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US Originated Asymmetric Volatility Spillover Effects: An Intraday Comparison Between Korean and Japanese Stock Markets

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Abstract: The Efficient Market Hypothesis (EMH) posits that asset value information is immediately integrated into prices in an efficient market, rendering the consistent generation of above-average investment returns unfeasible. This study challenges the EMH by introducing a short volatility strategy that leverages observed intraday asymmetric volatility spillover effects in the Korean and Japanese stock markets. This study investigated the relationship between the impact of US stock market volatility on the Korean and Japanese markets on the following day. It scrutinized the daily opening and closing prices of several indices by utilizing the regression analysis - S&P 500, VIX, KOSPI 200, V-KOSPI 200, NIKKEI225, and NIKKEI225_VI - from February 2012 through December 2022. The data was sourced from Yahoo Finance, KRX, and the JPX exchange website. To examine the volatility spillover effects emanating from the United States, this study disregarded data where business day differences exceeded two days owing to market closures. Moreover, this study accounted for time differences among the United States, Korea, and Japan by factoring in a one-day lag in their respective trading days. To further delve into volatility spillover phenomenon, this study divided the intensity of volatility into intervals of 0%, 3%, 6%, and 9%. Empirical findings indicate an upswing in volatility at the close of the US market is wholly repflected in the opening volatility of both the Korean and Japanese markets. Conversely, when the US market concludes with a drop in volatility surpassing 6%, the impact permeates from the opening to closing prices in the Korean and Japanese markets. This study puts forth intraday volatility selling strategy (Short Volatility Strategy: SVS), capitalizing on this distinctive intraday spillover pattern by recommending the sale of volatility at market open and liquidation of positions at market close. The SVS strategy, utilizing intraday asymmetric volatility spillover effects, counterexample of the EMH and demonstrated above-average returns in Korean and Japanese markets. Regarding the Sharpe Ratio, Korea's benchmark (BM) reported 3.14, while the SVS strategy attained 4.59. In Japan, the corresponding figures stood at 1.21 for the Japan’s BM and 3.49 for the SVS strategy. Significantly, the SVS strategy considerably diminished the Maximum Drawdown (MDD) in both markets, with Korea's BM MDD decreasing from -47.44% to -31.75% and Japan's BM MDD plunging from -85.33% to -48.98%.

Keywords: Efficient Market Hypothesis, Spillover Effect, Volatility Index, Short Volatility Strategy

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1. Introduction

In the decades since Fama et al.[1] introduced the Efficient Market Hypothesis (EMH), numerous economists and investors have applied it in their research. The central tenet of the EMH is the immediate incorporation of asset value information into market prices, thereby rendering the consistent attainment of above-average investment returns unfeasible. However, the number of counterexamples of market efficiency, including behavioral finance arguments, is increasing. Proponents of behavioral finance argue that market inefficiencies exist because humans exhibit limited rationality and repeat behaviors.

De Bondt and Thaler[2] study is foundational in behavioral finance, proposing that market inefficiencies occur in the stock market due to limited human rationality and repetitive behaviors. It investigates the behavior of investors in the stock market, focusing on the phenomenon of "overreaction" and its resulting price biases. They argue that the stock market tends to overreact to recent performance, leading to stocks being overvalued or undervalued relative to their average value. These reactivity and price biases are examples of behavioral finance, supporting the notion that market inefficiencies arise from human-limited rationality and repetitive behaviors in the stock market.

The primary objective of this research is to employ the information spillover effect within diverse stock market data to identify effective strategies that yield consistent profits. The information spillover effect pertains to the phenomenon wherein stock market information originating from one country or industry disseminates its influence to other countries or industries, consequently impacting their respective stock prices. In the current era of globalized stock markets, heightened interconnectedness is evident due to the liberalization of capital markets and technological advancements in communication. For instance, movements in the Korean stock market are significantly affected by the previous night's fluctuations in the US stock market. Consequently, domestic investors vigilantly observe changes in US stock prices overnight and follow significant news in the morning to make well-informed investment decisions.

Kim[3] discovered an asymmetric volatility spillover effect as a counterexample of the EMH in the Korean stock market. The asymmetric volatility spillover effect is an anomaly wherein the Korean market's opening prices fully mirror the increased volatility of the US market. However, when the US market experiences a decrease in volatility, the Korean market follows suit, maintaining this decreased volatility until the market's close. Based on this finding, Kim proposed a trading strategy that utilizes this phenomenon to outperform market returns.

