INFORMATION TRANSMISSION EFFECTS BETWEEN A AND H DUAL LISTING SHARES

Ai-Chi Hsu, National Yunlin University of Science and Technology
Show-Yen Lai, National Yunlin University of Science and Technology
Lien-Hui Chao, Capital Investment Management Corporation

ABSTRACT

The current study, taking A and H dual listing shares as the participants, aimed to investigate the effect of China's opening-up policy on the information transmission among dual listing shares. The results indicated that China's opening-up policy strengthened the integration of dual listing share and attracted more companies to collect funds via dual listing, making information transmission more frequent. Overall, with policies gradually unfolded, the co-movement between A and H shares grew closer, leading to the consistency in price discovery contribution ratio of A and H dual share markets. On the other hand, regression was employed to analyze factors resulting in the price difference of A and H stocks. The results revealed that information asymmetry was the most significant factor, followed by liquidity and exchange rate.

INTRODUCTION

The Chinese stock markets have grown rapidly since 2000. Despite controls from policies and regulations, the stock markets in Shanghai and Shenzhen still attract a huge surge of investments, domestic as well as foreign. The stock markets are gradually moving from a closed one to an open market. The foreign fund into A shares and domestic fund into H shares have also shifted to supervised limited capital flow. The energy of a capital market lies in the capital flow, and capital inflow and outflow inevitably affect stock price. With China's opening-up policy towards stock markets, capital flow and information transmission have been the direct factor leading to the price co-movement of A and H shares.

The response and co-movement to information of the stock prices of an asset in different markets serve to explain the relationship and influence among different markets. Finding this kind of relationship and pattern and investigating factors of co-movement among different capital markets benefit research concerning the use of one market to predict the future stock price of another market, the information transmission among markets, and the relationship of response rate to new information between the two markets. One of the major functions of the secondary market is price discovery. When a company enters the market simultaneously in several exchanges, price discovery is no longer domestic; instead, its stock price is determined by all market information. When market information influences asset price, it means that the market has made a contribution to the asset price. The greater the contribution, the faster the stock price of the asset responds to new information. Hasbrouck (1995) stated that price discovery is a process in which the financial market digests new information and adjusts to balanced price. If the capital market could swiftly respond to the impact from new information, the market would immediately transmit the information to other markets. Different response rates of stock price to information were the main factor that determined the lead-lag relationship among stock markets (Mech, 1993; Hameed, 1997).

Stock markets in Mainland China have headed for internationalization and liberalization with the following measures: the establishment of stock exchanges and securities commission, the enforcement of Securities

Acts, the approval of domestic investment in B shares, the overseas listing of large state-run companies, the practice of QFII (Qualified Foreign Institutional Investors) System, the conclusion of CEPA (Mainland and Hong Kong Closer Economic Partnership Arrangement), the implementation of QDII (Qualified Domestic Institutional Investor), the opening of foreign capital to underwrite/tutor companies for listed ones, and the announcement of Through Train Plan.

Since late 1970s, foreign banks and transnational financial institutions have been swarming into Hong Kong due to a series of financial liberalization policy adopted by the Hong Kong government, including the removal of regulations of foreign exchange and gold, the act to unfreeze bank license, and the cancellation of deposit interest tax. Hong Kong Stock Exchange, a liberal and international capital market, has been the second largest IPO center after exceeding New York Stock Exchange in 2006, indicating that Hong Kong has become the ideal location for international investors to expand business in Asia. Between 2003 and 2006, Hong Kong and China signed a four-year CEPA agreement, which facilitated the goods, service and business investment between the two places, strengthened the economic and trade relationship, and promoted regional integration. The aforementioned has positively influenced how China attracts foreign capital and has helped foreign capital to better understand listed companies in China.

In terms of international economy, Chinese business has gradually stepped towards offshore stock markets. Meanwhile, as Chinese economy keeps growing rapidly, major stock exchanges around the globe have targeted on China, attracting Chinese companies to become listed one in offshore stock exchanges. Well-organized domestic Chinese companies, therefore, become targets worth fighting for. In addition, there are many advantages when Chinese business enters Hong Kong market. First, the open channel to financing after a company becomes a listed one helps garner international capital, beneficial to the long-term development of the company. Second, a company's influence and international image could be expanded by virtue of the international financial center that Hong Kong holds. Third, Hong Kong capital market is large in scale and mature, resulting in high participation among investors/retail investors and high market liquidity. Fourth, Hong Kong does not regulate foreign exchange and does not impose tax on dividend or stocks sold. Fifth, A shares could be issued in Mainland China when a company become a listed one in Hong Kong. As international capital liquidity grows liberalized (particularly stock exchanges' continual reinforcement of alliance in the process of competition and cooperation), dual listing of a company also becomes a common phenomenon.

If the international capital market circulates liberally and efficiently, stock prices should stay the same and dual (or multiple) listing stocks should have the same anticipated cash flow and risk characteristics, uninfluenced by the location where a company becomes listed. However, most emerging markets would impose restrictions on foreign investors. China is no exemption, dividing stocks in Shanghai, Shenzhen, and Hong Kong respectively into A shares, B shares, and H shares based on an investor's identity. Stock prices differ due to the division of stock markets. The dispute about over-/under-estimation has been existing in China's stock markets, such as premium in A shares. Different price behaviors have been existing in A shares and H shares. To investigate if China's gradual adjustment of government policies leads to different effects on the two markets, the current study, based on stock prices of A and H dual listing companies, examined the cointegration between the two markets, with an aim to understand changes of balance and information transmission between the two markets. In addition, the leading position of one market in terms of price discovery was analyzed. Different hypotheses proposed by previous researchers were also verified, for the purpose of providing useful information regarding the interrelationship among different markets.

