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# Internationally cross-listed stock prices during overlapping trading hours: price discovery and exchange rate effects

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**Abstract**

We analyze exchange rates along with equity quotes for 3 German firms from New York (NYSE) and Frankfurt (XETRA) during overlapping trading hours to see where price discovery occurs and how stock prices adjust to an exchange rate shock. Findings include: (a) the exchange rate is exogenous with respect to the stock prices; (b) exchange rate innovations are more important in understanding the evolution of NYSE prices than XETRA prices; and (c) most (but not all) of the fundamental or random walk component of firm value is determined in Frankfurt.


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*Keywords:* International stock markets; Cross-listing; Price discovery

## 1. Introduction

Stocks of many non-US firms are traded in the United States. The issue of where price discovery occurs for such firms is surprisingly understudied. For instance, we lack evidence that yields a firm answer to the question of whether US trading follows the home market or the home market follows the US. Furthermore, how do the prices in both markets adjust to an

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exchange rate shock? Does arbitrage avoidance require both markets to simultaneously adjust to a new exchange rate or does the adjustment tend to occur all in one market?

While there is no paper that attempts to address both of these issues as will be done here, there is a literature that addresses the relationship between prices of foreign equities and their US listings. This literature is overwhelmingly focused on low-frequency daily returns so that issues of non-synchronous prices are potentially important. Exceptions include Ding et al. (1999), who examine the links between Singapore and Malaysia trading for one Malaysian firm, and Eun and Sabherwal (2003), who examine the links between US and Canadian trading for a sample of Canadian firms. These studies show significant price discovery in both the home and foreign market. While these papers are innovative and instructive, they differ from the analysis developed below in that they do not model the exchange rate process, but use exchange rates to convert equity prices into common units across countries. In addition, their samples have more time aggregation between observations than the sample employed below. Harris et al. (2001) examine high-frequency spread and transaction price dynamics for Daimler-Chrysler (DCX) after the creation of the global ordinary DCX shares and show how US interest in DCX trading decreased in the first six months following the merger of Daimler-Benz and Chrysler.

While analysis in an intra-day setting is required to provide hard evidence, lower-frequency studies have found an independent effect of the US market. For instance, Kim et al. (2000) use daily data on 21 Japanese, 21 British, 5 Dutch, 5 Swedish, and 4 Australian firms to estimate VAR models of the impact of the underlying shares, the New York afternoon exchange rate, and the US market index on ADR prices. They find that the underlying shares appear to be most important, but there is a significant independent role for the exchange rate and the US market index in pricing ADRs. While their paper does not specifically address the issue of price discovery, their findings of a role for the US factor suggest that the issue of price discovery requires a more detailed analysis. Other studies using daily data on individual stocks have focused on other markets. Kato et al. (1990) examine seven UK, eight Japanese, and eight Australian stocks also traded in New York and find evidence that the price in the home country leads the price in New York. They convert home country prices into dollars using a daily exchange rate taken from the *Wall Street Journal*. Lau and Diltz (1994) study seven Japanese stocks also traded in New York and find bi-directional causality but a stronger impact of NYSE returns on Tokyo returns than the reverse. They convert the Tokyo prices into dollars using daily exchange rates from the Chicago Mercantile Exchange. Lieberman et al. (1999) examine six Israeli stocks that are listed in New York and find that price discovery appears to occur in Israel for five of the firms with Teva having a dominant role for the US. They suggest that the result for Teva is due to Teva being a multinational firm. Their study converts the Israeli prices into dollars using a daily exchange rate from the Bank of Israel. Wang et al. (2002) examine a group of Hong Kong stocks that are also traded in London and find bi-directional causality for local market returns between the two markets but with Hong Kong being the dominant market. The exchange rate is not incorporated into their analysis.

The evidence from low-frequency daily data indicates that the issue of price discovery for cross-listed shares is rather unsettled. Generally, the papers are not actually conducting tests for price discovery in the recent sense of the word but are examining pricing links across markets. One may draw inference, however, that while the majority of low-