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Information Transmission between Dual Listed Stocks with Non-Overlapping Trading Hours

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Abstract

This paper examines the information transmission between stocks and their corresponding deposit receipts (DRs) by collecting samples with good reputations and high liquidity in both markets. Using eight years of daily panel data from six cross-listed Taiwanese firms, our results show the feedback causality between the domestic and U.S. markets and illustrates bi-directional information transmission across markets. This is opposite to previous Taiwanese cases, which did not control for the impact of reputation and liquidity. In other words, reputation and liquidity are important factors that direct the information flow for Taiwanese cross-listed stocks.

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1. Introduction

With the trend of the integration of capital markets around the world, more and more companies have cross-listed their stocks on both local and overseas stock exchanges. A spate of research has emphasized this issue, especially regarding the revelation and transmission of information between domestic and corresponding DR markets, as informed traders could benefit from their superior information through trading assets between the separate markets (Chowdhry and Nanda 1991).

These studies focused on examining the direction of information transmission. Some found that information transfers in a uni-directional way, either from domestic to overseas (Hauser *et al.* 1998; Liberman *et al.* 1999; Chen 1998; Yang *et al.* 2002) or vice versa other (Neumark *et al.* 1991; Kim *et al.* 2000). However, other studies indicate that information could be transmitted bi-directionally. For example, Lau and Diltz (1994) and Wang *et al.* (2002) address feedback causal price linkage between domestic and overseas markets. Obviously, there is not a consensus about the direction of information flow.

In practice, the market conditions are quite different between home countries and corresponding DR markets. This is mainly shown in two aspects. Firstly, companies have different levels of influence based on their reputation in each country. Bailey *et al.* (2008) shows that investors prefer to trade DRs that are well known in their domestic countries. Secondly, the trading volume or frequency between the two countries might also be distinct. Chan *et al.* (2007) and Levy Yeyati *et al.* (2009) suggest that the illiquidity of the markets makes the prices of DRs and their underlying shares inefficient. Uneven market conditions could be an important factor causing a discrepancy in information transmission, but few studies note this. This study thus tries to explore the issue by controlling for firms' reputations and for trading conditions.

We controlled for reputation and trading condition by collecting a specific set of sample firms. The sample firms included had to satisfy the following conditions: 1) the size of the company had to be in the top 10% of the total domestic listed companies, 2) ownership by foreign investors had to be above 20%, 3) the firms' stocks were traded heavily and frequently in the firms' domestic market (the trading volumes of these companies had to be in the top 10% of the Taiwan Stock Exchange), and 4) their DRs were sponsored and had high liquidity. The first two conditions ensure that the sample firms have a good reputation, and the last two conditions ensure that the trading conditions are almost similar between both markets. Moreover, the four conditions make certain that the prices of the stocks are relatively efficient so that we can make precise estimations.

Our sample includes six representative firms in Taiwan that dually list their shares both in Taiwan and the U.S.[1] Through regressing the six firms' eight years of daily panel data, we found evidence of bi-directional information transmission across markets. This result is opposite to Yang *et al.*'s (2002) findings, which also used a sample from Taiwan, but did not control for reputation and trading criteria. This implies that reputation and trading environment indeed have a great influence on the direction of information transmission.

The remainder of this paper is organized as follows. Section 2 presents the data and

[1] Low liquidity usually causes the inefficient and less informational stock price and, consequently, leads to the distortion of the information revelation. For prevent from the bias of estimation, low reputation firms are not included in our sample. Furthermore, low reputation firms are usually accompanying with low liquidity. As a result, our sample only consists of high reputation and high liquidity firms.

introduces the econometric model. The empirical results are reported in Section 3. We draw our main conclusions in Section 4.

2. Data and Method

Our sample contains six Taiwanese stocks that are publicly traded in both the domestic market and in the NASDAQ or the New York Stock Exchange (level II and level III ADRs). (Table I) We used daily closing prices for the market index and underlying stocks and their ADRs. We collected the data from the Yahoo website for stocks and their ADR prices. The sample period is from January 2004 to June 2012; we excluded the observations around the ex-dividend date.

We employed the Granger causality test to examine the direction of information transmission between domestic and ADR markets. The selected model is as follows.

$$R_{j,t}^{H} = \alpha_j^{H} + \sum_{i=1}^{K} \beta_{HH,i} R_{t-i}^{H} + \sum_{i=1}^{K} \beta_{AH,i} R_{t-i}^{A} + \varepsilon_t^{H} \quad (1)$$

$$R_{j,t}^{A} = \alpha_j^{A} + \sum_{i=1}^{K} \beta_{AA,i} R_{t-i}^{A} + \sum_{i=0}^{K-1} \beta_{HA,i} R_{t-i}^{H} + \varepsilon_t^{A} \quad (2)$$

where

$R_{j,t}^{H} = \ln\left(\frac{P_{j,t}^{H}}{P_{j,t-1}^{H}}\right) - R_t^{M}$ defines the daily excess return of domestic stock for firm *i* and

$R_{j,t}^{A} = \ln\left(\frac{P_{j,t}^{A}}{P_{j,t-1}^{A}}\right) - R_t^{M}$ defines the daily excess return of ADR for firm *i*.