The remainder of the paper is organized as follows. Section II briefly reviews previous researches on co-movement of stock markets between China and Hong Kong and the information transmission of stock prices in stock markets. Section III describes the data and the methodology and introduces the theoretical framework of information share model. Section IV analysis the empirical results. A brief summary concludes the article in Section V.

LITERATURE REVIEW

The literature is replete with empirical evidence regarding the co-movement of stock markets between China and Hong Kong. Most researchers, while probing into China's stock markets, generally believed the market segmentation in China's stock markets (Bailey, 1994; Yang, 2003; Chakravarty, Sarkar, and Wu, 1998; Ma, 1996; Fung, Lee, and Leung, 2000). Researches considered the reform and liberalization of capital markets in China beneficial to market cointegration. Wang and Iorio (2007) stated that high cointegration existed between A and B shares as well as between A and H shares. Luo, Sun and Mweene (2005) found that after the reform, information transmission between the two stock markets became more frequent, symbolizing a long-term balanced relationship. Therefore, the opening-up policy helps improve market segmentation and information transmission, and indirectly promotes the co-movement among markets. Thus, the investigation into the lead-lag relationship among stock markets and price discovery benefits the understanding of which market holds the leading position.

Yang (2003), examining SSE A Share, SSE B Share, Shenzhen Index A, Shenzhen Index B, Red chips stocks, and Hong Kong H Shares, found that there was no sign of cointegration among the six markets between 1995 and 2000. Wang and Iorio (2007) found that between 1995 and 2004, high cointegration existed between A and B shares as well as between A and H shares. Chen (2005) investigated changes before and after China's policy that Hong Kong investors could directly buy stocks of A shares, and found that before the opening-up policy, H shares was more influential in terms of price. After the opening-up policy, frequent information transmission and prominent information spillover resulted in more mutual influence on stock prices between the two markets. Qiao, Li, and Wong (2008), focusing on China's derestriction on B shares investment, found dual causality in B and H share stock markets before the policy change, while B shares held the leading position after the policy change, evidencing that changes of government policies were important factors in affecting market changes.

In previous literature regarding price information transmission, Poon and Fung (2000) analyzed the information transmission of stock prices in SSE Index, Shenzhen Index, Red chips stocks, and Hong Kong H shares, and found that mutual influence existed among stock markets. Wang and Jiang (2004), investigating 16 dual listing companies between 1996 and 2001, stated that no significant causality was found in stock price returns of A and H shares, suggesting that previous stock price returns of A shares (H shares) could not be used to predict the current stock price returns of H shares (A shares). Luo et al. (2005) indicated that in terms of price discovery contributions, A shares held the leading position in terms of information. Investigating dynamic information transmission of 76 companies of A and B dual listing shares, Chan, Menkveld, and Yang (2007) found that prior to the opening of allowing Chinese people to buy B shares, the stock market of A shares dominated B shares in price discovery. However, after the opening-up policy, the stock market of B shares took the lead in price discovery.

Based on the aforementioned information, the current research found that studies concerning factors affecting the stock price information transmission in A and H shares remained inconsistent. As stock markets in China keeps opening up, more and more overseas capital has invested in A shares via QFII (Qualified Foreign Institutional Investors). Meanwhile, more and more institutional investors choose to invest in Hong Kong market through QDII (Qualified Domestic Institutional Investor). Numerous scholars have proposed different hypotheses and extensively discussed factors that affected stock prices of A and H shares.

Information Asymmetry

Researchers have proposed that due to language barrier, different accounting system and the lack of reliable information, foreign investors face more challenges of obtaining information than domestic investors, thus creating information asymmetry (Chakravarty et al., 1998; Wang and Jiang, 2004). However, Tian and Wan (2004) stated that compared with domestic investors, foreign investors were mostly experienced institutional investors, possessing more resources and technologies to analyze new information in the local area. Myers and Majluf (1984) stated that large-scale companies faced relatively fewer information

asymmetry and obtained external financing opportunities more easily. Eng and Mak (2003) suggested that the bigger the company, the more information the company would disclose to solve information asymmetry in the capital market. Investors could obtain correct information with relative ease, thus reducing information asymmetry.

Transaction Costs

Fleming, Ostdiek, and Whaley (1996) stated that markets with lower transaction costs responded quicker to new information, thus having higher price discovery ability. However, some scholars used numerous bid-ask spreads to evaluate investors' execution cost, and found that the high the cost, the lesser the deals from investors having information, thus lowering liquidity. Therefore, a market's response rate to new information might also drop (Huang and Stoll, 1997).

Liquidity

Amihud and Mendelsohn (1986) proposed liquidity premium theory, in which liquidity was an important influential factor in asset pricing. The expected yield of low-quality liquid assets is high, and vice versa. The enhancement of stock liquidity lowers a company's capital cost. Jain-Chandra (2002) found that many companies used dual listing to enhance stock liquidity, and those investors tended to trade in high-quality liquid markets. Hasbrouck (1995) suggested that price discovery of New York Stock Exchange and its stock trading volume were positively correlated.

DATA AND METHODOLOGY

In the current article, companies of A and H dual listing shares in Taiwan Economic Journal ranging from 2000/1/1 to 2009/12/31 were examined. For each share we use Thomson DataStream to obtain daily information on a wide set of variables including share price, total market value (to evaluate size as the proxy variable of information asymmetry), and the trading volume (number of shares traded for a stock on a particular day). We collect daily data on the bid and ask share prices to evaluate the spread as the proxy variable of investors' transaction cost rate. A shares are traded in RMB, while H shares in HKD. Therefore, before the relevant analyses, stocks in H shares were converted into RMB based on the exchange from HKD to RMB. Exchange was also retrieved from Thomson DataStream. To simplify analyses, the exchange from HKD to RMB was hypothesized to remain the same within a day. Up to the end of December, 2009, there were 60 companies of A and H dual listing shares. Due to insufficient information of three companies, 57 listed companies were included in the final data analysis.

