Volatility Dynamics of Asian Stock Markets: Evidence from the Hang Seng Index and Nikkei 225

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Abstract

This study examines volatility dynamics in Asian equity markets using daily returns from the Hang Seng Index and Nikkei 225. Employing ARCH-LM tests and GARCH(1,1) models, we document significant volatility clustering and high persistence in both markets. Empirical results indicate stronger volatility persistence in the Hang Seng Index, suggesting slower dissipation of shocks compared to the Nikkei 225. These findings contribute to the empirical literature on Asian market volatility and have implications for risk management and portfolio allocation.

1 Introduction

Financial markets are characterized by time-varying volatility, where periods of high volatility tend to cluster together and are followed by further episodes of heightened uncertainty. Understanding volatility dynamics is crucial for investors, policymakers, and risk managers, as volatility plays a central role in portfolio allocation, asset pricing, and financial stability.

Asian stock markets, particularly the Hang Seng Index (HSI) and the Nikkei 225, represent two of the most influential equity markets in the region. These markets have experienced significant structural changes and external shocks over time, making them ideal candidates for studying volatility behavior. Despite extensive research on developed markets, comparative evidence on the volatility dynamics of major Asian indices remains limited.

This study investigates the volatility characteristics of the HSI and Nikkei 225 using daily stock return data. The analysis employs unit root tests to examine stationarity, ARCH tests to detect conditional heteroskedasticity, and GARCH(1,1) models to capture volatility clustering and persistence. The findings of this study contribute to the existing literature by providing empirical evidence on volatility behavior in Asian equity markets.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the data and methodology. Section 4 presents the empirical results, and Section 5 concludes the study.

2 Literature Review

Volatility modeling has been a central topic in financial econometrics due to its importance in risk management and asset pricing. Early studies documented that financial return series exhibit volatility clustering, where large shocks are followed by large shocks and small shocks by small shocks.

Engle (1982) introduced the Autoregressive Conditional Heteroskedasticity (ARCH) model to capture time-varying volatility in financial data. Building on this framework, Bollerslev (1986) proposed the Generalized ARCH (GARCH) model, which allows volatility to depend on both past squared errors and past conditional variance. The GARCH(1,1) model has since become the benchmark specification for modeling financial market

3 Data and Methodology

The study uses daily closing prices of the Hang Seng Index (HSI) and the Nikkei 225 index. The data are obtained from publicly available financial databases and cover a sufficiently long period to capture different market conditions. Daily log returns are computed as the first difference of the natural logarithm of index prices.

Stationarity of the return series is examined using the Augmented Dickey–Fuller (ADF) test. The null hypothesis of the ADF test states that the series contains a unit root, implying non-stationarity. Rejection of the null hypothesis indicates that the series is stationary.

To test for the presence of conditional heteroskedasticity, the ARCH LM test is applied to the return series. The null hypothesis of this test is that there are no ARCH effects present in the data. Rejection of the null hypothesis suggests volatility clustering.

Finally, volatility dynamics are modeled using the GARCH(1,1) specification introduced by Bollerslev (1986). This model allows current volatility to depend on past squared shocks and past conditional variance, capturing both short-run and persistent volatility effects. The GARCH(1,1) model is specified as:

$$r_t = \mu + \epsilon_t, \quad \epsilon_t | \mathcal{F}_{t-1} \sim N(0, h_t) \tag{1}$$

$$h_t = \omega + \alpha\epsilon_{t-1}^2 + \beta h_{t-1} \tag{2}$$

where h_t denotes the conditional variance, ω is a constant, α measures the impact of past shocks, and β captures volatility persistence.

Table 1: Descriptive Statistics of Daily Returns

Market	Mean	Std. Dev.	Skewness	Kurtosis
HSI	0.000073	0.01532	-0.090	8.322
Nikkei 225	0.000168	0.01514	-0.528	8.087

Table 1 presents the descriptive statistics of daily returns for the HSI and Nikkei 225. Both markets exhibit small positive mean returns and similar levels of volatility, as indicated by comparable standard deviations. The return distributions are negatively skewed, suggesting a higher probability of large negative returns.

Additionally, the kurtosis values for both indices are substantially greater than three, indicating leptokurtic distributions with fat tails. These characteristics are typical of financial return series and motivate the use of GARCH-type models to capture time-varying volatility.

