Analyzing Stock Price Volatility: A Statistical Study of Three Listed Companies on the Dhaka Stock Exchange

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ABSTRACT

This study focuses on the Dhaka Stock Exchange (DSE) volatility, employing GARCH (Generalized Autoregressive Conditional Heteroscedasticity) models and various statistical and mathematical methods to forecast the future volatility of selected companies. The analysis covers stock market volatility from January 2018 to June 2023, using the daily closing prices of Arab Bangladesh Bank Limited (ABBL), Bata Shoe Company (Bangladesh) Limited (BATA), and Jamuna Oil Company Limited (JOCL). The results indicate that the time series distribution of the companies' daily returns exhibits non-stationary behavior with both positive and negative skewness. High volatility and rapid fluctuations are observed, particularly in ABBL and BATA compared to JOCL. The calculated standard deviation of BATA's volatility highlights significant and unpredictable price movements 2022 (1.16%) and 2021 (0.73%). Finally, JOCL's stock volatility has shown a declining trend over the past three years relative to the other two firms.

Key words: Volatility, Stock Price, DSE Return, ABBL, BATA, JOCL

INTRODUCTION

Stock price volatility refers to the degree of fluctuation in the price of a specific stock or index over a given period and is a key concept in investment markets. Generally, volatility is defined as the speed and unpredictability of asset price movements (Hafer & Hein, 2007). While investors aim to earn returns, they must also contend with inherent risks associated with price fluctuations around the average. Various factors can trigger sudden market downturns, potentially leading to financial crises. For instance, the global financial crisis profoundly impacted most major stock markets worldwide 9 (Oseni & Nwosa, 2011). Bangladesh's stock market experienced a turbulent phase between 1996 and 2011, mainly due to prolonged price collapses over the preceding two decades.

The study of market volatility is critical in developing nations such as Bangladesh (Aziz & Uddin, 2014). The Dhaka Stock Exchange (DSE), a key component of the country's financial system, is vital in facilitating investment and driving economic growth. Understanding the patterns, causes, and implications of volatility in the DSE is essential for market participants and regulators to make informed decisions and formulate effective policies (Abken & Nandi, 1996).

The stock market can drive a nation's economic growth by generating wealth, expanding market opportunities, and improving access to capital. Over the past few decades, the Dhaka Stock Exchange (DSE) has undergone significant transformations, including increased investor participation, regulatory reforms, enhanced monitoring mechanisms, and shifts in macroeconomic conditions (Chowdhury, 2014). Additionally, short-term measures such as trading suspensions have been introduced to curb panic selling during periods of market stress. These developments have introduced new dynamics to the market, making it essential to examine how volatility has evolved and to identify the key factors influencing it.

Volatility, defined as the standard deviation of a stock's annualized returns over a specific period, reflects the extent to which a stock's price may rise or fall. Therefore, analyzing stock volatility from January 2018 to June 2023 provides practical insights and recommendations for market investment. This study investigates the daily return time series and historical volatility of the DSE to offer a comprehensive understanding of market variability. A descriptive approach is employed to analyze the central tendency, dispersion, and other characteristics of stock return distributions in a clear and accessible manner. Ultimately, this research aims to compare the volatility of selected companies, focusing on implied volatility as a predictor of expected future fluctuations.

Literature Review

Volatility refers to the frequency and magnitude of price fluctuations in a stock exchange over a given period. Higher volatility indicates sharp price movements, which can quickly reverse direction. Using monthly data from January 2001 to December 2015, Hasan & Zaman (2017) examined the impact of microeconomic factors on stock return volatility in Bangladesh. Their findings revealed that all variables exhibited leptokurtosis and deviated from a normal distribution. Other studies have explored the influence of institutional mechanisms on market volatility in the DSE, such as circuit breakers and time-varying risk-return correlations (Babikir et al., 2012). Even though risk-return parameters vary significantly across samples and data frequencies, a strong relationship was identified between conditional volatility and market returns. Notably, a negative overall correlation coefficient between risk and return challenges traditional portfolio theory, suggesting that investors in emerging markets may not always demand higher risk premiums. For example, circuit breaker mechanisms can be compared to lock-in measures, with the former significantly impacting the realized return's volatility.