Stocks that belong to a company yet are issued and traded in different markets normally maintain a balanced relationship in the long run. However, certain deviation is inevitable in the short run. That is, the two stocks have a common change trend (a.k.a. common factor), referring to the common valid price that the two market prices implicate, resulting from common valid information on the market. The information of a market makes contribution to the price discovery of an asset when the market information affects the asset price. Hasbrouck (1995) proposed the information share model (ISM), one of the models widely employed to investigate the common factor of price discovery in the field of market microstructure. ISM decomposes the variance of common factor and defines price discovery based on the contribution rate that new information of each market makes to common factor variance. To accurately quantify the long- / short-term relationship between A shares and H shares and the contribution to price discovery, the current study adopted Hasbrouck's (1995) ISM to determine if a common long-term trend existed between two unbalanced price series. Cointegration relationship between two markets was utilized to construct error correction model, with which common factor contribution was analyzed. In doing so, the current study could not only specify which market held the leading position but also confirm the information advantages of each market in terms of quantity.

In addition to the use of ISM to determine the price discovery of dual listing stocks, Johansen's cointegration test was adopted to investigate the co-movement of A and H dual listing stocks. Due to the page limitation,

tests widely applied to relevant financial empirical literature, such as unit root test, cointegration test, structural break test, and vector autoregression, were skipped. The introduction of ISM was as follows: ISM measures the contribution that new information in the market makes to the common factor variance, using the variance of common factor moderator variable to evaluate price discovery; that is, to evaluate the relative contribution that the market makes to the given common factor moderator variable variance. This kind of contribution rate is also known as information share. Considering the two price series with first-order stationarity $Y_t = (y_{1t}, y_{2t})'$, the difference $Z_t=\beta'Y_t= y_{1t} - y_{2t}$ was the error correction term. ISM starts with vector error correction model (VECM) illustrated in equation (1):

$$\Delta Y_t = \alpha\beta'Y_{t-1} + \sum_{i=1}^{k} \Phi_j \, \Delta Y_{t-1} + e_t \tag{1}$$

Where α and β' were the error correction and cointegration vector, $\alpha\beta'Y_{t-1}$ was the long-term dynamic balanced relationship, Φ was the coefficient vector that lag period corresponded to, k was the quantity of vector in the lag period, $\sum_{j=1}^{k} \Phi_j \Delta Y_{t-j}$ was the unbalanced short-term dynamic relationship, e_t was the random moderator variable irrelevant to the series. The average was 0. Adjust covariance equation (2):

$$\Omega = \begin{bmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{bmatrix} \tag{2}$$

where σ_1^2 and σ_2^2 were the variance of new information and ρ was the correlation coefficient.

The current study set cointegration on the price series of A and H shares $P_{i,t} = \left[P_{i,t}^A, P_{i,t}^H\right]$ issued by *i* company. The error correction model was illustrated in equation (3):

$$\Delta P_{i,t} = \alpha_i Z_{i,t-1} + \sum_{j=1}^{k} \beta_j \, \Delta P_{i,t-1} + \varepsilon_{i,t} \tag{3}$$

where k was the best-fit lag phases determined by the minimum SBC (Schwartz Bayesian criterion). $\varepsilon_{i,t}$ was the residual vector. The error correction term was $z_{i,t}=\beta_i'P_{i,t}$, $\alpha_i = \left[\alpha_i^A, \alpha_i^H\right]$ was the error correction vector, and $\beta_i = \left[\beta_i^A, \beta_i^H\right]$ was the cointegration vector. ISM converted Equation (3) into the vector moving average form in equation (4) and the cointegration form in equation (5):

$$\Delta Y_t = \psi(L)e_t \tag{4}$$

$$Y_t = Y_0 + \tau\psi(\sum_{s=1}^{t} e_s) + \psi^*(L)e_t \tag{5}$$

where Y_0 was the constant vector that reflects its average price difference, τ was the row vector, $\psi^*(L)$ was a matrix polynomial in the lag operator. Equation (5) included common factors of all prices. ψe_s was the component of price variation, defined as the common valid price of two markets (common factor) (Hasbrouck, 1995). The next was to decompose the variance of common factor moderator variable ψe_t. The increment ψe_t was the component of the price change that was permanently impounded into the stock price and was presumably due to new information. The variance of the term is $\psi\Omega\psi'$. When sequential correlation did not exist among VECM residual terms (i.e., covariance matrix Ω was a diagonal matrix), then $\psi\Omega\psi'$ only contained two elements in the diagonal line. The first (second) element referred to the contribution that the impact of the first (second) market made to the common factor. The proportion of this for market j relative to the total variance was defined as market j's information share in Equation (6). The relative information sharing of two markets was expressed in equation (7):

$$S_j = \frac{\psi_j^2 \Omega_{jj}}{\psi\Omega\psi'} \tag{6}$$

$$\frac{\psi_1^2 \sigma_1^2}{\psi_2^2 \sigma_2^2} \tag{7}$$

When the new information of market price was significantly correlated, Equation (6) was not tenable. To solve the problem of correlation, Cholesky's factorization was employed to eliminate the current correlation among new information share. If positive correlation existed among new market information, then the information share of the first variable was the largest and that of the last variable was the smallest. The information share of the j market would be defined as equation (8):

$$S_j = \frac{([\psi M]_j)^2}{\psi \Omega \psi'} \tag{8}$$

where $[\psi M]_j$ was the *jth* element of the row matrix ψM. M was expressed in equation (9):

$$M = \begin{bmatrix} m_{11}, & 0 \\ m_{12}, & m_{22} \end{bmatrix} = \begin{bmatrix} \sigma_1, & 0 \\ \rho \sigma_2, & \sigma_2(1-\rho^2)^{1/2} \end{bmatrix} \tag{9}$$

This matrix satisfied $\Omega = M_i M'_i$, therefore information share of A and H shares could be expressed in equation (10) and (11):

$$S_i^A = \frac{[\gamma_i m_{i,11} + (1-\gamma_i)m_{i,12}]^2}{[\gamma_i m_{i,11} + (1-\gamma_i)m_{i,12}]^2 + [(1-\gamma_i)m_{i,22}]^2} \tag{10}$$

$$S_i^H = \frac{[(1-\gamma_i)m_{i,22}]^2}{[\gamma_i m_{i,11} + (1-\gamma_i)m_{i,12}]^2 + [(1-\gamma_i)m_{i,22}]^2} \tag{11}$$

where γ_i was the weight of common factor of ith market.