Researchers have yet to identify the asymmetric volatility spillover effect in stock markets of countries other than Korea. Consequently, this research examines whether the geographically adjacent Japanese stock market also observes the asymmetric volatility spillover effect. Additionally, the study aims to analyze the profitability of investment strategies derived from this effect.

2. Literature Review

Advancements in information communication technology and the globalization of stock markets have escalated the intensity of volatility spillover effects and relationships in financial markets. These effects are exemplified by Ko and Kang[4] using Diebold and Yilmaz's[5] spillover index model, which discloses a profound interdependence among global stock markets. The hegemony of the US financial market in the Korean counterpart is further validated by Park and Jung[6].

Significant short-term global spillovers, with the highest contagion experienced by the Japanese market, have been identified by Golosnoy et al.[7]. Additional contributions by Yarovaya et al.[8] and Gamba-Santamaria et al.[9] examine the asymmetric spillover effects from the US market and the variation in spillover intensity contingent on the stock market phase.

Choi and Cho[10] highlight the intricate nature of spillover effects, identifying bidirectional volatility

spillover effects in the United States, South Korea, and China. In contrast, the US directs price return spillover effects towards the latter two nations. Further investigations by Lee and Choi[11], Baek[12], Han et al.[13], and Lee and Kim[14] delve deeper into different facets of volatility spillover and its interplay with multiple market phenomena.

The influence of external variables on spillover effects constitutes another critical area in the literature, with Park et al.[15] and Yoon and Kim[16] focus on the role of macroeconomic variables and international crude oil prices. The fluid nature of these effects is underscored by Park[17] and Park[18], who studied the changes in the volatility spillover relationship and the dominant role of the US market following the COVID-19 outbreak.

Further explorations by Li and Giles[19], Lien et al.[20], Choi[21], Kim and Ryu[22], and Wang et al.[23] inter-market dynamics offer valuable insights into volatility spillover dynamics, the transmission of unexpected shocks, and the predictive value of spillover information, specifically focusing on the US and Asian markets.

Li and Giles[19] explored the interconnections of stock markets across the United States, Japan, and six Asian developing countries for two decades (1993 to 2012). Their research uncovers significant unidirectional shock and volatility spillovers from the US market toward Japanese and Asian emerging markets. Lien et al.[20] analyzed the dynamic nature of volatility spillovers between the US and eight East Asian stock markets during two financial crises. They found that the US market triggered volatility spillovers regardless of the crisis's geographical origin.

Choi[21] observed the dynamic interaction of stock market volatility among Northeast Asian countries and the United States. Kim and Ryu[22] examined return spillover, volatility transmission, and cojump behavior between the US and Korean stock markets, determining that the US stock market is the primary instigator of return spillover effects in the Korean market. The research found that the US was a consistent source of volatility shocks.

Lastly, Wang et al.[23] evaluated the volatility spillover effects from the United States and its impact on international stock markets. The study discovered substantial evidence of strong volatility spillovers from the United States to five key stock markets, with these effects magnified during periods of US economic recession.

In summary, the existing literature paints a complex and nuanced picture of the volatility spillover effect, often featuring the US market in a dominant role. Influencing factors, such as the stock market phase and external events like the COVID-19 pandemic, significantly shape the intensity and direction of spillovers. However, despite these valuable insights, the existing literature has primarily centered on examining the volatility spillover phenomenon itself. It has yet to explore whether this volatility spillover aligns with the EMH principles or deviates from them. Consequently, there is a need for more research endeavors aimed at proposing trading strategies that could capitalize on the economic implications of this spillover effect.

3. Methodology

3.1 Research Design

This study’s primary instrument was the daily opening and closing prices of the S&P 500, VIX, KOSPI 200, V-KOSPI 200, NIKKEI225, and NIKKEI225_VI from February 2012 to December 2022, using data from Yahoo Finance, KRX, and JPX exchange website. This study utilized secondary data for analysis by removing data with business day differences of more than two days and assumed a one-day lag in the trading days of the US, South Korea, and Japan.