Note that R_t^{M} denotes the daily return of the market index. [2]

Equation (1) illustrates that the ADR return may be affected by the previous K days' home shares return. Because the U.S. exchanges open after the Taiwan stock exchange closes, the domestic share may be affected by the ADR returns on the current date and the previous date. Thus, we use 0 to K-1 in Equation (2) instead of using 1 to K in Equation (1). The key parameters of the above equations contain $\beta_{HA,i}$ and $\beta_{AH,i}$ to test the hypotheses of information transmission from the domestic market to the ADR market and from the ADR market to the domestic market (with *i* dates lagging), respectively.

As Hasbrouck (1985) pointed out, the estimation of the equations may suffer a mis-specification problem. For example, to consider the case that the information only reveals in the domestic market, the autoregressive prices process of the domestic markets result in a spurious correlation between $R_{j,t}^{H}$ and $R_{j,t-1}^{A}$. Therefore, we also incorporate the autoregressive lag term into the equations to mitigate the problem.

[2] The daily return of Taiwan Capitalization Weighted Stock Index (TAIEX) is employed as the market return for domestic stocks. Also, we use NYSE composite index and Nasdaq composite as the proxy of the market return for the ADR listed in NYSE and Nasdaq, respectively.

3. Empirical Results

This section reports the empirical results for our model. We first calculate the correlation coefficients of the domestic stocks and their ADR return. We also analyze the lead-lag relationship across the two markets.

We simply use the close-to-close return as the measure for the daily return; that is, the return for date t is defined as the logarithm of the ratio of closed price at *t* and *t*-1. The upper (lower) triangle in Table II displays the mean values (medians) of the six firms' correlation coefficients. The correlation coefficient of R_{t-1}^{A} and R_{t}^{H} is 0.38823; it implies that the ADR return indeed correlates with the underlying stock on the next domestic trading date. Similarly, we also show that the correlation coefficient of the daily returns of the two assets on the same calendar date is approximately 0.17. This implies that domestic share returns relates the ADRs in the U.S. markets, which is open after the Taiwan stock exchange has closed. The result of Table II shows that the relationship between the underlying stocks and the ADR seems to feature bi-directional information transmission.

Table III presents the direction of information transmission. We first estimate the equations with 4-days lag (K=4). The top half of Table III reports the coefficients for one- up to four- day lags and Granger-causality tests for the Equation (1) and (2). The coefficients $\beta_{AH,i}$ and $\beta_{HA,i}$ are significantly positive and show a lead-lag relationship between the two markets; this result also implies that information transfers bi-directionally from one market to the other. The bottom half displays the summarized statistic. F-test is as well available to illustrate the feedback causality relation between the stock markets and their corresponding ADR markets. The F-values for equation (1) and (2) respectively provides evidence to reject the null hypothesis $\beta_{HA,1} = \beta_{HA,2} = \ldots = \beta_{HA,K} = 0$ and $\beta_{AH,1} = \beta_{AH,2} = \ldots = \beta_{AH,K} = 0$ at the 1% significance level. Consequently, our empirical evidence suggests that the information transmission between the ADRs and their underlying stocks is bi-directional.

As that pointed out in Section 2, it is necessary for us to examine whether the returns of the two markets contain a spurious correlation. Phillips (1986) suggests that the D-W statistic is helpful to distinguish between genuine and spurious regressions. Specifically, the spurious relationship is associated with a D-W statistic closed to zero. The D-W statistics in Table III provides sufficiently evidence to reject to hypothesis of the spurious regression.

In Table III, we measure the daily return by using the logarithm of the ratio of closing price to the previous closing price. Because Taiwan and U.S. stock exchanges share no overlapping trading hours for time zone difference, this close-to-close daily return may contain not only the information transferred from the other markets but also the current information that is announced immediately. As a result, to avoid the estimation error due to time zone difference between Taiwan and U. S., we use the overnight return as the dependent variables of equation (1) and (2). Specifically, we define the return of date t by $\ln(\frac{open\ price\ at\ date\ t}{closing\ price\ at\ date\ t-1})$. Table IV presents the results and we find the similar result to Table III even if the impact of the intra-day information is eliminated. The bi-directional relationship is confirmed.

4. Discussion

This paper addresses information transmission between domestic stocks and their corresponding ADRs, which do not share any overlapping trading hours because of the different time zones of the relevant markets. Our sample includes the daily return of the domestic shares and their ADRs for the six Taiwanese cross-listing firms from January 2004 to June 2012. We employ Granger causality regression to support our results.