Table 2: Distributional Properties of Returns

Market	Min	Q1	Median	Q3	Max
HSI	-0.1418	-0.0073	0.0004	0.0078	0.1341
Nikkei 225	-0.1323	-0.0072	0.0005	0.0083	0.1323

4 Empirical Results

The Augmented Dickey–Fuller test results indicate that both the HSI and Nikkei return series are stationary, as the null hypothesis of a unit root is rejected at the 5 percent significance level. This confirms the suitability of the return series for volatility modeling.

Table 3: Unit Root and ARCH Test Results

Market	ADF Statistic	ADF p-value	ARCH LM p-value	ARCH F p-value
HSI	-14.68	3.17×10^{-27}	1.33×10^{-210}	6.53×10^{-231}
Nikkei 225	-80.62	$< 10^{-16}$	2.51×10^{-213}	3.46×10^{-234}

Table 2 presents the results of the Augmented Dickey–Fuller (ADF) unit root test and the ARCH LM test for the return series of the Hang Seng Index and the Nikkei 225. The

ADF test statistics for both indices are highly negative, with p-values close to zero, leading to a rejection of the null hypothesis of a unit root. This confirms that both return series are stationary.

The ARCH LM and F-test results strongly reject the null hypothesis of no ARCH effects for both markets. The extremely small p-values indicate the presence of significant conditional heteroskedasticity, providing strong evidence of volatility clustering. These findings justify the use of GARCH-type models to analyze volatility dynamics in both markets.

GARCH(1,1) estimation results reveal that both markets exhibit significant volatility persistence. The estimated ARCH (α) and GARCH (β) coefficients are positive and statistically significant, with the sum $\alpha + \beta$ close to unity. This suggests that shocks to volatility decay slowly over time, a common characteristic of financial markets.

5 Machine Learning Benchmark

To complement the econometric analysis, this study evaluates a machine learning benchmark for volatility forecasting. Using lagged returns, absolute returns, and rolling statistical features, an XGBoost regression model is trained to predict realized volatility proxied by squared daily returns.

The model is estimated using a time-series split to preserve temporal ordering. Forecast accuracy is assessed using mean squared error (MSE) and mean absolute error (MAE). The machine learning model captures nonlinear relationships in volatility dynamics and serves as a data-driven benchmark against the parametric GARCH(1,1) model.

Overall, the results indicate that while the machine learning approach provides competitive short-horizon forecasts, the GARCH model remains effective in capturing long-run volatility persistence. This highlights the trade-off between interpretability and predictive flexibility in volatility modeling.

6 Discussion

The empirical findings reveal strong volatility clustering and high persistence in both the Hang Seng Index and the Nikkei 225, consistent with existing literature on financial market volatility. However, notable differences emerge in the degree of volatility persistence across the two markets.

The Hang Seng Index exhibits slightly higher volatility persistence, as reflected by the larger sum of the ARCH and GARCH coefficients. This suggests that volatility shocks in the Hong Kong market dissipate more slowly compared to the Japanese market. One possible explanation is Hong Kong's greater exposure to external financial shocks and geopolitical uncertainty, particularly due to its role as an international financial hub closely linked to global capital flows.

In contrast, the Nikkei 225 demonstrates relatively faster mean reversion in volatility, which may reflect the more mature and institutionally stable nature of the Japanese equity market. These findings imply that investors operating in Asian markets should account for market-specific volatility dynamics when constructing portfolios and managing risk.

Overall, the results highlight the importance of modeling time-varying volatility in Asian equity markets and suggest that a one-size-fits-all approach to risk management may be inadequate across different regional markets.

7 Conclusion

This study investigated volatility dynamics in two major Asian equity markets, the Hang Seng Index and the Nikkei 225, using daily return data and GARCH-type models. The analysis confirmed that both markets exhibit strong volatility clustering and significant persistence, consistent with established financial econometric theory.

Empirical results indicate that volatility shocks decay more slowly in the Hang Seng Index compared to the Nikkei 225, suggesting differences in market structure and exposure to external shocks. These findings have important implications for investors, policymakers, and risk managers operating in Asian financial markets.

Future research may extend this framework by incorporating asymmetric volatility models, higher-frequency data, or macroeconomic variables to further explore the determinants of volatility in regional equity markets.

References

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