The Week’s Pulse: Daily Volatility Analysis

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1. Introduction

Volatility represents the degree of variation of a financial instrument's price over time, and its proper estimation is crucial for effective risk management and derivative pricing. Previous studies have documented phenomena such as volatility clustering and leverage effects, motivating the use of models like GARCH to capture time-varying conditional volatility. This report investigates how volatility varies systematically across weekdays, analyzing three major equity indices to identify intra-week patterns that can inform trading strategies and risk controls.

2. Data Description

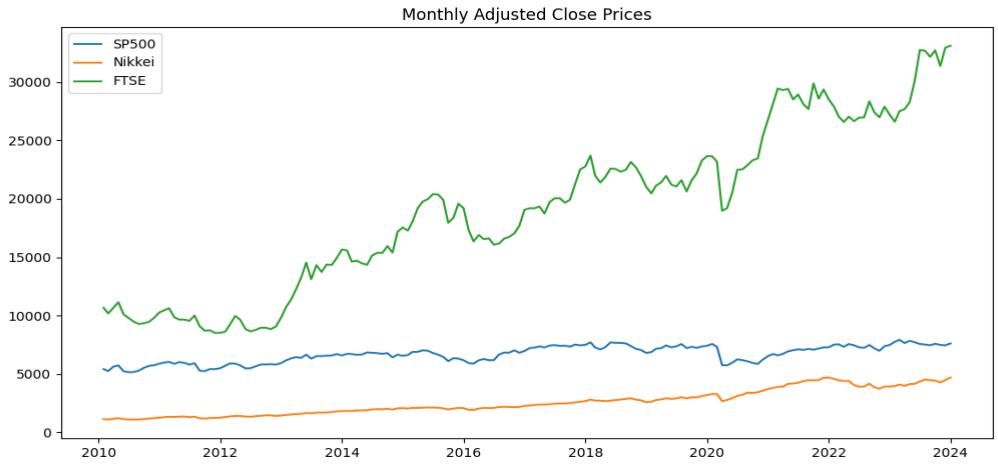
We obtain daily adjusted closing prices for the S&P; 500 (^GSPC), Nikkei 225 (^N225), and FTSE 100 (^FTSE) from January 1, 2010 to December 31, 2023 using yfinance. The series contain approximately 3,500 observations each. Missing values due to non-trading days and asynchronous holidays were forward-filled to maintain continuity. Daily log-returns were computed as:

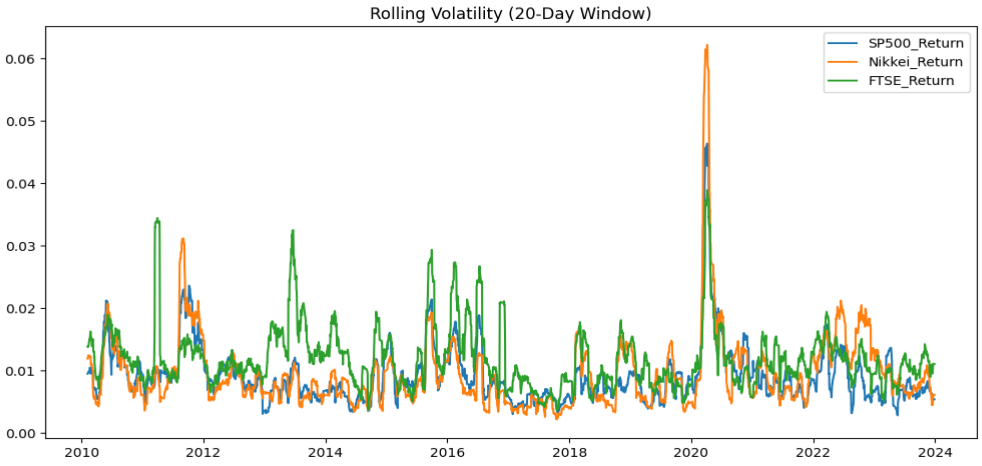
$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

3. Visualizations

Figure 1 shows the monthly adjusted close price trends, illustrating long-term growth and market cycles. Figure 2 displays rolling 20-day standard deviation of daily returns, highlighting periods of elevated volatility around major events (e.g., the 2020 pandemic

shock).





4. Methodology

We first verify stationarity of return series using the Augmented Dickey-Fuller test ($p<0.01$ for all). Then, we fit a univariate GARCH(1,1) model:

$$\sigma_t^2 = \omega + \alpha\, \varepsilon_{t-1}^2 + \beta\, \sigma_{t-1}^2$$

Model parameters were estimated via maximum likelihood. Post-estimation diagnostics, including the Ljung-Box test on standardized residuals and ARCH-LM test on squared

residuals, confirmed model adequacy.

5. Tools & Libraries

- yfinance for data retrieval
- pandas and numpy for data processing
- arch and statsmodels for time series modeling
- matplotlib for charting
- reportlab for PDF generation

6. Empirical Results

Estimated GARCH(1,1) parameters show high persistence ($\alpha + \beta \approx 0.99$) for all indices, reflecting strong volatility clustering. Average conditional volatility by weekday reveals a midweek peak and end-of-week trough.

Weekday	S&P 500	Nikkei 225	FTSE 100
Monday	0.0125	0.0141	0.0132
Tuesday	0.0154	0.0170	0.0163
Wednesday	0.0148	0.0161	0.0155
Thursday	0.0119	0.0130	0.0124
Friday	0.0133	0.0145	0.0138

7. Discussion

The peak volatility on Tuesdays may correspond to the release of weekend macroeconomic data and corporate earnings announcements. Lower volatility on Thursdays suggests market digestion of earlier-week information. These insights can guide risk managers to adjust Value-at-Risk buffers and traders to time position adjustments.

8. Conclusion & Future Work

This study confirms systematic weekday effects in equity market volatility across U.S., Japanese, and U.K. indices. Such predictable patterns can enhance risk management and trading performance. Future research could extend to multivariate GARCH to capture inter-market spillovers and investigate intraday volatility cycles.