According to empirical analysis, the Dhaka Stock Exchange (DSE) return series does not conform to the assumption of normality and instead follows a random walk pattern, suggesting an inefficient capital market (Mollik, 2009). In another study, Islam and Khaled presented conflicting evidence regarding the DSE's market efficiency (Islam & Khaled, 2005). They analyzed monthly and daily DSE data from before and after the 1996 market crash, evaluating market efficiency with and without adjustments for heteroscedasticity. Their findings indicate that market efficiency significantly deteriorated following the 1996 meltdown. Additionally, a study analyzing the monthly returns of sixteen developed and emerging markets in the Asia-Pacific region from January 2004 to December 2009 assessed the weak form of market efficiency. The results suggest that these markets were generally robust and efficient, with arbitrage opportunities proving profitable for investors (Ariff & Finn, 1989). In the context of Bangladesh, stock prices in 2011 were heavily influenced by various government and Bangladesh Bank policies, including tight monetary policy, margin lending regulations, and changes to the cash reserve ratio (CRR), among others (Hossain et al, 2021).

An upward trend in DSE index volatility was observed in 2009, and many stakeholders firmly believed that this growth trajectory would continue, despite Bangladesh's status as a developing economy. However, such an improving trend can deteriorate rapidly and may not be sustainable in the long term. Experienced investors often capitalize on this volatility by recognizing market value buying when prices are low and selling when prices are high. In contrast, such market conditions can be particularly risky for novice investors. The economics of developing stock markets are especially vulnerable to sudden regime changes (Naik & Mohan, 2021). Studying the risk-return behavior of the stock market is especially important in developing countries, where most investors tend to be risk-averse. Due to the high volatility of the stock market, investors demand a higher risk premium, which increases the cost of capital and hinders economic growth (Mala & Reddy, 2007).

In statistics, heteroskedasticity (or heteroscedasticity) refers to the condition where the standard deviations of a predicted variable are not constant across observations. Heteroskedasticity is commonly classified as either unconditional or conditional. Conditional heteroskedasticity captures volatility that varies based on past periods' volatility, making it especially relevant in time series analysis. Numerous studies have focused on modeling and forecasting stock market volatility using conditional heteroskedasticity frameworks, most notably the ARCH (Autoregressive Conditional Heteroskedasticity) and GARCH (Generalized ARCH) models (Xing et al, 2021).

The impact of market surveillance on share prices has been highlighted in various newspaper reports. For instance, when remittance inflows gradually increase but withdrawals become significant enough to reduce the money supply, a decline in share prices often follows. DSE returns exhibit notable deviations from normality, including excess kurtosis, positive skewness, and serial correlation (Chowdhury, 2014). These characteristics and the time-varying nature of volatility point to inefficiencies in the stock market. Moreover, studies have confirmed a strong correlation between conditional volatility and overall market performance (Chowdhury et al, 2013). Additional research has reinforced the finding that the return series of the DSE does not follow a normal distribution (Mia & Rahman, 2016). Evidence of volatility clustering and leptokurtosis, as reflected in high excess kurtosis values, further supports this conclusion (Abdullah et al., 2017). The presence of serial correlation and volatility shifts over time suggests patterns inconsistent with efficient market behavior. Consequently, this study undertakes a descriptive statistical analysis of stock price volatility, forming a basis for further conditional modeling and exploration of volatility dynamics.

METHODOLOGY

The methodology employed in this study is designed to facilitate statistical analysis and enhance understanding of volatility in the Dhaka Stock Exchange (DSE). For this purpose, the daily closing prices of three Bangladeshi companies, Arab Bangladesh Bank Limited (ABL), Bata Shoe Company (BATA), and Jamuna Oil Company Limited (JOCL), were selected from the stock exchange index. Key statistical measures such as mean, median, and standard deviation were calculated to provide a comprehensive view of volatility over time. In addition, skewness and kurtosis were computed to evaluate the asymmetry and tailedness of the return distribution, respectively assessing deviations from a normal distribution and identifying potential distortions. Time series plots and volatility charts were also analyzed to observe trends and forecast volatility patterns.

