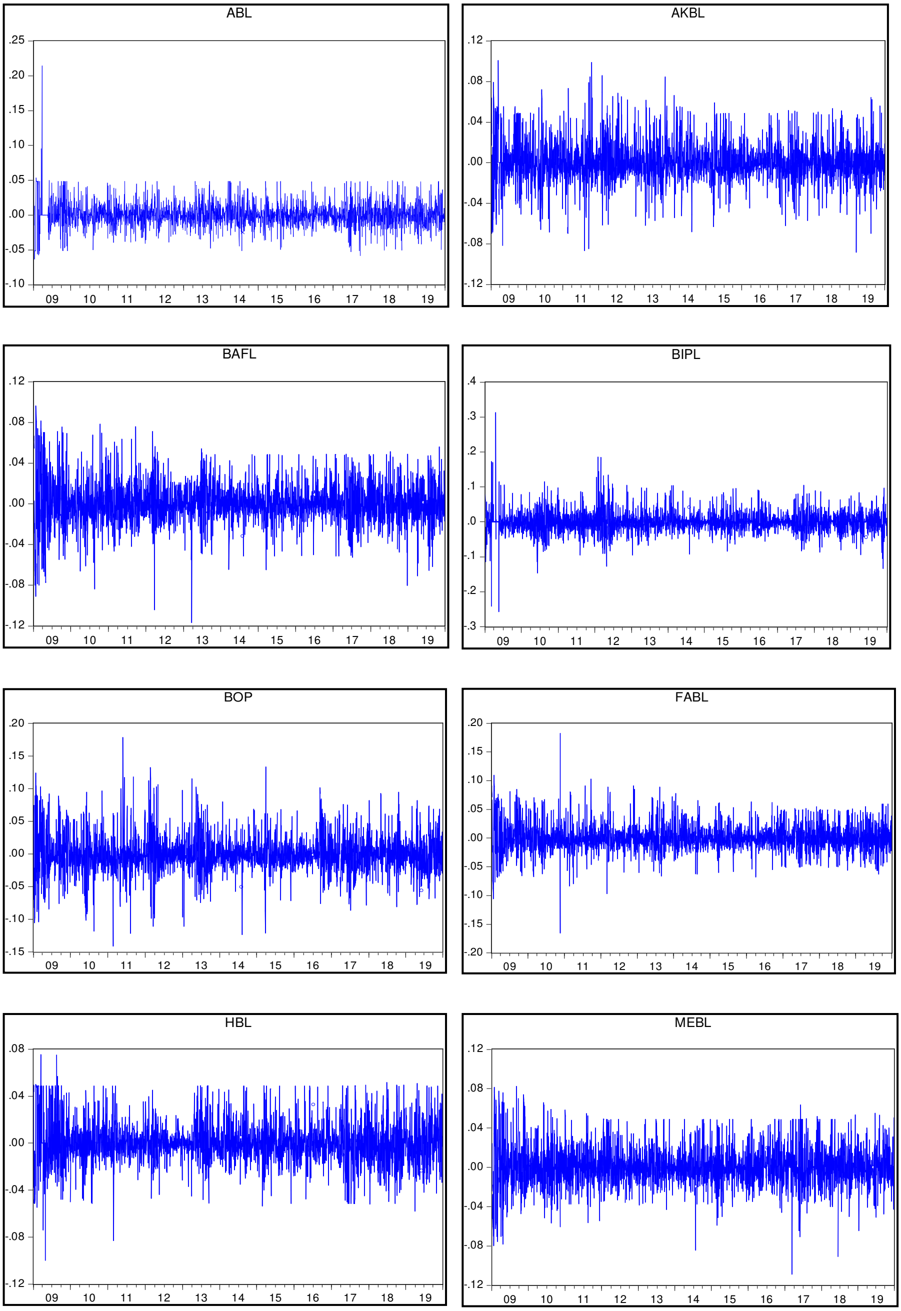

Figure 2. Continued