Market Segmentation, Price Disparity and Transmission of Pricing Information: Evidence from Class A and H Shares of Chinese Dual-Listed Companies

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Market Segmentation, Price Disparity and Transmission of Pricing Information: Evidence from Class A and H Shares of Chinese Dual-Listed Companies

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Abstract

This paper examines the transmission of pricing information of dual-listed stocks between class A and H shares of Chinese companies. There still exists a large price discount for H shares relative to the A shares. We hypothesize that if price discount or price disparity between two shares is larger, the effect of these price disparity on the transmission of pricing information between two shares will be stronger because of increasing price arbitrage pressure. We also compare the transmission of pricing information in the pre-liberalization period and in the post-liberalization period between two markets. We find that the spillover of the pricing information is strong between two shares in the post-liberalization period and all the sample periods between two markets both for the firms of high price discount or price disparity and for the firms of low price discount or price disparity. However, the spillover of the pricing information is relatively weak for the firms of low price discount, compared with for the firms of high price discount or price disparity only in the pre-liberalization period. Thus, we find that the price disparity can have only partial effect on the transmission of pricing information only in the pre-liberalization period. Transmission of pricing information is much stronger in the post-liberalization period, compared with in the pre-liberalization period. We concludes that liberalizations have much more effect on the transmission of pricing information rather than price discount or disparity between two class of shares.

Key word: Market Segmentation, Price Disparity, Transmission of Pricing Information, A and H Shares, GJR-GARCH(1,1)-M Model

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I. Introduction

In many emerging countries, stock markets are segmented to allow companies to issue shares that attract foreign funds whereas minimizing risk of market destabilization and loss of ownership control to foreign investors. Under these segmented markets, two classes of shares are normally issued: restricted shares that can be traded by local investors, and unrestricted shares that can be traded by both local and overseas investors. Although restricted and unrestricted shareholders receive the identical voting rights and cash flows, it has been reported that unrestricted shares usually trade at a premium over restricted shares. A notable exception in stock is China. Specifically, unlike other countries, China's stock market has substantial and persistent price discounts instead of premium on B shares (the equivalent to unrestricted shares in other markets) relative to A shares (the equivalent to restricted shares). In China, the Shanghai Stock Exchange (SHSE) was established in December 1990, and the Shenzhen Stock Exchange (SZSE) in July 1991. The two exchanges are not allowed cross listing. Some firms issue two types of shares in China: class A shares, which are quoted in Renminbi (RMB) and traded among Chinese citizens, and class B shares, which are quoted in foreign currencies (U. S. dollars on the SHSE and Hong Kong dollars on the SZSE) and traded among non-Chinese citizens or overseas Chinese. A and B shares are listed on SHSE and SZSE in China. Like firms issue both A shares and B shares, some companies issue both A shares and H shares that are listed in the Hong Kong Stock Exchange (HKSE). Chinese citizens are forbidden from trading in H shares. In fact, Hong Kong has a H share market and a 'red-chip' market. Red-chip stocks are the stocks of China firms incorporate outside China and listed in Hong Kong. The actual business is based in China and controlled by the central, provincial or municipal governments of China. Therefore, foreign investors can trade in B share market, H share market, and red-chip market. Unlike A shares and B shares, A shares and H shares are segmented in terms of the listing and trading locations. Specifically, while A shares are traded by local investors in the SHSE and SZSE, H shares are traded by investors in Hong Kong. The unique nature of segmentation between A shares and H shares proposes that price discounts of H shares to A shares may be caused by local market risks and investors' attitudes. There were two important stock market liberalization reforms in China. The first one is the opening of the B share market to local Chinese investors in February 2001. The B share market responded very fanatically. The SHSE and SZSE B share indices rose by 178% and 122%, respectively, from February 2001 to June 2001, whereas the A share indices increased by 11% and 9%, respectively, in the counterpart periods. The second one is the approval of a scheme to allow Qualified Foreign Institutional Investors (QFII) in the A share market in

December 2002. On the contrary to the first one, it seems that the QFII scheme does not have obvious impacts to A share market. Before the opening of the B share market to local Chinese investors, the B share and H share price discounts remained at a similar level. However, the B share price discount reduced dramatically after the opening, whereas the H share price discount remained unchanged. The liberalization reforms have been finished in December 2002.

We believe that the liberalization reforms impact the price disparity and the transmission of pricing information between China market and Hong Kong market. This paper examines the impacts of the liberalization on these stock markets. To do this, we divide our overall sample into two sub-periods, the period before December 2002 and the period after December 2002. When the stock is trading at different prices, it will lead to arbitrage pressure. It is very likely that if price disparity between two shares is larger, the effect of the price disparity on the transmission of pricing information between two shares will be stronger because of increasing arbitrage opportunity pressure. Most of previous studies examine the transmission of pricing information at the stock market index level. However, the empirical tests are performed at the company-specific level in this study. The sample of this study includes the companies that issued both A share and H share.