The factorization imposed a hierarchy that maximizes the information share on the first price and minimizes the information share on the last price. An upper bound for a market's information share could be obtained by permuting ψ and Ω to place that market's price first. A lower bound could be obtained by permuting to place that market's price first (Hasbrouck, 1995). In addition, the stronger the correlation of information among markets, the higher the upper bound and the lower the lower bound. Baillie, Booth, Tse, and Zabotina (2002) proved that the average of upper bound and lower bound served to explain information share. To further investigate factors that affected price difference, the current study defined company size, transaction volume rate, transaction cost rate, and exchange rate as the independent variables. The rate of H shares (converted into RMB) minus the stock price of A shares relative to the stock price of A shares was the calculation basis of dependent variable (i.e., price difference). Negative (positive) average price difference in the sample periods was defined as the discount (premium) of H shares relative to A shares, expressed in equation (12):

$$PD_{i,t} = \frac{(P_{i,t}^H * EXRATE - P_{i,t}^A)}{P_{i,t}^A} \tag{12}$$

where PD was price difference, P^A and P^H respectively referred to as daily closing price of A and H shares, EXRATE was the exchange rate from HKD to RMB. Independent variables were discussed as follows:

Size

The current study adopted Guo and Tang's (2008) employment of total market capitalization to evaluation size, serving as the proxy variable of information asymmetry. The equation was defined in equation (13):

$$SIZE_{i,t} = \log(MV_{i,t}^A + MV_{i,t}^H) \tag{13}$$

where SIZE was the logarithm of total market capitalization. MV^A and MV^H were daily total market capitalization of A and H shares, respectively. In general, the bigger the company, the more consistent information the investors (domestic or foreign) received, the easier the information was noticed by investors or institutions, and the more transparent the information disclosure, thus lowering information asymmetry. Therefore, the current study anticipated that there was an inverse relationship between company size and price difference.

Transaction Volume Rate

Transaction volume rate was defined as equation (14):

$$VOL_{i,t} = \frac{VOLUNME_{i,t}^H}{VOLUNME_{i,t}^A} \tag{14}$$

where VOL was the transaction volume rate, and $VOLUNME^A$ and $VOLUNME^H$ were the daily transaction volume of A and H shares, respectively.

Amihud and Mendelsohn (1986) proposed liquidity premium theory, in which liquidity was an important influential factor in asset pricing. The expected yield of low-quality liquid assets is high, and vice versa. The enhancement of stock liquidity lowers a company's capital cost and enhances company value. Datar Naik, and Radcliffe (1998) used stock turnover rate as the evaluation indicator for liquidity, and found that the liquidity of non-financial stocks traded in NYSE had significant explanatory power over stock profits. Transaction volume rate was employed in the current study as the proxy variable for liquidity. Higher transaction volume rate led to bigger liquidity that H shares had towards A shares, and vice versa. The smaller (bigger) the liquidity premium required by foreign investors in H shares, the smaller (bigger) the price difference. Therefore, the current study anticipated that there was a reverse relationship between transaction volume rate and price difference.

Transaction Cost Rate

The transaction cost rate was defined in equation (15):

$$SPREAD_{i,t} = \frac{SPR_{i,t}^H/P_{i,t}^H}{SPR_{i,t}^A/P_{i,t}^A} \tag{15}$$

where SPREAD was the bid-ask spread rate. SPR^A and SPR^H were daily bid-ask spread of A and H shares, respectively.

The current study adopted Huang and Stoll's (1997) employment of SPREAD as the proxy variable to evaluate investors' transaction cost rate. The higher the bid-ask spread, the higher the cost. Investors who had information reduced transaction. Liquidity as well as a markets' response rate to new information dropped consequently. Generally speaking, the higher the bid-ask spread, the bigger the stock price differences between A and H shares. Therefore, the current study anticipated that there was a positive relationship between transaction cost rate and price difference.

Foreign Exchange Risk

Domowitz, Glen, and Madhavan (1997) investigated dual listing stocks in Mexico and proved that foreign exchange risk was an important factor that affected foreign investors to evaluate risks. Financial statements of many H shares listed in Hong Kong were not presented in HKD, while HKD was the currency used in Hong Kong stock market. Therefore, fluctuations in exchange influenced the operation and stock price of a company. The scope of influence differed depending on whether the structure of a company's cost of revenue was mainly expert cost or import cost. Thus, the current research took exchange as the fourth explanatory variable. The regression model based on the exchange from HKD to RMB was expressed in equation (16).

$$PD_{i,t} = \alpha_i + \beta_1 SIZE_{i,t} + \beta_2 VOL_{i,t} + \beta_3 SPREAD_{i,t} + \beta_4 EXRATE_{i,t} + e_i \qquad (16)$$

where α_i was the constant term, and e_i was the error term.