This study investigated the relationship between the impact of US stock market volatility on the Korean and Japanese markets on the following day. This study further categorized the VIX from the

previous day into increases and decreases to analyze the asymmetric intraday volatility spillover phenomenon. To further delve into the asymmetric intraday volatility spillover phenomenon, this study divided the intensity of VIX volatility into intervals of 0%, 3%, 6%, and 9%.

In order to examine the relationship between daily VIX and V-KOSPI, the regression analysis employed the logarithmic returns of the previous day's VIX as the independent variable and the logarithmic returns of the current day's V-KOSPI as the dependent variable. Also, In order to examine the relationship between daily VIX and NIKKEI225_VI, the regression analysis employed the logarithmic returns of the previous day's VIX as the independent variable and the logarithmic returns of the current day's NIKKEI225_VI as the dependent variable.

3.2 Data Description

[Table 1] shows basic statistics for the daily returns of the stock indices and volatility indices in the United States, South Korea, and Japan. Each country's daily return stock data did calculate as the percent return between the previous day's closing price and the current day's closing price—that is, current day closing price/previous day closing price - 1.

[Table 1] Basic Statistics for Daily Returns

	USA		KOREA		JAPAN	
	S&P 500	VIX	KOSPI200	V_KOSPI	NIKKEI225	NIKKEI225_VI
Average	0.0387%	0.0056%	0.0046%	0.009%	0.0493%	-0.0015%
Std Dev	1.090%	7.871%	1.031%	5.579%	1.308%	6.517%
Skewness	-0.5322	1.1847	-0.0696	0.806	-0.1243	1.0617
Kurtosis	15.43	6.6781	6.09	4.72	3.99	5.84
Min	-12.76%	-29.98%	-7.97%	-30.26%	-8.25%	-27.45%
Max	8.96%	76.82%	8.75%	43.43%	7.73%	57.18%
Correlation	-0.7325		-0.5910		-0.5968	

Generally, when a stock index rises, the volatility index tends to decline, and vice versa. Additionally, volatility indices exhibit asymmetric behavior in the decreasing and increasing phases of stock prices; this phenomenon is called the leverage effect and is attributable to the financial leverage of companies and risk-averse investor sentiment, which causes more rapid increases in volatility when stock indices decline. The stock market returns in the United States, South Korea, and Japan exhibit a fat-tailed distribution, consistent with the results of studies of the distribution of stock returns in various countries. Meanwhile, the correlation coefficients between stock index returns and volatility index returns were the highest for the US S&P 500 and the VIX at -0.7325, followed by Japan at -0.5968 and South Korea at -0.5910 evidence of a robust negative correlation

4. Results

4.1 Analyzing US Originated Asymmetric Volatility Spillover Effects

The volatility spillover phenomenon in financial markets refers to the transmission of volatility from one industry, asset, or country to another asset or country. It occurs due to the interconnectedness of global financial markets, economic and investment relationships between countries, and the complex interplay of investor participation. The liberalization of global financial markets and the development of technology have made global financial markets increasingly interconnected, facilitating the transmission of information. For example, a financial crisis in the United States spreads globally and impacts other countries. Similarly, when the US Federal Reserve raises interest rates, it affects financial markets in countries outside the United States. In particular, the surges in the VIX index that appear

alongside collapses in the US stock market significantly impact the volatility of stock markets in other countries by negatively affecting the psychology of global investors.

The trading hours of the New York Stock Exchange are from 9:30 AM to 4:00 PM New York time, and it closes at 6:00 AM the next day in Korean time. Three hours after the New York Stock Exchange closes, the stock markets in South Korea and Japan open, and the opening prices in the two countries stock markets reflect the fluctuations of the New York Stock Exchange. For this reason, the world pays close attention to the movements of the US stock market—especially in Asian countries where stock markets open after the US market closes—using the movements of US stock indices and the VIX index as critical factors in investment decision-making.