A. Data Collection

The primary data sources for this study are the closing prices and trading volumes of stocks listed on the Dhaka Stock Exchange (DSE). The data was retrieved from the official DSE library (https://www.dse.com) on September 18, 2023. The study covers January 1, 2018, to June 30, 2023. It is important to note that the COVID-19 pandemic caused disruptions in the market, resulting in a two-month gap in the data for April–May 2020. For each company analyzed, the data set contains 1278 rows of daily stock prices and trading volumes.

B. Data Preprocessing

Daily volatility refers to measuring fluctuations within a stock's closing price over a day. However, the daily closing price is often non-stationary, so it is not ideal for direct analysis. Previous studies, however, have suggested calculating the volatility of the return series to better capture price movements (Karmakar, 2005). In this study, daily returns for the DSE index are calculated using the following formula:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{1}$$

where R_t is daily return at time t, P_t is the closing price at time t, and P_{t-1} is the closing price at the previous time period.

C. Standard Deviation

To analyze the rate of variation in the companies' returns, the standard deviation of the daily return is calculated monthly and annually. The standard deviation is as follows:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(X_i-\mu)^2}{N}} \tag{2}$$

when the mean is $\mu = \sum_{i=1}^{N} X_i/N$

D. Skewness

In order to calculate sample skewness and kurtosis, a small adjustment is added to the empirical formula of skewness (the function of the adjustment is to correct a bias inherent in small samples):

$$\text{Sample skewness} = \frac{\sqrt{n(n-1)}}{(n-2)} \times (population\ skewness)$$

$$= \frac{\sqrt{n(n-1)}}{(n-2)}\sqrt{n}$$

$$= \frac{n\sqrt{n-1}}{(n-2)} \frac{\sum_{i=1}^{n}(x_i-\bar{x})^3}{\left(\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\right)^3} \tag{3}$$

E. Kurtosis

Kurtosis is the ratio of the fourth moment to the second moment squared. We also make adjustments to calculate the sample kurtosis as follows:

$$\frac{(n+1)(n-1)}{(n-2)(n-3)} \times (population\ kurtosis) - \frac{3(n-1)^2}{(n-2)(n-3)}$$

$$= \frac{n(n+1)(n-1)}{(n-2)(n-3)} \frac{\sum_{i=1}^{n}(x_i-\bar{x})^4}{\left(\sum_{i=1}^{n}(x_i-\bar{x})^2\right)^2} - \frac{3(n-1)^2}{(n-2)(n-3)}$$

$$= \frac{n(n+1)(n-1)}{(n-2)(n-3)} \frac{\sum_{i=1}^{n}(x_i-\bar{x})^4}{\left(\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\right)^4} - \frac{3(n-1)^2}{(n-2)(n-3)} \tag{4}$$

RESULTS AND DISCUSSIONS

This section uses historical volatility trends to give the results of an analysis of the volatility of DSE-nominated firms. Understanding the characteristics of DSE volatility and its consequences for investors and policymakers is possible thanks to the conversation.

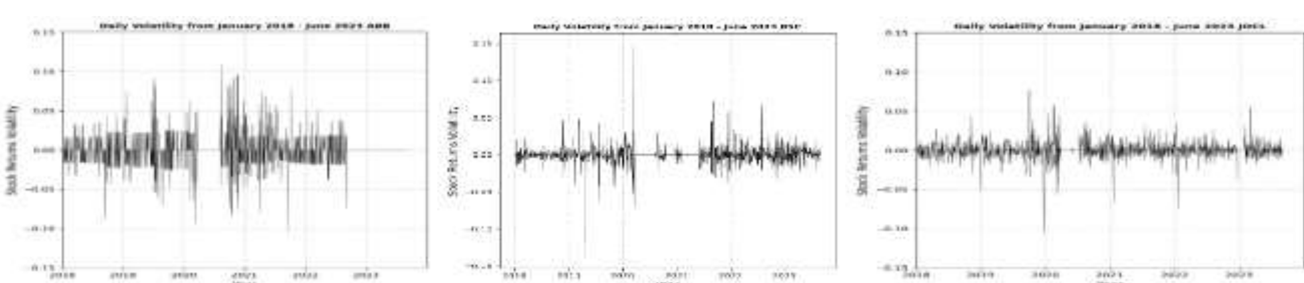

Figure 1: Variation of daily return time-series graph for the selected companies of DSE

