Is There a Reversal in the Price Discovery Process under Different U.S. Market Conditions? Evidence from Asian ADRs and their Underlying Foreign Securities

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Abstract. This paper investigates the price discovery ability of American Depository Receipts (ADRs) for three Asian markets. We examine the information transmission dynamics between ADRs and their underlying foreign stocks under different U.S. market conditions. The results indicate that when the U.S. market is stable, the Korean underlying stocks dominate the price discovery process, but the price discovery process reverses when the U.S. market is volatile However, Trading of Taiwan's ADRs is more informative than that of the underlying stocks and Hong Kong underlying market offers a dominant source of ADR pricing, regardless of the state of the U.S. market. In sum, the price discovery for the three Asian markets differs, and the reversal effect is unique to Korean ADRs.

Keywords: ADRs, Cross-Listed Stocks, Price Discovery.

1. Introduction

In Asian, there are many firms issue American Depositary Receipts (ADRs) on United States (U.S.) stock exchanges. Because each ADR can be converted into some multiple of its underlying foreign security, the foreign and U.S. prices of any given security must be the same, after adjusting for transfer costs. However, legal barriers and the non-overlapping trading hours of U.S. and Asian stock exchanges make it difficult to determine which market dominates in the price discovery process. Although academic literature has examined price discovery for cross-border listings on U.S. exchanges, empirical evidence has not revealed a common direction for price transmissions. Gramming et al. (2005), Su and Chong (2007), and Agarwal et al. (2007) indicate that the home market determines the stock prices, but Kim et al. (2000) and Iwatsubo and Inagaki (2007) indicate that the U.S. market has a stronger impact. This study therefore aims to clarify the price discovery process in Asian ADRs, and address possible reasons for the mixed empirical results.

This study formulates the following hypothesis. A drastic change in the U.S. stock market movement improves the price discovery ability of ADRs, because American investors will expect the shock to spread to foreign markets. The ADR trading process depends on arbitrage opportunities, since it reflects investors' expectations with respect to the impact of the underlying foreign prices. Therefore, the trading is information-driven when the U.S. market is extremely volatile. On the other hand, in the absence of a major change in the U.S. market, ADR trading reflects price information regarding the underlying stocks; that is, the trading is for liquidity provision.

The key findings of this paper are as follows. First, as also found in previous studies, when U.S. stock market is stable, the underlying Korean stocks affect their ADRs more than the ADRs affect the underlying stocks; this indicates that the ADR trading reflects the foreign information arrival. Second, during periods of large change in U.S. market, price discovery occurs in the United States, which shows investors' anticipation that the market fluctuations would impact the underlying prices. However, the reversal effect is unique for Korean market among the three Asian markets.

2. Data and methodology

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This study examines five Korean, five Taiwanese and 11 Hong Kong companies that cross-listed on the NYSE. We select these markets because their regions and stock market values are similar each other. The sample period is from January 1, 2004 to December 31, 2010. Our source for daily data is the *Datastream* database, and the underlying market prices are converted into US dollars.

To select periods of stability and wide fluctuations in the US stock markets, we use the DJIA chart to determine the trends in four major periods: the stable period (2004/1/1 to 2006/7/17), the rising period (I) (2006/7/18 to 2007/10/9), the falling period (2007/10/10 to 2009/3/9), and the rising period (II) (2009/3/10 to2010/12/31).

To examine the reversal mechanisms of price transmission between underlying and U.S. markets, the WPC method can specify how one market movement affects the opening price of the other market. If after observing the daytime price changes in ADRs, Asian investors use the closing prices as a guideline to determine the opening prices of the underlying stocks, we indicate that the price information of ADRs lead that of the home market. Similarly, price discovery occurs in the home market if the ADRs' opening prices approach the Asian closing prices. We use the WPC formula to measure the influence of U.S.-related trading information on the Asian opening prices, which is given by:

$$WPC = \sum_{t=1}^{T} \left(\frac{\left| RN_{i,t+1}^{H} \right|}{\sum_{t=1}^{T} \left| RN_{i,t+1}^{H} \right|} \right) \times \left(\frac{RD_{i,t}^{A}}{RN_{i,t+1}^{H}} \right) \quad (1)$$

The first item on the right-hand side indicates the weighted average of the aggregated overnight returns of the home market stocks ($RN_{i,t}^{H}$) during the sample period. The second item is the contribution percentage of the trading returns of ADRs ($RD_{i,t}^{A}$) to the overnight returns of underlying stocks.

3. Results

3.1. WPC Results for Korean Market

This study tests the effect of the daytime returns of ADRs (underlying stocks) on overnight returns for underlying stocks (ADRs) under different U.S. market conditions, with the results in our Table. Panel A shows that, the average WPC values of the daytime returns of the ADRs to the overnight returns of the underlying stocks in this period is 68.67%. The daytime price changes in five Korean underlying stocks contribute an average of 65.56%, similar to that of the underlying stocks. The WPC of the ADRs does not dominate the underlying stocks and vice versa. The result will not enable us to determine which market makes a greater contribution to price discovery. Therefore, it is important to investigate the dynamics of information transmission under different market conditions.