For example, on February 27, 2020, at the onset of the COVID-19 pandemic, the US S&P 500 index closed down 4.62% compared to the previous day. The following day, the KOSPI 200 index opened down 1.71% from the previous day, and the NIKKEI 225 index started down 1.96%. Moreover, on February 27, 2020, the US VIX index increased by 42.08% compared to the previous day, which led to a 19.59% increase in the V-KOSPI at the opening of the Korean market and a 12.43% increase in the NIKKEI225_VI at the opening of the Japanese market the following day.

$$\begin{aligned} R^{i}_{cc,t} &= \left(\frac{\textit{Close of Index i at Day t}}{\textit{Close of Index i at Day t}-1}-1\right)\times 100 \\ R^{i}_{co,t} &= \left(\frac{\textit{Open of Index i at Day t}}{\textit{Close of Index i at Day t}-1}-1\right)\times 100 \\ R^{i}_{oc,t} &= \left(\frac{\textit{Close of Index i at Day t}}{\textit{Open of Index i at Day t}}-1\right)\times 100 \end{aligned} \quad (1)$$

for i = VX(S&P500 VIX), VK(KOSPI 200 VIX), VN(NIKKEI 225_VI)

$R^{i}_{cc,t}$ represents the return on index i from the close of day (t-1) to the close of day t, $R^{i}_{co,t}$represents the return on index i from the close of day (t-1) to the open of day t, and $R^{i}_{oc,t}$represents the return on index i from the open of day t to the close of day t. In addition, to examine the impact of the previous day's US volatility index VIX on the Korean volatility index VK and the Japanese volatility index VN, this study tested the following regression equation:

$$\begin{aligned} R^{VK}_{cc,t} &= 0.0008 + 0.31108 \times R^{VX}_{cc,t-1} \\ R^{VN}_{cc,t} &= 0.0009 + 0.36226 \times R^{VX}_{cc,t-1} \end{aligned} \quad (2)$$

$$\begin{aligned} R^{VK}_{co,t} &= 0.0081 + 0.28456 \times R^{VX}_{cc,t-1} \\ R^{VN}_{co,t} &= 0.0050 + 0.33807 \times R^{VX}_{cc,t-1} \end{aligned} \quad (3)$$

$$\begin{aligned} R^{VK}_{oc,t} &= -0.0073 + 0.0263 \times R^{VX}_{cc,t-1} \\ R^{VN}_{cc,t} &= -0.0038 + 0.02123 \times R^{VX}_{cc,t-1} \end{aligned} \quad (4)$$

The results of the regression equations assessing the connection between the US VIX, Korean VK, and Japanese VN are outlined in [Table 2]. The data demonstrate a substantial volatility spillover from the US to the Korean and Japanese markets, with statistically t-values at 95% and 99% confidence intervals.

[Table 2] Regression Equation Estimations

VIX Vol	EQ. NO	Intercept	Slope	VIX Vol	EQ. NO	Intercept	Slope
VK (KR)	2	0.0008	0.31108 (22.65)**	VN (JP)	2	0.0009	0.36226 (26.09)**
	3	0.0081	0.28456 (33.87)**		3	0.0050	0.33807 (32.71)**
	4	-0.0073	0.0263 (2.43)*		4	-0.0038	0.02123 (1.91)

* significant at 95%, ** significant at 99%

An initial examination of the association between the US VIX and the Korean VK yielded a slope of 0.31108 and a t-value of 22.65 in regression equation (2), underlining the significant influence of US stock market volatility on the volatility of the Korean stock market on the following day. In the case of a regression equation (3), which investigated the impact of the previous night's US stock market volatility on the next day's opening price volatility in the Korean market, the results were similarly significant, with a slope of 0.28456 and a t-value of 33.87. Regression equation (4), exploring the influence of the prior night's US market volatility on the Korean market from opening to closing the next day, returned a slope of 0.0263 and a t-value of 2.43.

An evaluation of the volatility spillover between the US VIX and the Japanese VN in regression equation (2) demonstrated high statistical significance, with a slope of 0.36226 and a t-value of 26.09. Regression equation (3) continued to exhibit significance with a slope of 0.33807 and a t-value of 32.71. However, regression equation (4) displayed a slope of 0.02123 and a t-value of 1.91, falling just short of the t-value threshold for a significance of 2.0.

These analyses corroborate the significant impact of US stock market volatility on the volatility of the Korean and Japanese markets on the subsequent day. This effect persisted from market opening to closing, suggesting a potential advantage for Korean and Japanese investors to generate higher returns. The focus of this study was the intraday volatility spillover phenomenon between the US VIX index, Korean VK, and Japanese VN. Results of a regression equation (4) are presented in [Table 3], highlighting an asymmetric volatility spillover anomaly between the US and Korean markets, with a lesser extent present in the Japanese market. Notably, the Korean and Japanese markets showed substantial reactions when the US VIX decreased by 6% or more.