Figure 1 presents the time series graph of daily return values over the sample period. The graph indicates that the return patterns for ABBL and BATA are more erratic, while JOCL in the DSE exhibits relatively less volatility. For BATA, periods of low volatility are generally followed by additional low volatility; however, sudden, sharp positive and negative surges occur intermittently. The two most significant price swings during the sample period occurred between April 25, 2019, and March 16, 2020, when prices plummeted from 1141.3 TK to 668 TK, and again on September 8, 2021, when prices rose from 936 TK to 1000.7 TK. Similarly, ABBL exhibits a pattern of high volatility and rapid fluctuations throughout much of the sample period. This consistent behavior strongly suggests volatility clustering and indicates that both time series have significant time-varying return variances. Such instability is likely driven by the frequent, erratic stock market bubbles observed in Bangladesh's stock market.

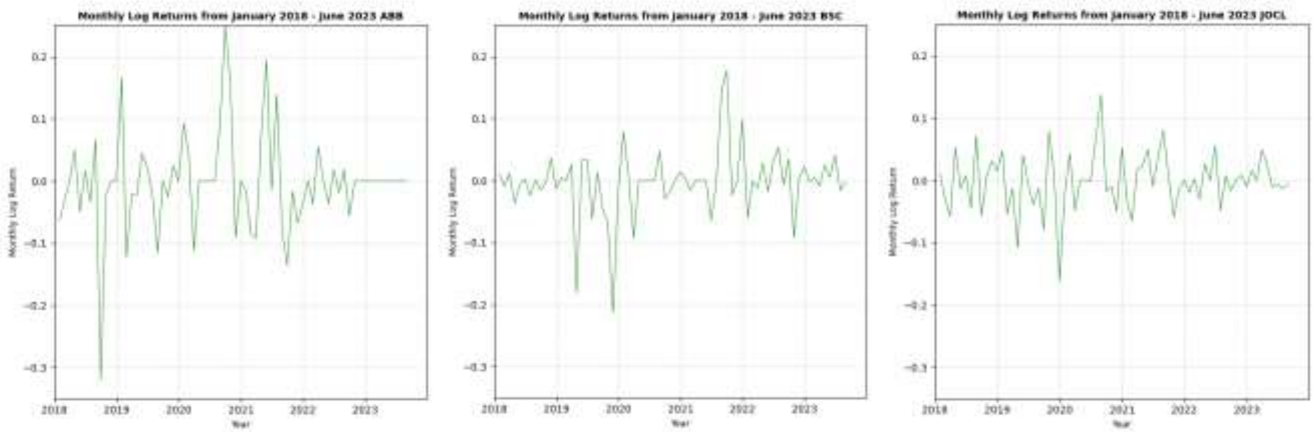

Figure 2: Variation of the monthly returns index of companies from January 2018 to June 2023

Figure 2 illustrates the monthly variation in stock return prices. The plot shows that returns fluctuated significantly throughout the study period, suggesting that the monthly trend patterns have changed. This observation proves that the daily return values for ABBL, BATA, and JOCL are non-stationary.

Descriptive statistics offer valuable insights into stock return distributions, providing key information about dispersion, centrality, and other data characteristics. The overall performance of the three companies ABBL, BATA, and JOCL from January 2018 to June 2023 is summarized in the descriptive statistics presented in Table 1. Table 1(a-c) provides the year-by-year computed statistical values derived from the stock market's daily return data.

According to the mean value of ABBL in Table 1(a), 2020 had the highest average daily return at 0.27%, while 2018 recorded the lowest average daily return at -0.15%. This indicates that, over the study period, the daily return price increased the most in 2020 and decreased the least in 2018. Furthermore, the skewness for 2020 is 0.511, which is nearly zero, suggesting a relatively symmetrical distribution for that year. However, the skewness values for the remaining years indicate that ABBL's stock returns were not symmetrically distributed, exhibiting a leptokurtic nature, meaning there was higher peak concentration and more frequent extreme values. This suggests that the company experienced significant volatility in stock market returns over time. Moreover, the kurtosis values for all five years were leptokurtic, implying more frequent outliers. These results confirm that ABBL's stock returns do not follow a normal distribution throughout the sample period.