Panel B shows that, when the U.S. market is steady, WPC values for Korean daytime trading are large, with an average of 84.90%. In contrast, the average WPCs of the ADRs' daytime price changes to the overnight returns of the underlying stocks is 41.79%, only half that of the underlying stocks. The WPC results indicate that for the Korean market, price discovery occurs largely in the home market; this conclusion is similar to that revealed in previous empirical studies. On the other hand, in the volatile period, the WPCs of the two markets are reversed. In the rising period (I), although the WPC values of the ADRs remain less than that of the underlying stocks, the overall value increases to 63.89%, but the WPC of the underlying stocks drops to 72.54%. In the falling period and rising period (II), the daytime returns of the five ADRs show higher price contributions than their underlying stocks. Even though the mean and volatility of KOSPI are higher than those of DJIA after the financial crisis (rising period II), the WPC value of ADRs' daytime trading (68.01%) are much greater than those of the underlying stocks' daytime trading (58.15%) during the period.

As expected, the empirical results provide convincing evidence that the New York market plays an important role in the price discovery process. The reversal in price transmission does not indicate market inefficiency but rather reflects the existence of arbitrage opportunities between the two markets. The trading of ADRs shows that investors' expectations regarding Korean market performance and the closing prices in the United States can serve as a benchmark for predicting the opening prices of underlying stocks, particularly during periods of sharp decline in the former. Thus, our main hypothesis has explanatory power

regarding the process of price discovery and the formation of opening prices for Korean ADRs and their underlying stocks.

3.2. WPC Results for Taiwan and Hong Kong Markets

It is important to investigate the reversal effect for other Asian markets under different U.S. market conditions such that we can provide investors with more direction in forecasting changes to their investments. We therefore examine the international flows of Taiwan and Hong Kong ADRs and their underlying stocks during the same periods.

This table also summarizes the WPC values, as measured by Eq. (1). Panel A provides the results for the full sample period. Compared with those for the Korean market, the WPC values in these cases indicate inconsistent directions for price discovery. Trading of Taiwan's ADRs is more informative than the underlying stocks. In contrast, the Hong Kong market offers a dominant source of pricing; in line with previous empirical studies.

In Panel B, we examine the reversal effect in various US market conditions. The WPC results indicate that the price discovery contribution does not change for either market, regardless of the level of stability of the U.S. market. The price discovery for the three markets also differs, and the reversal effect is unique to Korean ADRs. One possible explanation for such mixed empirical evidence relies on industry effect. The five Taiwanese ADR-issuing companies function in information technology (IT) industries, and the U. S. is the major export market for Taiwanese IT products. In contrast, the ADR-issuing companies from Hong Kong focus their businesses on the Chinese market. Thus, the stock prices for Taiwan and Hong Kong should correspond more closely with the U.S. and Chinese markets, respectively. The operation of the Korean issuing companies does not depend heavily dependent on any other single market, so its information transmission is more efficient.

4. Conclusions

Table. Weighted price contribution (WPC) results for ADRs and underlying stocks under different U.S. market conditions

Panel A: The full sample period

Market	WPC (A)	WPC (H)
Korea	68.67%	65.56%
Taiwan	**79.25%**	50.85%
Hong Kong	53.16%	**80.51%**

Panel B: The average of WPCs under U.S. market is stable or large movement

Condition	Stable period		Rising period (I)		Falling period		Rising period (II)	
Market	WPC(A)	WPC(H)	WPC(A)	WPC(H)	WPC(A)	WPC(H)	WPC(A)	WPC(H)
Korea	41.79%	**84.90%**	63.89%	**72.54%**	**91.66%**	57.45%	**68.01%**	58.15%
Taiwan	**59.06%**	57.49%	**87.76%**	51.83%	**90.77%**	41.02%	**86.63**	55.97%
HK	12.97%	**29.34%**	49.39%	**76.95%**	60.06%	**75.43%**	45.83%	**81.15%**

Notes: This table summaries WPC as measured by Eq. (1) for various markets under different U.S. market conditions. The WPC (A) is the weighted price contribution for the ADRs' daytime returns on the underlying stocks' overnight returns; and The WPC (H) is the weighted price contribution for the home market's daytime returns on the ADRs' overnight returns. The stable period is from 2004/1/1 to 2006/7/17; the rising period (I) is from 2006/7/18 to 2007/10/9; the falling period is from 2007/10/10 to 2009/3/9; the rising period (II) is from 2009/3/10 to 2010/12/31.

Many empirical studies have shown that the trading of cross-listed stocks depends on price information provided by the home market. This paper investigates the price transmission dynamics between the U.S. and three Asian markets, and extends prior research by showing how the U.S. market movements affect the price discovery of Korean ADRs. We conclude that in certain situations, Korean ADRs and their underlying stocks exhibit price discovery capability. The reversal effects support that the economic linkage between Korea and U.S. is closely, and provide the reason for the mixed information flows in previous literature. The findings back up the efficient use of information in the ADR market through arbitrage by both Korean and foreign investors, and inform investors to forecast the changes of their investments more accurately.

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