Most time series of financial data have problems of fat tail and heteroskedasticity. An Autoregressive Conditional Heteroskedasticity (ARCH) model introduced by Engle (1982) and a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model developed by Bollerslev (1986) are believed to be suitable to analyze the time series data to handle the problems. More recently, a GARCH model developed by Glosten, Jaganathan and Runkle (hereafter GJR) (1993) is widely known to appropriate for analyzing not only symmetric spillover effect but also asymmetric spillover effect.

Our work extends the existing literature in the following ways. First, our paper is the first to examine the transmission effect directly by comparing firms of low price discount with those of high price discount. Second, this study examines the transmission of pricing information existing in the pre-liberalization sub-sample period and in the post-liberalization sub-sample period between two markets. Third, current study employ a GJR-GARCH model to examine the spillover effect more precisely.

The rest of this paper is organized as follows. Section 2 reviews the finance literature related to current topic. Section 3 describes the data and methodology. Section 4 reports and discusses the empirical results. Finally, section 5 concludes this paper.

2. Literature Review on the Discount Puzzles in the Chinese Stock Market

The finance literature reports that stocks of foreign-only class have higher prices than those of domestic-only class. Hietala (1989) finds a substantial premium for the foreign-only share price relative to domestic-only share price for the Finnish stock market for 1984~85. Bailey and Jagtiani (1994) report an average premium of 19 percent on the Alien Board of the stock exchange of Thailand. Stulz and Wasserfallen (1995) document foreign investors pay higher prices than domestic investors in Switzerland. Domowitz, Glen, and Madhavan (1997) find significant stock price premiums for B share stocks in the Mexican market. An exception is China. In his pioneer work, Bailey (1994) examines eight Chinese B share stocks for the period from March 1992 to March 1993, and reports a significant discount in the B share prices relative to the A share counterparts. This puzzling phenomenon is confirmed by studies of Ma (1996), Chen, Lee, and Rui (2001), and Lee, Rui, and Wu (2008), etc. Over the years, academics have made efforts to explain the puzzling phenomenon. So far, there exist four potential explanations about the sources of the price differences between A shares and B shares: the differential demand hypothesis (Stulz and Wasserfallen (1995) and Domowitz, Glen, and Madhavan (1997)), the asymmetric information hypothesis (Chakravarty, Sarkar and Wu (1998)), the liquidity hypothesis (Amihud and Mendelson (1986)), and the differential risk hypothesis (Ma (1996)). Kim and Choi (2009) noticed that most B shares are traded by small retail investors, whereas most H shares are traded by foreign institutional investors. They find that the momentum is the most important factor to explain the price discount for H shares relative to A shares because institutional investors frequently use momentum investment strategy. Wei and Zeng (2011) examine the causality between liquidity and price disparity for H and N shares. They report that causality between price disparity and liquidity runs both ways. They also show that the H shares have higher liquidity and lower short-term returns. Cai, McGuinness and Zhang (2012) examine the co-integration relation between the H- and A-share prices of dual-listed Chinese stock. They find that policy and corporate governance change seems to be the crucial force increasing efficiency to reduce price disparity and error corrections. They also show that weakening informational asymmetries may contribute to much of the change in the markets' relative pricing.

The above papers try to investigate the puzzling phenomenon and determinants of the discount puzzles. In the meanwhile, there exist papers try to find the transmission and spillover effect of stock market indices or Chinese companies which are cross-listed in the Shanghai, Hong Kong and U.S. markets. Zhang and Zhao (2003) argue that Chinese companies can issue A, B and H shares to Chinese, foreign and Hong Kong investors, respectively. They find that price differential among the shares is caused by the country-specific risk related to the Chinese stock market by the three groups of investors. Li, Yi and Su (2011) also investigate the spillover effect of returns of Chinese cross-listed stocks which are traded in Shanghai, Hong Kong and U.S. markets simultaneously. They report a strong unidirectional spillover effect from U.S. market to Shanghai market. They also find that there exists a significant two-way influence between Hong Kong and US markets. Chong and Su (2006) investigate the comovement between the A shares and H shares of cross-listed Chinese firms. They find that only a small portion of the cross-listed Chinese firms have a comovement in their A- and H-share prices. Their findings suggest that the stock markets of China and Hong Kong are segmented. Wang and Iorio (2007) examine the agenda of market segmentation and integration about China stock markets. Specifically, they analyze the agenda of China-related share markets with both the Hong Kong stock market and the world market. They find that A share market was a segmented market during the whole sample period. However, there was a higher level of integration between the A and B share markets, and the A share and H share markets during the sub-period. They argue that the integration between the A share and B share markets is attributable to the opening of the B share market in February 2001, and the integration between the A share and H share markets is due to increasing economic integration of Hong Kong and China.