The BATA statistics show that the lowest average daily return occurred in 2018 at -0.016%, while the highest average daily return was 0.145% in 2021. 2018 shows a symmetrical distribution of stock market returns, whereas in the other years, the distribution is asymmetrical. The kurtosis values for all five years were leptokurtic, suggesting a higher concentration of extreme values. Notably, the value of kurtosis for 2020 is 49.69, which is exceptionally high and suggests that the return distribution is far from normal. These results further confirm that the stock returns for BATA are not generally distributed throughout the sample period.

Lastly, like the other two companies, JOCL experienced the highest average daily return in 2020 at 0.0836%, while 2022 recorded the lowest average daily return at -0.0048%. The skewness for 2020 is 0.677, indicating a distribution close to zero, suggesting a relatively symmetrical return pattern for that year. However, the skewness values for the remaining years show that the daily returns were leptokurtic throughout the period, indicating that the returns were not symmetrically distributed and that extreme values occurred more frequently. As a result, volatility in stock returns is evident. The normality test confirms that JOCL's stock returns do not follow a normal distribution over the entire sample period.

Table 1(a): Year-wise descriptive statistics (ABBL)

Year	2018	2019	2020	2021	2022	2023
Mean%	-0.149176	-0.004150	0.269944	-0.031644	-0.013395	0.000000
Median%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Maximum%	4.651163	9.615385	11.627907	8.064516	5.263158	0.000000
Minimum%	-8.474576	-6.818182	-8.888889	-9.859155	-7.142857	0.000000
Std.Dev.%	1.626893	2.286025	3.132642	2.222110	1.429187	0.000000
Skewness	-0.460	0.725	0.511	0.474	0.091	-
Kurtosis	5.875	5.833	5.208	6.144	6.780	-
Jarque-Bera stat	91.131	99.596	47.853	108.745	142.039	-
p-value	1.6262e-20	2.3603e-22	4.0626e-11	2.4335e-24	1.4343e-31	-
Observations	240	236	194	242	238	139

Table 1(b): Year-wise descriptive statistics (BATA)

Year	2018	2019	2020	2021	2022	2023
Mean	-0.016450	-0.188238	0.017318	0.145965	0.000428	0.033792
Median	0.000000	-0.109707	0.000000	0.000000	-0.078727	0.004994
Maximum	4.758951	4.847531	16.115960	7.497991	6.984299	2.921276
Minimum	-3.042249	-12.950145	-6.845638	-4.005282	-3.551828	-3.083788
Std.Dev.	0.730238	1.509424	1.631298	1.592500	1.166284	0.992693
Skewness	1.194	-2.783	4.030	2.197	1.172	-0.142
Kurtosis	12.653	25.771	49.696	12.219	8.509	3.546
Jarque-Bera stat	980.615	5403.353	19273.982	1038.701	361.454	2.584
p-value	1.1539e-213	0.0000e+00	0.0000e+00	2.811e-226	3.2451e-79	2.7473e-01
Observations	238	236	206	239	242	164

Table 1(c): Year-wise descriptive statistics (JOCL)

Year	2018	2019	2020	2021	2022	2023
Mean	0.001679	-0.115230	0.083677	0.018242	-0.004855	0.035734
Median	0.000000	-0.103961	0.000000	0.000000	0.000000	0.000000
Maximum	4.399783	7.911803	5.874499	3.075995	3.329571	5.562061
Minimum	-2.995868	-9.981401	-5.431755	-6.570605	-7.213115	-1.77975
Std.Dev.	0.830802	1.373356	1.399622	0.975541	0.916220	0.886746
Skewness	0.659	-0.869	0.677	-0.916	-2.079	1.916
Kurtosis	6.746	18.674	6.951	11.375	19.765	11.752
Jarque-Bera stat	157.690	2445.395	151.210	756.413	3070.651	639.019
p-value	5.7292e-35	0.0000e+00	1.4624e-33	5.5834e-165	0.0000e+00	1.7e-139
Observations	240	236	208	247	247	168

Volatility, or the degree of variation in a company's returns over a specific period, is commonly measured by the standard deviation of its stock price. A high standard deviation indicates significant volatility, meaning there are substantial up-and-down swings in the stock price. Assets with higher volatility are typically considered riskier investments due to their greater potential for price fluctuations in both directions, which can lead to larger gains and losses. Conversely, a low standard deviation suggests that the price movements are relatively stable, with smaller gaps between trading ranges. This implies that the stock's price is less prone to significant fluctuations, making it more predictable.

