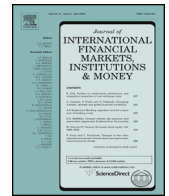




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Price linkage between the US and Japanese futures across different time zones: An analysis of the minute-by-minute data[☆]

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ABSTRACT

This study uses minute-by-minute data to analyze price discovery dynamics between the Nikkei 225 index in Japan and the E-mini S&P 500 index futures in the United States across their respective time zones. Specifically, we apply Gonzalo and Granger's (1995) and Hasbrouck's (1995) models to examine long-term price discovery in the markets and use a Granger-causality test to analyze the short-run dynamics of information transmission. We find a consistent result in the short- and long-run price discovery process. Our results show that the Nikkei 225 index futures price is influenced mainly by information from the location of trading rather than from the home market, supporting the trading-place-bias hypothesis. We also find that the leading role in information transmission has changed over time, from the United States in 2011–2012 to Japan in 2013.

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1. Introduction

Increasing globalization and improved technology concerning the trading of financial assets have sharpened competition among stock exchanges. A large number of studies have focused on information transmission around the world and how information is incorporated into prices for cross-listings of securities. Two alternative hypotheses address price discovery studies among international cross-listed securities. The first is the trading-place-bias hypothesis, which states that the price is influenced mainly by information on trading hours or the location of trading. Some studies, such as [Dhillon et al. \(1997\)](#), [Fung et al. \(2001\)](#), [Kao and Fung \(2012\)](#), [Liu and An \(2011\)](#), and [Otsubo \(2014\)](#), examine pricing spillover among international markets. They show that price discovery performs better in the offshore market (i.e., in the trading place) than the home market, supporting the trading-place-bias hypothesis. The second is the home-bias hypothesis, which states that information flows primarily from the home market to the offshore market. Many studies, such as [Frijns et al. \(2010\)](#), [Gramming et al. \(2005\)](#), [Kehrle and Peter \(2013\)](#), and [Korczak and Phylaktis \(2010\)](#), support the home-bias hypothesis. So far, the literature is still unclear as to which hypothesis is better supported.

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Some studies specifically examine information transmission between Japan and the United States, the two largest financial markets globally. Although the US market has played a leadership role in terms of pricing-information transmission across markets, as suggested in most of the literature (Fung et al., 2001; Liu and An, 2011; Otsubo, 2014), the influence of the Japanese stock market on other markets is also important (Cha and Cheung, 1998; Ng, 2000). Since the 2008 financial crisis, many developed economies have suffered sharp price declines. The United States and Japan have essentially exhausted the possibilities of conventional monetary policy by driving interest rates to almost zero. The United States has also employed unconventional monetary policy measures, including the large-scale asset purchases called quantitative easing (QE), which was effective in boosting U.S. stock prices. In 2013, Prime Minister of Japan Shinzo Abe used three pillars (or “arrows”), collectively referred to as Abenomics (expansive monetary policy, fiscal policy, and economic growth strategies), to stimulate the Japanese economy, and these policies also helped the Japanese stock market to rise sharply. The goal of this study is to examine whether there are structural changes from price discovery and whether the U.S. market continues to be the information leader across other markets in the wake of the use of quantitative easing policy by the United States and Japan.

Prices are expected to reflect domestic and global information immediately in efficient markets. Information is often released actively during trading hours, especially in the daytime. Japan and the United States do not have overlapping business trading hours. Most studies that examine price discovery and information transmission in Japan and the United States mainly use overnight returns or daily returns. Such an analysis may fail to detect price impacts because information has been incorporated quickly within a day. The minute-by-minute data of the futures contracts across listed exchanges are useful for analyzing cross-market information flows and thus are utilized in this study. We separately examine price discovery across Asian and American time zones. The minute-by-minute data can help us investigate more accurately the information transmission between the United States and Japan for index futures contracts.

In this study, we use the index futures contracts because of their relative ease for arbitrage and faster information to be reflected in futures prices in competitive markets. The Nikkei 225 index futures are listed on three futures exchanges (i.e., triple-listed): the Osaka Securities Exchange (OSE) in Japan, the Singapore Exchange (SGX) in Singapore, and the Chicago Mercantile Exchange (CME) in the United States. The SGX, OSE and CME are located in different time zones. In addition, there are two types of S&P index futures contracts traded on the CME: the standard-sized S&P500 and the E-mini S&P500, which is one-fifth the size of the standard-sized S&P500. Prices of the two futures contracts are very closely related. Some studies have shown that E-mini futures dominate in price discovery in the two index markets in the United States (Ates and Wang, 2005; Hasbrouck, 2003; Kurov and Lasser, 2004). Moreover, E-mini S&P500 index futures are traded on the CME with an electronic trading platform (GLOBEX) for almost 24-h of trading. To compare the price discovery dominance and information transmission between Japan and the US across different time zones, we use the E-mini S&P 500 as a proxy for the US market because of its faster price discovery properties.

Nikkei 225 index is a price-weighted average of 225 of the largest stocks listed on the Tokyo Stock Exchange (TSE) in Japan. S&P 500 index is an American stock market index based on the market capitalizations of the largest 500 companies having common stocks listed on the New York Stock Exchange (NYSE) or the National Association of Securities Dealers Automated Quotations (NASDAQ) in the US. During the Japan (Tokyo) trading hours, it is midnight in the US while the US trading (NYSE) trading hours is midnight in Japan (Tokyo). The trading operations at midnight are relatively inactive and the trading volumes become small. Does the price information of Nikkei 225 index futures and S&P 500 index futures have different roles in the US and Japan trading hours? To answer the question, we set the regular trading hours based on Japan (Tokyo) stock market as the Asian zone, which is ranged from 9:00 (0:00 GMT) to 15:00 (6:00 GMT) and the regular trading hours based on US (NYSE) stock market as the American zone, which is from 8:30 (14:30 GMT) to 16:00 (21:00 GMT).³

To shed light on price discovery and patterns of information transmission across the Asian and American time zones, we focus on the two major global financial centers. We conduct an investigation of price transmission between a pair of index futures prices on the basis of vector error correction models. We use Hasbrouck's (1995) information shares and Gonzalo and Granger's (1995) permanent-transitory common factor weights to gauge the roles played by the index futures series across Asian and American time zones in long-term price discovery. We also examine short-run causality linkages across the Nikkei 225 and E-mini S&P 500 index futures listed on the OSE, SGX, and CME. We apply a Granger-causality test to determine the causal linkages across the Nikkei 225 and E-mini S&P 500 index futures markets.

Previous studies that examine information transmission indicate that they use prices in the same time zone and thus have overlapping trading hours. How price discovery works and differs across markets without overlapping trading hours, such as Japan and the United States, is an interesting issue. This study fills the research gap and examines the dynamic of price discovery across these two markets. In particular, we focus on futures markets located in the Asian and American time zones, which do not have overlapping trading hours.

Our study contributes to the literature in several ways. First, this study uses minute-by-minute data to shed light on price discovery and information transmission. Although price discovery across international markets has become increasingly important, most studies examine overlapping intra-trading hours or daily prices, which do not provide a continuous data series. Unlike previous studies, we use minute-by-minute data to examine price discovery and information transmission. The Nikkei 225 and E-mini S&P 500 index futures are traded on the CME using GLOBEX almost 24-h a day, while the Nikkei 225

³ During the Daylight Savings Time, the trading hours will start at 13:30 GMT and end at 20:00 GMT.

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