The empirical evidence suggests the feedback causality between the domestic and U.S. markets and concludes bi-directional information transmission across markets. Our results, which are opposite to past studies that found uni-directional causality between the markets, may be due to our representative sample selection. The stocks and DRs of the six chosen firms are heavily traded, liquid, and well-known, so the prices are expected to fully reflect the relevant information and be more efficient. Intuitively, for two markets with non-synchronous trading hours, information will be revealed immediately in the market that is currently open and then transfer to the market that opens afterward. Therefore, the feedback causality we found for our data is unsurprising. Although we provide neither alternative models nor samples to check the robustness of our results, the key contribution of this study is to identify the importance of the sample selection. Specifically, firm characteristics as well as trading environment may be factors that influence the direction of information transmission across DRs and their corresponding stock markets.

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Table I The Sample Firms

Firms (Symbol)	Domestic market	ADR market	Sector	ADR Listing date
Taiwan Semiconductor Manufacturing Co. Ltd. (TSM)	Taiwan Stock Exchange	NYSE	Electronic Technology	1997/10/9
Siliconware Precision Industries Co. (SPIL)		NASDAQ		2000/9/7
United Microelectronics Corp. (UMC)		NYSE		2000/9/19
Advanced Semiconductor Engineering Inc. (ASX)		NYSE		2000/10/2
AU Optronics Corp. (AUO)		NYSE		2002/5/23
Chunghua Telecom Co. Ltd. (CHT)		NYSE	Communications	2008/1/30

Table II The Matrix of Correlation Coefficient

	R_t^H	R_{t-1}^H	R_t^A	R_{t-1}^A
R_t^H	1.00000	0.04652	0.16704	0.38823
R_{t-1}^H	0.04628	1.00000	-0.01690	0.16609
R_t^A	0.16941	-0.01828	1.00000	-0.11256
R_{t-1}^A	0.38803	0.16849	-0.11628	1.00000

Table II summarizes coefficient of correlation of the daily returns of domestic stocks and their ADRs with one date lag. The upper triangular correlation matrix presents the mean correlation coefficients of the six firms in our sample while the lower triangular is their medians.

Table III Granger-causality tests

Model	Equation (1)		Equation (2)	
Coefficient	$\beta_{HH,i}$	$\beta_{AH,i}$	$\beta_{AA,i}$	$\beta_{HA,i}$
Coefficients t-test (H_0: $\beta_{..,t-k} = 0$)				
With 1 Lag	-0.085332***	0.404516***	-0.233618***	0.270871***
With 2 Lags	-0.058092***	0.144464***	-0.099154***	0.053502***
With 3 Lags	-0.019418**	0.108272***	-0.033017***	0.021781**
With 4 Lags	-0.038075***	0.010049	-0.049369***	0.007862
Summary Statistics				
F-value	622.493***		186.553***	
R^2	0.17416		0.07407	
Adjusted R^2	0.17328		0.07308	
Durbin-Watson	2.00693		2.00325	

Note. This table reports the results for the regression results for equations (1) and (2) with four-days lag. The top half of the table displays the key coefficients of the regression while the bottom half presents the summarized statistics. The sample period is from January 2, 2004 to 29 June, 2012. ** and *** indicate statistical significance at the 0.05 and 0.01 levels, respectively. The D-W statistics is available to distinguish between genuine and spurious regression.

Table IV Granger-causality tests (with opening price adjustment)

Model	Equation (1)		Equation (2)	
Coefficient	$\beta_{HH,i}$	$\beta_{AH,i}$	$\beta_{AA,i}$	$\beta_{HA,i}$
Coefficients t-test ($H_0: \beta_{..,t-k} = 0$)				
With 1 Lag	-0.115470***	0.235500***	-0.233618***	0.477117***
With 2 Lags	-0.096685***	0.110856***	-0.099154***	0.150520***
With 3 Lags	-0.023965**	0.055721***	-0.033017***	0.111786***
With 4 Lags	-0.030011***	0.011291	-0.049369***	0.036155***
Summary Statistics				
F-value	90.6265***		257.4029***	
R^2	0.08845		0.21605	
Adjusted R^2	0.08747		0.21521	
Durbin-Watson	1.90291.		1.83217.	

Note. This table reports the results for the regression results for equations (1) and (2) with four-days lag. We use the overnight return for the dependent variables. Specifically, the return of date *t* is replaced by using the logarithm of the ratio of opening price at date *t* and the closing price at *t*-1. The top half of the table displays the key coefficients of the regression while the bottom half presents the summarized statistics. The sample period is from January 2, 2004 to 29 June, 2012. ** and *** indicate statistical significance at the 0.05 and 0.01 levels, respectively. The D-W statistics is available to distinguish between genuine and spurious regression.