Figure 3 (a-c) illustrates the standard deviation of daily returns. The bar graph for ABBL shows an upward trend until 2020, indicating that the company experienced increased volatility or greater price fluctuations during that period. From 2020 onward, the graph reveals a downward trend, suggesting a decrease in volatility or reduced-price fluctuations in recent years. This shift may indicate that the factors influencing the stock or overall market conditions became more stable and predictable after 2020.

For BATA, the bar graph shows an upward trend until 2020, indicating an increase in the company's price swings or volatility. Starting in 2020, however, a negative trend emerges, suggesting that BATA stock experienced reduced volatility or smaller price fluctuations in the subsequent years. This could imply that, beginning in 2020, the market or other factors influencing the stock became more stable and predictable.

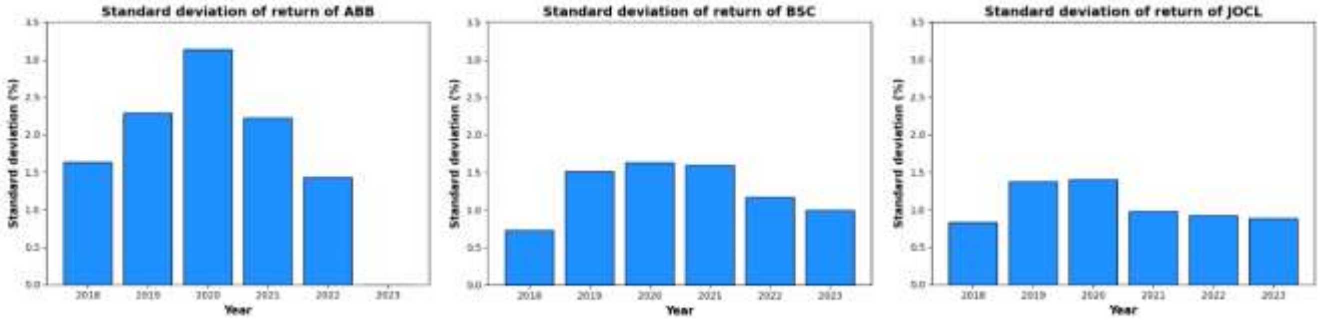

Figure 3: Standard deviation of return (2018-2023) of ABBL, BATA, and JOCL.

Lastly, it can be observed that the standard deviation for JOCL fluctuates continuously, indicating that the stock's price movements have been highly unpredictable with considerable variation over the past five years. The graph illustrates that the company experienced its most volatile years in 2019 and 2020, suggesting that the stock underwent significant price fluctuations and carried higher investment risk during those periods. In contrast, the shorter bar lengths in 2018 and 2023 reflect lower volatility and more stable price behavior, indicating that JOCL's stock was relatively more predictable and experienced fewer extreme price swings in those years.

Conclusion

Risks and returns are inherently linked to volatility; therefore, understanding the statistical characteristics of volatility has important practical implications. This study's statistical and mathematical methods provide a quantitative assessment of market volatility. From January 1, 2018, to June 30, 2023, three companies' daily and monthly return values, ABBL, BATA, and JOCL, were analyzed. First, volatility is evident as the DSE return time series is not symmetrically distributed. Second, the return series exhibit leptokurtosis and volatility clustering, as both positive and negative skewness values indicate.

Additionally, the histograms and descriptive statistics confirm that the stock returns of all three companies do not follow a normal distribution. Instead, they exhibit characteristics associated with non-normal distributions, such as leptokurtosis and fat tails, indicating a higher probability of extreme return values. Furthermore, the volatility of JOCL stock has shown a consistent downward trend over the past three years, suggesting increasing stability in its price movements during this period.

This study suggests several avenues for future research to improve the modeling of return volatility in the Dhaka Stock Market, particularly using the GARCH family of models. One key recommendation is the use of longer time series data, as extending the dataset beyond the five-year period (2018–2023) would likely enhance the accuracy and robustness of volatility estimations and projections.

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