[Table 3] Regression Equation (4) Estimations by VIX Direction

		KOREA		JAPAN	
US Vol	EQ. NO	Intercept	Slope	Intercept	Slope
UP	4	0.00332	0.0021 (0.10)	0.0009	0.00291 (0.15)
Down	4	0.01025	-0.00185 (-0.07)	0.00427	-0.03305 (-1.14)
3% Up	4	0.00296	0.00347 (0.12)	0.00239	-0.00455 (-0.20)
3% Down	4	0.01144	0.01046 (0.29)	0.00624	-0.01259 (-0.30)
6% Up	4	0.00287	0.00524 (0.14)	0.00427	-0.01662 (-0.47)
6% Down	4	0.02474	0.01234 (2.23)*	0.02514	0.13987 (2.20)*
9% Up	4	0.00706	-0.00652 (-0.23)	0.01072	-0.03108 (-1.00)
9% Down	4	0.03603	0.2044 (2.09)*	0.04413	0.25919 (2.23)*

* significant at 95%, ** significant at 99%

As detailed in [Table 1], the VIX's average daily standard deviation was 7.871%, meaning a 6% VIX movement falls within one standard deviation. In Korea, a 6% or more decrease in the US VIX corresponded to a regression slope of 0.01234 and a t-value of 2.23, and a 9% or more decrease led to a slope of 0.024 and a t-value of 2.09. A similar pattern was observed in Japan: for a 6% or more fall in the US VIX, the regression slope was 0.1398, and the t-value was 2.20. These values remained significant for a VIX decrease of 9% or more, with a regression slope of 0.025919 and a t-value of 2.23.

Kim[3] first discovered the volatility spillover anomaly in the US and Korean markets, and this study showed that the asymmetric volatility spillover phenomenon exists in Korea and partially in Japan. This finding will have significant strategic implications for investors in the financial markets.

5. Discussion

5.1 Proposed Short Volatility Strategy Using the Asymmetric Volatility Spillover Effect

As the preceding analysis confirmed, if the US market closed with a drop of more than -6% in volatility the previous day, even if the Korean and Japanese markets start with drops in volatility that day, significant additional declines will occur during the trading session. This study, therefore, propose a volatility selling strategy for such a situation. Meanwhile, this study recommend not participating in trading if the US market closed with increased volatility the previous day. This intraday volatility selling strategy (Short Volatility Strategy: SVS) can be defined as follows in equation (5): if the volatility of the US market the previous day closed with a drop exceeding a certain level, enter a volatility selling position at the opening of the Korean and Japanese stock markets simultaneously; then, at the market close, proceed with position liquidation transactions.

Short Volatility strategy for V-KOSPI(VK) and Nikkei 225_VI(VN)

$$\begin{aligned} &\boldsymbol{IF\ R_{cc,t-1}^{vx} < -level\ then\ Sell\ VK\ (VN) Open\ at\ Day\ t;} \\ &\boldsymbol{IF\ Market\ Close\ then\ Exit\ VK\ (VN)} \\ &\boldsymbol{Close\ at\ Day\ t;} \end{aligned} \tag{5}$$

SVS is a day-trading strategy that liquidates short volatility positions at the market close, eliminating risk from drastic changes in global stock prices overnight. Executing the SVS strategy for a certain period, enables us to calculate the trading performance's total return (TR) as in equation (6).

$$\begin{aligned} \boldsymbol{TR_T} &= \sum_{t=1}^{T} \frac{\boldsymbol{VK(VN)\ Close\ at\ Day\ t}}{\boldsymbol{VK(VN)\ Open\ at\ Day\ t}} \times \mathbf{100} \times \boldsymbol{D_t}, \\ \boldsymbol{D_t} &= \boldsymbol{-1\ if\ R_{cc,t-1}^{VX} \le -\mathrm{level},\ 0\ otherwise} \end{aligned} \tag{6}$$

The TR function is the cumulative sum of the profits from the selling strategy that sells the volatility index in Korea and Japan on the morning of day t and liquidates the position at the market close that day if the volatility VIX of the US on day t-1 closes with a drop of more than 6%, resulting in Dt = -1.

5.2 Trading Performance of the Short Volatility Strategy

Table 4 shows the intraday selling strategy performance, utilizing the asymmetric volatility spillover pattern, for the V-KOSPI volatility index and the NIKKEI225_VI volatility index from February 2012 to December 2022.