RESULTS AND DISCUSSION

Sample Period

To investigate the dual listing stock markets under the opening-up policy in China's stock markets, the current research divided the information into three subsamples. Phase 1 (2000/1/1~2004/7/12) referred to the period before China allowed Hong Kong investors to buy A shares via Hang Seng Bank Limited. Phase 2, 2004/7/13 to 2006/4/12, referred to the official practice of QDII (Qualified Domestic Institutional Investor) announced by the People's Bank of China. Phase 3, 2006/4/13 to 2009/12/31, covered the period after the practice of QDII. The current research also adopted Chow's (1960) breakpoint test (i.e., using F-test to decide the breakpoint that caused structural change) to examine the appropriateness of dividing collected information into the aforementioned three subsamples. In phase 1, 2004/7/12 was set as the breakpoint, the results of Chow's examination revealed that the proportion of structural change reached 89%. In phase 2, the examination of 2006/4/12 as the breakpoint indicated that the proportion of structural change reached 88%. The results suggested that the three subsample of A and H dual listing shares were representative samples.

Analysis of Cointegration

Johansen's (1988) cointegration test was employed to investigate the co-movement relationship between A and H dual listing shares. To non-normally distributed sample, cointegration test could also reach robustness. Johansen trace λ_{trace} and λ_{max} were employed to examine the cointegration vectors of A shares and H shares respectively in the three subsample phases. Johansen and Juselius (1990) stated that when the two statistical results were inconsistent, λ_{max} was utilized to determine the cointegration relationship among variables and to further confirm the number of cointegration vectors.

The results in Table 1 revealed that dual listing companies with cointegration in phase 1 accounted for 12 dual listing companies (42.9%). There were 16 dual listing companies without cointegration (57.1%), suggesting that China's opening-up policy that allowed the investment in B shares indirectly stimulated the stock markets in Shanghai and Shenzhen. In addition, QFII (Qualified Foreign Institutional Investors) allowed foreign institutions to trade in A shares and bond market with limited funds, and made large foreign institutional investors originally restricted to the investment in B shares and HKEx capable of investing in A shares because of the opening-up policy, indirectly promoting the cointegration of the two stock markets. In this sample period, A and H dual listing shares possessed partial cointegration, suggesting that markets were not entirely segmented. The number of companies with cointegration might seem fewer; however, compared with Yang's (2003) findings that no integration was found among the six stock markets (i.e., SSE A Share, SSE B Share, Shenzhen Index A, Shenzhen Index B, Red chips stocks, and Hong Kong H shares) between 1995 and 2000, the opening-up policy has affected the mutual connection of dual listing stocks.

In phase 2, there were nine companies with cointegration and 21 without cointegration (70%), indicating that the opening-up policy for Hong Kong to invest in A shares did not enhance the co-movement between stock markets of A and H shares. The long-term balanced relationship between the two stock markets could not be clearly observed. Possible reasons might be that reform of non-tradable shares, practiced less than one year, had little impact on the market, and that H shares was connected with international capital. Therefore, consequences as the result of reform within a short period of time could not be clearly observed. In phase 3, there were 29 companies with cointegration and 28 without cointegration. Although the proportions were equally matched, the number of companies with cointegration grew by 2.2 times (from 9 in the previous phase to 29 in the current phase), yielding an increased mutual connection of dual listing stocks in this phase. Possible reasons might be that in addition to QFII that drew international funds injection, QDII invested China's funds in H shares. The circulation of funds in the two markets increased

the long-term balanced relationship among stock prices. Another possibility might be that follow-up influences as the result of reform of non-tradable shares improved the problem of insufficient liquidity in non-tradable shares, strengthening China's business system. The internationalization of A shares expedited the link between the two capital markets, making dual listing stocks possess more long-term balanced relationship than ever before.

Table 1：Summary of Johansen Cointegration Test

Period	Cointegration / %	Non-Cointegration/ %
phase 1 (2000/01/01~2004/07/12)	12 / 42.9%	16 / 57.1%
phase 2 (2004/07/13~2006/04/12)	9 / 30%	21/ 70%
phase 3 (2006/04/13~2009/12/31)	29 / 50.9%	28 / 49.1%

This table summarizes the Johansen's (1988) cointegration test for A and H dual listing shares in three phases. Column 2 shows the number and ratio of dual listing companies with cointegration. Column 3 shows the number and ratio of dual listing companies without cointegration.

Analysis of Price Discovery Contributions

Considering that information share model (ISM) required prices of A shares and H shares must meet cointegration in the sample period, the current study divided the period ranging from 2000/1/1 to 2009/12/31 into three sample periods, respectively investigating price discovery contributions of 35 A and H dual listing companies with cointegration (see Table 2). The results in Table 2 revealed that in phase 1, the average price discovery contribution of the H shares was 61.3%, while that of the A shares was 38.7%, suggesting that H shares had the leading position in terms of information. H shares responded quicker to new information than A shares. In phase 2, the average price discovery contribution of the H shares was 44.9%, while that of the A shares was 55.1%. Compared with phase 1, A shares had the leading position in terms of price discovery. Due to the initial opening of Hong Kong investment in A shares, no significant long-term balanced relationship was found in stock prices of A and H dual listing stocks.

In phase 3, the average price discovery contribution of H shares was 52.5%, while that of the A shares was 47.5%. Compared to the two previous phases, differences in contribution ratio of price discovery between the two markets shrank. Possible reasons might be that China's opening-up policy on stock markets led to more frequent information transmission between A and H shares, improving the uncirculated information characteristic of the previous stock markets in China. The leading position of one stock market was not significantly located in terms of the information processing speed. Therefore, the increase of co-movement between A and H dual share markets led to a gradual consistency in price discovery contribution ratio of A and H dual share markets.

Table 2：Ratio of Price Discovery Contributions

Period	Average Information Share of H Shares	Average Information Share of A Shares
Phase 1 (2000/01/01~2004/07/12)	61.3%	38.7%
Phase 2 (2004/07/13~2006/04/12)	44.9%	55.1%
Phase 3 (2006/04/13~2009/12/31)	52.5%	47.5%

This table shows the results of average contribution to price discovery for A and H dual listing shares. Column 2 shows the average information share of H shares dual listing companies. Column 3 shows the average information share of A shares dual listing companies.