Xu and Fung (2002) analyze patterns of information flows for China-backed stocks that are dual-listed in Hong Kong and New York using a bivariate GARCH model. They find that the cross-listed stocks have significant mutual feedback of information between Hong Kong and New York markets in terms of pricing and volatility. They also find that stocks listed in Hong Kong play a bigger role of information transmission in the pricing process, while stocks listed in New York play a more significant role in the volatility spillover. Kutan and Zhou (2006) analyze the determinants of returns and volatility of nine Chines ADRs as listed at NYSE using an ARCH model. They report that Hong Kong market (underlying market), U.S. market (host market), and local (Shanghai A and B) markets all are important determinants of returns of the Chines ADRs. Among three markets, the Hong Kong market has the most significant effect on mean returns of the ADRs. However, only shocks to the underlying markets are significant in terms of the determinants of the conditional volatility. Lee, Rui and Wu (2008) find that, after the opening of the B share market in February 2001, the B share price discount declined considerably, while the H-share price discount remained virtually unchanged.

Most ADR markets and underlying markets have different opening and closing hours. However, transmission of information could be detected more clearly if trading hours of two markets is somewhat concurrent. This is the case where we examine the transmission of information between Hong Kong market and Chinese market. Kim (2011) investigates transmission of pricing information of stock market indices between Chinese and Hong Kong stock markets, and he finds that there are no causal relations between two classes of stocks. However, he did not analyze the transmission at the company-specific level. Wei and Zeng (2011) also show that the Hong Kong market is more active in response to arbitrage opportunities. Price disparity or arbitrage pressure may impact on the transmission of pricing informations between two markets.

3. Data and Methodology

3.1 Data

<Table 1> Dual-Listed Stocks

Company Name	Ticker	Number of A shares	Number of H shares
BEIREN PRINT.MCH.	BPM	322,000	100,000
DONGFENG ELT.TECH.	DME	313,560	170,000
GUANGZHOU SHPYD.INTL.	GUA	337,280	157,398
LUOYANG GLASS	LGC	250,018	250,000
MAANSHAN IRON & STL	MIS	5,025,620	1,732,929
NANJING PANDA ELEC.	NNP	413,015	242,000
NORTHEAST ELECT.DEV.	NET	615,420	257,950
TSINGTAO BREWERY	TTB	653,150	655,069

Current paper divides the eight companies into two sub-groups, the group of high price discount or disparity and that of low price discount or disparity with respect to median value. The former group is composed of four companies which have price discount or disparity more than 80%, while the latter group is made up for four firms which have price discount or disparity less than 50 % during the whole sample period. Table 2 presents the stocks of high price discount or disparity from highest to lowest order in our sample. Similarly, table 3 shows the stocks of low price discount or disparity from lowest to highest order in our sample.

<Table 2> Dual-Listed Stocks of High Price Discount or Disparity in Order

Company Name	Number of A shares	Number of H shares
LUOYANG GLASS	250,018	250,000
NORTHEAST ELECT.DEV.	615,420	257,950
NANJING PANDA ELEC.	413,015	242,000
BEIREN PRINT.MCH.	322,000	100,000

<Table 3> Dual-Listed Stocks of Low Price Discount or Disparity in Order

Company Name	Number of A shares	Number of H shares
DONGFENG ELT.TECH.	313,560	170,000
TSINGTAO BREWERY	653,150	655,069
GUANGZHOU SHPYD.INTL.	337,280	157,398
MAANSHAN IRON & STL	5,025,620	1,732,929

Since A shares are quoted in RMB and H shares are quoted in Hong Kong dollars, H shares are converted into RMB denomination. Specifically, daily Hong Kong dollars are adjusted to RMB using the daily exchange rate. Thus, all data are expressed in terms of RMB for comparison. This paper analyzes the price differences and pricing and volatility transmission of dual-listed stocks using daily data from both markets not only for the whole sample period but also the period before and after December 2002 of Chinese liberalization.

3.2 Methodology

Spillover effect between international stock markets could be decomposed into price spillover effect and volatility spillover effect. Summary statistics show that our time series data do not follow a normal distribution. Hence, we should employ a heteroskedasticity model to capture the transmission of information between Chinese A share market and Hong Kong H share market.