[Table 4] Trading Performance of the Suggested Strategy

	V-KOSPI		NIKKEI 225_VI	
	BM (Everyday Sell)	SVS (Sell when VIX -6%)	BM (Everyday Sell)	SVS (Sell when VIX -6%)
Total Return	1996.36%	556.98%	909.15%	483.26%
Transaction No	2,580	441	2,445	432
Time in Market	100%	18.0%	100%	18.0%
Win Ratio	64.30%	68.25%	57.34%	64.35%
Max Draw Down	-47.44%	-31.75%	-85.33%	-48.98%
Average Profit	0.77%	1.26%	0.37%	1.12%
Standard Deviation	3.89%	4.34%	4.86%	5.06%
Sharpe Ratio	3.14	4.59	1.21	3.49

The benchmark (BM) strategy, a standard comparative approach, involves daily trading of the volatility index in the Korean and Japanese stock markets, irrespective of the preceding day's movements in the US volatility index. This strategy begins with selling at the market open and concludes with liquidation at the market close.

In contrast, the Korean and Japanese SVS strategies were active for merely 18% of the total period. Consequently, the absolute returns of these SVS strategies, capitalizing on the information from asymmetric volatility spillover, were less than that of the BM strategy. However, upon application of the Sharpe Ratio index, a measure that computes risk-adjusted returns, the SVS strategies in both Korean and Japanese markets outperformed the BM strategies. In Korea, the BM had a Sharpe Ratio of 3.14, while the SVS strategy presented a higher value of 4.59. Similarly, the SVS strategy in Japan recorded a Sharpe Ratio of 3.49, exceeding the BM's Sharpe Ratio of 1.21. A higher Sharpe Ratio indicates superior risk-adjusted performance, making it a critical performance indicator for investment strategies.

Additionally, the Maximum Draw Down (MDD), a risk measure of paramount concern to investors, was significantly reduced in the SVS strategies in both markets. In Korea, the BM's MDD stood at -47.44%, while the SVS strategy lowered the MDD to -31.75%. Analogously, in Japan, the BM's MDD was at -85.33%, but with the implementation of the SVS strategy, the risk was curtailed to -48.98%.

6. Conclusion

This study proposes an investment strategy using asymmetric volatility spillover effects and analyzes its profitability. This study scrutinized the daily volatility spillover effects within the Korean and Japanese stock markets, specifically examining the influence of volatility in the US market. The empirical evidence, which spans a considerable period of approximately 11 years from February 2012 to December 2022, includes the S&P 500 and VIX volatility index of the US market, the KOSPI 200 and V-KOSPI 200 volatility index of the Korean market, and the Nikkei 225 and Nikkei 225_VI volatility index of the Japanese market.

The empirical analysis results can be summarized as follows. Firstly, this study find that the volatility in the US stock market from the previous day significantly influences the volatility in the Korean and Japanese stock markets on the following day, showing a strong presence of volatility spillover effects, similar to previous research.

Secondly, upon a detailed analysis of the patterns of volatility spillover, it reveal that the spillover of volatility from the US stock market to the Korean and Japanese markets exhibits different patterns

depending on whether the US market's volatility declined or increased on the previous day. When the volatility in the US market increases, the volatility in the Korean and Japanese markets fully reflects this impact at the morning market opening. It follows a typical pattern of an efficient market, with no significant impact beyond that point. However, on days following a significant decline of -6% or more in US market volatility, the volatility in the Korean and Japanese markets does not fully reflect this impact at the morning market opening and it shows a pattern of continuously decreasing volatility until the market close.

Thirdly, based on the asymmetric volatility spillover effects, this study propose an intraday volatility selling strategy and demonstrate its superior profitability through empirical analysis.

This study not only reconfirmed the asymmetric volatility spillover phenomenon in the Korean market, as previously identified by Kim[3], but it also confirmed that this phenomenon is partially present in the Japanese stock market.

Despite its contributions, the current study has its limitations. Future research might benefit from incorporating artificial neural network techniques combined with diverse market data and trends from the preceding day's volatility in the US market. Moreover, the low trading volumes of volatility futures contracts on the Korean and Japanese markets pose a practical trading constraint. Subsequent research should address this constraint and explore potential solutions for volatility trading on the Korean and Japanese options markets.

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