Analysis of Factors That Affected Stock Price Differences

Companies might go overseas listing to collect funds, to increase risk sharing, and to lower cost of capital (Stulz and Wasserfallen, 1995), or opt for dual listing to enhance liquidity, to expand markets, to eliminate information asymmetry, or to gain the effect of price difference. Many researchers analyzed the price difference in dual listing stocks and found that premium existed in offshore stocks. However, discount was found in China's stock markets. For example, Bailey (1994) found that relative to A shares, discount existed in B shares. Su and Chong (2007) included H shares and Red chips stocks in data analysis and also found the sign of price discount, revealing the specialty of foreign capital stocks. Bailey, Chung and Kang (1999), analyzing the stock markets in 11 countries, such as Swiss, Mexico, Singapore, Taiwan, and China, found

that except for the discount of China's B shares relative to A shares, price premium existed in foreign capital stocks in other countries. To investigate factors that affected price difference, the current study followed the aforementioned analysis, taking 35 dual listing companies with cointegration as the participant and analyzing factors concerning discount, premium, and stock price difference. Discount (premium) of H shares relative to A shares was illustrated in Table 3. Daily price difference was detailed in Figure 1. The results in Table 3 revealed that not all H shares had discount towards A shares, with premium (five companies) larger than discount (four companies) in H shares in phase 2. The information suggested that the opening-up policy for Hong Kong to invest in A shares and reform of non-tradable shares increased stock liquidity and improved the price discount of offshore distribution. Although in phase 3, discount of H shares relative to A shares appeared again, the shortening of the range of price discount indicated that price differences of A and H dual listing shares gradually shrank.

Table 3：Summary Discount / Premium of H Shares Relative to a Shares

Period	Number of Discount / %	Number of Premium / %
Phase 1 (2000/01/01~2004/07/12)	12 / 100%	0 / 0%
Phase 2 (2004/07/13~2006/04/12)	4 /44.4%	5 / 55.6%
Phase 3 (2006/04/13~2009/12/31)	28 / 96.6%	1 / 3.4%

This table summarizes the daily average to price differences in three phases. The discount (premium) means the average to price difference of H shares relative to A shares is negative (positive) in sample period. Column 2 shows the number of company with negative value and the ratio of cointegrated dual listing companies. Column 3 shows the number of company with positive value and the ratio of cointegrated dual listing companies.

Figure 1: Average Price Difference Chart
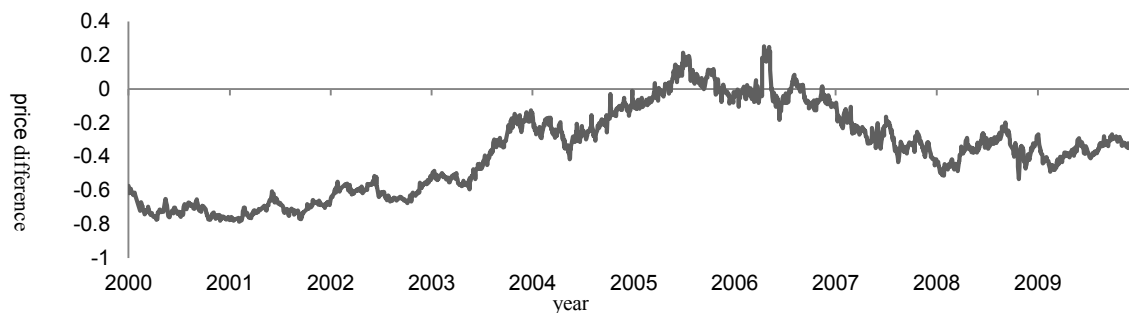
This figure shows the daily average to price difference of H shares relative to A shares for fully sample period.

Price differences of A and H dual listing shares have remained hotly debated. The current study carried out a regression analysis based on company size (SIZE), transaction volume rate (VOL), transaction cost rate (SPREAD), and exchange rate from HKD to RMB (EXRATE). The results of regression in Table 4 showed that size was the most salient factor. The number of companies that reached significance in all three subsample periods amounted to 91%, suggesting that the bigger the company, the more transparent and public the information disclosure. Investors found it easier to obtain correct information regarding the company in a stock market, thus indirectly lowering the problem of information asymmetry. The bigger the company, the fewer the information asymmetry, and the smaller the price difference. The findings were consistent with anticipated results, verifying the hypothesis of information asymmetry.

Many reseachers took transaction volume and transaction cost as evlauation indicators of market liquidity. In terms of transaction volume rate, the number of companies reaching significance in all three subsample periods were respectively 41.7%, 66.7%, and 72.4%, suggesting that transaction volume was more important in price differences. Negative regression coefficients indicated the bigger the transaction volume rate, the smaller the price difference. Moreover, the results of transaction cost rate revealed the number of companies that reached significance in phase 1 and phase 3 were higher than 65.5%, and that positive correlation was found, suggesting the bigger the bid-ask spread rate, the higher the transaction cost, and the smaller the liquidity. The results of regression echoed Hu and Wang's (2008) findings that liquidity and information asymmetry had more explanatory power in explaining the price differences of A and H shares.

With regard to exchange rate, the number of companies that reached significance in all three subsample periods were respectively 100%, 77.8%, and 93.1%, revealing that exchange rate had significant effect on price difference. However, positive and negative regression coefficients in the last two sample periods were almost equivalent to each other (44.4% vs. 51.7%), indicating that positive or negative effect that exchange rate had on price difference differed from cost structures of companies' revenue or other different conditions.

