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# Intraday price dynamics in spot and derivatives markets



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## HIGHLIGHTS

- We examine intraday relationships among the spot index, futures, and implied volatility.
- We analyse high-frequency data using the VAR(1)-asymmetric BEKK-MGARCH model.
- There is a bi-directional causal relationship between the spot and futures markets.
- The futures return shock affects the spot market more severely.
- Both the positive risk–return relationship and asymmetric volatility phenomenon are detected.

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## ABSTRACT

This study examines intraday relationships among the spot index, index futures, and the implied volatility index based on the VAR(1)-asymmetric BEKK-MGARCH model. Analysis of a high-frequency dataset from the Korean financial market confirms that there is a strong intraday market linkage between the spot index, KOSPI200 futures, and VKOSPI and that asymmetric volatility behaviour is clearly present in the Korean market. The empirical results indicate that the futures return shock affects the spot market more severely than the spot return shock affects the futures market, though there is a bi-directional causal relationship between the spot and futures markets. Our results, based on a high-quality intraday dataset, satisfy both the positive risk–return relationship and asymmetric volatility effect, which are not reconciled in the frameworks of previous studies.

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## 1. Introduction

Traditional financial research analyses individual markets without consideration of the interactions between related financial markets. However, investors usually trade various financial assets and participate in multiple markets with the purpose of portfolio diversification, risk management, and speculation. As a result, the markets are closely related and the price movements of financial instruments and their volatilities are interrelated. Being aware of these relationships, recent studies focus on the interaction between financial markets and the effects of the market linkage [1–6]. By examining the related markets simultaneously, these studies attempt to characterise the dynamics of asset prices and volatilities and measure the market responses to external shocks.

In spite of these efforts, previous studies are limited in that they analyse low-frequency data. With the advent of home-based trading systems and the rapid development of the information technology (IT) industry, investors can easily implement intraday trading strategies, and the increase in intraday transactions requires academics to analyse the intraday behaviour of the markets in order to identify meaningful economic implications. Without analysis of an intraday dataset,

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one would miss the implications of information and/or spillover effects that might dissipate within a very short time. Though some quantitative studies examine the intraday relationship between related markets [7–12], there is still room for improvement with regard to methodology and out-of-sample testing. Most studies investigate the relationship between bivariate variables using simple vector autoregression (VAR) and vector error correction model (VECM) or simple bivariate GARCH models. In addition, they focus mainly on developed markets or the effects of shocks from developed markets on emerging economies.

The present study fills the gaps in the literature. We adopt a trivariate GARCH model as an extension of the BEKK GARCH model in order to incorporate the asymmetric volatility effect, a well-known market regularity. This model is called the VAR(1)-asymmetric BEKK-MGARCH model.<sup>1</sup> Using the model, we analyse the intraday return-spillover and intraday relationships between the spot index, index futures, and implied volatility. Our focus is the Korean financial market because it is analysed infrequently despite its global position and importance to investors worldwide. KOSPI200 futures, the representative index futures products of the Korean market, are one of the most liquid and remarkable index futures contracts in the world [13–16]. The Volatility Index of the KOSPI200 (VKOSPI) is an official implied volatility index of the Korean market and is derived from the market prices of KOSPI200 options, which are the single most liquid and top-ranked options in the world [17,18]. We conduct our assessment of the Korean market based on a high-quality intraday dataset collected over a long study period. Intraday analysis is important for this market because information flow is rapid and many investors implement intraday trading strategies, such as day-trading, stealth trading, and/or program trading, in Korea's index derivatives market [19–22]. Considering the importance of the financial products and the scarcity of knowledge of the Korean market, we expect that a thorough investigation of these financial products will be beneficial to academic researchers, market practitioners, regulators, and policy makers.

Our empirical results support a strong intraday market linkage between the spot index, KOSPI200 futures, and VKOSPI. Specifically, there is a bi-directional return-spillover effect between the spot and futures markets, with the effect of a futures return shock on the spot market being more significant than that of a spot return shock on the futures market. We also find that the increase in implied volatility, which can be interpreted as an increase in risk, leads to higher returns in both the spot and futures markets, whereas return shocks are negatively related to changes in the future implied volatility. The significance levels of the parameter estimates that capture the asymmetric volatility phenomenon support the use of the VAR(1)-asymmetric BEKK-MGARCH model applied in this study.

The rest of this paper is organised as follows. Section 2 introduces the KOSPI200 index, the KOSPI200 futures, and the VKOSPI. We explain why we focus on these products in Section 2. The sample data are briefly explained in Section 3, and Section 4 introduces the model used in this study. The empirical findings and discussion are provided in Section 5. We offer our conclusions in Section 6.

## 2. KOSPI200 index, KOSPI200 futures, and VKOSPI

The KOSPI200 index is a major stock price index calculated from 200 actively traded stocks of representative firms in Korea. The level and movement of the KOSPI200 index represents the status of the Korean financial market and indicates the current state and cycle of the Korean economy. A KOSPI200 futures contract, the underlying asset of which is the KOSPI200 index, is one of the most actively traded index futures in the world. In spite of its short history, the KOSPI200 futures market has gone international since the new millennium. According to the Futures Industry Association (FIA, [www.futuresindustry.org](http://www.futuresindustry.org)), the KOSPI200 futures market is currently ranked among the top five global index futures markets.

The VKOSPI is an official volatility index for the KOSPI200 index and was announced by the Korean Exchange (KRX) in April 2009. The VKOSPI is derived from the market prices of KOSPI200 options and therefore summarises the behaviours and sentiments of the KOSPI200 options market, which is the single most liquid and remarkable derivative market in the world. Though the KOSPI200 options market is less than 20 years old, it has maintained the top position among global derivatives markets as its trading volume far exceeds the combined trading volumes of other derivatives markets in the world (refer to the FIA). The abundant liquidity in the KOSPI200 futures and options markets explains its interest to both global and local investors.

In addition to the large trading volume and extensive investor interest, there are other reasons we analyse the intraday records of Korea's stock price index and index derivatives. First, the Korean market is purely order driven as there is no designated market maker, and this structure guarantees the anonymity of market participants. The anonymity enables rapid information flow between markets because informed traders trade as fast as they can based on their information superiority without worrying about exposing their identities.

Second, the definition of information superiority in the KOSPI200 derivatives market is unique. In equity markets, informed investors trade based on their private information, which allows them to maintain superior positions for relatively long periods. In contrast, in the index derivatives market, investors achieve information superiority by processing public information faster than other investors and by acquiring trading knowledge and techniques [23–26]. Such superiority tends to disappear quickly if the informed investors do not immediately exploit their short-term information advantage. This

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<sup>1</sup> The mean equations of this model are represented by the VAR(1) model. The abbreviation BEKK indicates that Bada, Engle, Kraft, and Kroner invented this model.

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