CONCLUSIONS AND SUGGESTIONS

The results in the current study revealed that with China's opening-up policy that allowed for foreign investment institutions' investment in A shares, market segmentation had started to fade away since the practice of dual listing stock markets in 2000. H shares held the leading position in terms of information transmission. The opening-up policy for Hong Kong to invest in A shares and reform of non-tradable shares derestricted the investment scope of A shares, increased the liquidity of dual listing stocks in A shares, and enhanced the information transmission A shares had toward H shares. In addition, relative to H share stocks, A share stocks had the leading position in price discovery. The implementation of QDII and the opening for Chinese people to invest in H share stocks improved the problem of insufficient liquidity in non-tradable shares. In addition, the opening-up policy attracted more companies to collect funds via dual listing. The closer fund liquidity between A and H shares not only expedite stock liquidity but also shortened the range of price discount of offshore distribution.

Table 4：Regression Summary of Price Differences

Period / Factors	Number of Significant* / %	Sign of Coefficient	Number of sign / %
Phase 1 (2000/01/01~2004/07/12)			
SIZE	11 / 91.7%	-	7 / 58.3%
VOL	5 / 41.7%	-	9 / 75%
SPREAD	9 / 75%	+	8 /66.7%
EXRATE	12 / 100%	-	10 / 83.3%
Phase 2 (2004/07/13~2006/04/12)			
SIZE	9 / 100%	-	4 / 44.4%
VOL	6 / 66.7%	-	7 / 77.8%
SPREAD	5 / 55.6%	+	5 / 55.6%
EXRATE	7 / 77.8%	-	4 / 44.4%
Phase 3 (2006/04/13~2009/12/31)			
SIZE	27 / 93.1%	-	16 / 55.2%
VOL	21 / 72.4%	-	16 / 55.2%
SPREAD	19 / 65.5%	+	24 / 82.8%
EXRATE	27 / 93.1%	-	15 / 51.7%

This table shows the summary of regression estimates of the equation: $PD_{i,t} = \alpha_i + \beta_1 SIZE_{i,t} + \beta_2 VOL_{i,t} + \beta_3 SPREAD_{i,t} + \beta_4 EXRATE_{i,t} + e_i$ where PD denotes the dependent variable of price difference of H Shares Relative to A Shares. The independent variables are SIZE, VOL, SPREAD and EXRATE denote the company size, transaction volume rate, transaction cost rate, and exchange rate, respectively. Column 2 shows the number of A / H shares that yield significant effects in subsample period. Column 3 shows the sign of coefficient. Column 4 summarizes the number of A or H shares which coefficient has the same sign with column 3. * indicates significance a t the 5 and 1 percent levels.

Overall, in terms of co-movement in dual listing stock markets, H shares held the leading position, meaning that information was transmitted from H shares to A shares. China's opening-up policy led to more frequent information transmission and increased co-movement between A and H shares, leading to a gradual consistency in price discovery contribution ratio of A and H dual share markets. In addition, factors that affected price difference included information asymmetry, transaction cost rate, transaction volume rate, and exchange rate, among which information asymmetry was the most significant influential factor. The major contributions of the current study lay in the adoption of dual listing companies (rather than stock market indices) and the investigation in price differences, providing investors with dual listing information transmission and factors affecting price differences at company level. In addition, the three sample periods based on major capital market reform policies yielded a better understanding of co-movement relationship in dual listing stock markets before and after the practice of the given policies. Moreover, the understanding of the trend of stock prices based on information transmission and price discovery of dual listing companies in two stock markets not only served as an evaluation indicator in investment decision-making but also facilitated future research into arbitrage of dual listing stock markets. However, dual listing shares in different markets may have their own characteristics. The results can only be applied to a particular sample and may not be inferred to other markets. Follow-up studies may extend to other markets.

REFERENCES

Amihud, Yakov and Haim Mendelson (1986) "Liquidity and Stock Returns," *Financial Analysts Journal*, Vol. 42(3), p. 43-48.

Amihud, Yakov and Haim Mendelson (1986) "Asset Pricing and the Bid-Ask Spread," *Journal of Financial Economics*, Vol. 17(2), p. 223-249.

Bailey, Warren (1994) "Risk and return on China's new stock markets: Some preliminary evidence," *Pacific-Basin Finance Journal,* Vol. 2(2-3), p. 243-260.

Bailey, Warren, Y. Peter Chung, and Jun-koo Kang (1999) "Foreign Ownership Restrictions and Equity Price Premiums: What Drives the Demand for Cross-Border Investments?," *Journal of Financial and Quantitative Analysis*, Vol. 34(4), p. 489-511.

Baillie, T. Richard, G. Geoffrey Booth, Yiuman Tse, and Tatyana Zabotina (2002) "Price Discovery and Common Factor Models," *Journal of Financial Markets*, Vol. 5(3), p. 309-321.

Chakravarty, Sugato, Asani Sarkar, and Lifan Wu (1998) "Information asymmetry, market segmentation and the pricing of cross-list share: Theory and evidence from Chinese A and B shares," *Journal of International Financial Markets*, Institutions and Money, Vol. 8(3-4), p. 325-356.

Chan, Kalok, Albert J. Menkveld, and Zhishu Yang (2007) "The informativeness of domestic and foreign investors' stock trades: Evidence from the perfectly segmented Chinese markets," *Journal of Financial Market,* Vol. 10(4), p. 391-415.

Chen, Guo-Fen, and Chien-Fu Chen (2005) "An Analysis of the Price Difference of A shares and H shares of Dual-listed Companies," National Dong Hwa University, Unpublished master's thesis.

Datar, Vinay T., Narayan Y. Naik, and Robert Radcliffe (1998) "Liquidity and stock returns: An alternative test," *Journal of Financial Markets,* Vol. 1(2), p. 203-219.

Domowitz, Ian, Jack Glen, and Ananth Madhavan (1997) "Market segmentation and stock prices: Evidence from an emerging market," *Journal of Finance*, Vol. 52(3), p. 1059-1085.

Eng, L. L. and Y. T. Mak (2003) "Corporate governance and voluntary disclosure," *Journal of Accounting and Public Policy,* Vol. 22(4), p. 325-345.

Fleming, Jeff, Barbara Ostdiek, and Robert E. Whaley (1996) "Trading costs and the relative rates of price discovery in stock futures and option markets," *Journal of Futures Markets*, Vol. 16(4), p. 353-387.

Fung, Hung-Gay, Wai Lee, and Wai Kin Leung (2000) "Segmentation of the A- and B-share Chinese equity markets," *Journal of Financial Research*, Vol. 23(2), p. 179-195.

Guo, L. and L. Tang (2008) "Cost of capital and liquidity of cross-listed Chinese companies," *Journal of Knowledge Globalization,* Vol. 1(2), p. 1-18.

Hameed, Allaudeen (1997) "Time-varying factors and cross-autocorrelations in short-horizon stock returns," *Journal of Financial Research*, Vol. 20(4), p. 435-458.

Hasbrouck, Joel (1995) "One Security, Many Markets: Determining the Contributions to Price Discovery," *Journal of Finance*, Vol. 50(4), p. 1175-1199.

Huang, D. Roger and Hans R. Stoll (1997) "The components of the Bid-Ask Spread: A General Approach," *Review of Financial Studies*, Vol. 10(4), p. 995-1034.

Hu, Zhanghong and Xiaokun Wang (2008) "The Empirical Study on Chinese A-H Share Premium," *Economic Research Journal,* Vol. 43(4), p. 119-131.

Jain-Chandra, Sonali (2002) "The Impact of Stock Market Liberalization on the Efficiency in Emerging Stock Markets," Columbia University Working Paper.

Johansen, Soren (1988) "Statistical analysis of cointegration vectors," *Journal of Economic Dynamics and Control*, Vol. 12(2-3), p. 231-254.

Johansen, Soren and Katarina Juselius (1990) "Maximum Likelihood Estimation and Inference on Cointegration - with Applications to the Demand for Money," *Oxford Bulletin of Economics and Statistics*, Vol. 52(2), p. 169-210.

Luo, Bo, L. Sun and R. Mweene (2005) "The evolvement and relevant factors of price discovery: A case study of cross-listed stocks in China," *Expert Systems with Applications*, Vol. 29(2), p. 463-471.

Ma, Xianghai (1996) "Capital controls, market segmentation and stock prices: Evidence from the Chinese stock market," *Pacific-Basin Finance Journal*, Vol. 4(2-3), p. 219-239.

Chow, G.C. (1960) "Tests of Equality between Sets of Coefficients in Two Linear Regressions," *Econometrica,* Vol. 28(3), p. 591-605.

Mech, Timothy S. (1993) "Portfolio return autocorrelation," *Journal of Financial Economics*, Vol. 34(3), p. 307-344.

Myers, Stewart C. and Nicholas S. Majluf (1984) "Corporate financing and investment decisions when firms have information that investors do not have," *Journal of Financial Economics,* Vol. 13(2), p. 187-221.

Poon, Winnie P.H. and Hung-Gay Fung (2000) "Red chips or H shares: Which China-backed securities process information the fastest?," *Journal of Multinational Financial Management*, Vol. 10(3-4), p. 315-343.

Qiao, Zhuo, Yuming Li, and Wing-Keung Wong (2008) "Policy change and lead-lag relations among China's segmented stock markets," *Journal of Multinational Financial Management*, Vol. 18(3), p. 276–289.

Stulz, René M. and Walter Wasserfallen (1995) "Foreign equity investment restrictions, capital flight and shareholder wealth maximization: theory and evidence," *The Review of Financial Studies*, Vol. 8(4), p. 1019-1057.

Su, Qian, and Tai-Leung T. Chong (2007) "Determining the contributions to price discovery for Chinese cross-listed stocks," *Pacific-Basin Finance Journal*, Vol. 15(2), p. 140-153.

Tian, Gary Gang and Guang Hua Wan (2004) "Interaction among China-related stocks: evidence from a causality test with a new procedure," *Applied Financial Economics*, Vol. 14(1), p. 7-72.

Wang, Steven Shuye and Li Jiang (2004) "Location of trade, ownership restrictions, and market illiquidity: Examining Chinese A- and H- shares," *Journal of Banking and Finance*, Vol. 28(6), p. 1273-1297.

Wang, Yuenan and Amalia Di Iorio (2007) "Are the China-related stock markets segmented with both world and regional stock markets?" *Journal of International Financial Markets, Institutions and Money,* Vol. 17(3), p. 277-290.

Yang, Jian (2003) "Market segmentation and information asymmetry in Chinese stock market: A VAR analysis," *The Financial Review*, Vol. 38(4), p. 591-609.

BIOGRAPHY

Ai-Chi Hsu is an Associate Professor of Finance and Finance Department Chairperson at National Yunlin University of Science and Technology. His research appears in journals that includes *Emerging Markets Finance and Trade, Applied Economics, Review of Securities and Futures Markets, Investment Management and Financial Innovations* and *International Journal of Business and Finance Research Accepted*. He can be reached at National Yunlin University of Science and Technology, 123 University Road, Section 3, Douliou, Yunlin 64002, Taiwan, R.O.C., hsuac@yuntech.edu.tw

Show-Yen Lai is a Doctoral Candidate of Finance and Finance Department lecturer at National Yunlin University of Science and Technology Graduate Institute of Finance. Her research appears in journals that includes *Investment Management and Financial Innovations and International Journal of Business and Finance Research Accepted*. She can be reached at National Yunlin University of Science and Technology, 123 University Road, Section 3, Douliou, Yunlin 64002, Taiwan, R.O.C., g9724804@yuntech.edu.tw
Lien-Hui Chao is a deputy project manager of Capital Securities Corporation. She can be reached at 14F, NO. 101, Sung Jen Road, Taipei City, Taiwan, R.O.C., h6644iris@gmail.com