A GJR-GARCH model developed by Glosten, Jaganathan and Runkle (1993) is found to be good fit for capturing the symmetric information spillover effect as well as asymmetric information spillover effect. The heteroskedasticity model introduced by Engle (1982) and developed by Bollerslev (1986) is based on ARCH(1) and GARCH(1,1).

$$R_t = a + \epsilon_t$$

where $\epsilon_t | \psi_{t-1} \sim N(0, h_t)$

$$h_t = \omega + \beta \epsilon_{t-1}^2 + \delta X_t$$

where $\omega > 0$ and $\beta, \theta \geq 0$

$$h_t = \omega + \beta \epsilon_{t-1}^2 + \gamma h_{t-1} + \delta X_t$$

R_t is returns at time t in the equation for conditional mean. h_t is the conditional variance of the returns at time t in the equation for conditional variance. X_t is exogeneous variable, and stands for square of the residuals in the ARCH(1) or GARCH(1,1).

We include some exogenous variables to reflect the attributes of data, even though the methodology is based on Engle (1982) and Bollerslev (1986).

Specifically, a GJR-GARCH(1,1)-M model is employed to examine the transmission of information between the Chinese market and Hong Kong market. The model allows us to investigate both pricing transmission and the volatility spillover of dual-listed stocks on Chinese and Hong Kong markets. The mean and variance equations for a GJR-GARCH(1,1)-M model can be specified as follows:

Equation for conditional mean:

$$HK_{1,t} = a_{1,0} + a_{1,1}CA_{1,t} + a_{1,2}h_{1,t} + e_{1,t} \quad (1)$$

Equation for conditional variance:

$$h_{1,t} = \omega_{1,0} + \beta_{1,1}h_{t-1} + \gamma_{1,2}e_{t-1}^2 + \delta_{1,3}CAA_{1,t-1} + \theta_{1,4}e_{t-1}^2 I_{1,t-1} \quad (2)$$

Equation for conditional mean:

$$CA_{1,t} = a_{1,0} + a_{1,1}HK_{1,t} + a_{1,2}h_{1,t} + e_{1,t} \quad (3)$$

Equation for conditional variance:

$$h_{1,t} = \omega_{1,0} + \beta_{1,1}h_{t-1} + \gamma_{1,2}e_{t-1}^2 + \delta_{1,3}HKK_{1,t-1} + \theta_{1,4}e_{t-1}^2 I_{1,t-1} \quad (4)$$

In the equations, CA and HK reflect stock returns of Chinese A share and Hong Kong H share, respectively. Also, CAA and HKK are squares of standard errors of Chinese A share and Hong Kong H share, respectively. $I_{1,t-1}$ in equation (2) is the residual of Chinese A share and $I_{1,t-1}$ in equation (4) is the residual of Hong Kong H share, respectively. $I_{1,t-1}$ is a 0 or 1 dummy variable which equals 1 if the residual is negative and 0 otherwise.

4. Empirical Results

We investigate the transmission of return and volatility of dual-listed stocks in Chinese market and Hong Kong market. To allow for the impact of Chinese liberalization on stock markets, we analyze the spillover effect not only for the whole sample period but also for the sub-periods, the period before December 2002 and the period after December 2002.

Table 4-A shows the results of spillover effects in returns and volatilities from Chinese A share to Hong Kong H share for firms of low price discount during the whole sample period. In the table, the coefficients of α_1 which indicate spillover effect of price disparity between markets are all significant at the 1% level. The result reflects the transmission of

pricing information. The coefficients of δ that indicate spillover effect of volatility between markets are significant for 3 out of 4 firms. The result implies that, for most stocks, there exists the transmission of volatility information. The coefficients of θ which indicate leverage effect are significant for 2 out of 4 firms.

Table 4-B presents the results of spillover effects in returns and volatilities from Chinese A share to Hong Kong H share for firms of high price discount during the whole sample period. Similar to table 4-A, the coefficients of α_1 which indicate spillover effect of price disparity are all significant at the 1% level. Likewise to table 4-A, the coefficients of δ are significant for 3 out of 4 firms. Again, these results suggest that there exist the spillover effect of pricing and volatility information. However, unlike to table 4-A, the coefficients of θ which indicate leverage effect are significant for 3 out of 4 companies, which imply there exists the transmission of leverage information.

Table 5-A reports the results of spillover effects in returns and volatilities from Hong Kong H share to Chinese A share for firms of low price discount during the whole sample period. In the table, the coefficients of α_1 which indicate spillover effect of price disparity are all significant at the 1% level. The coefficients of δ that indicate spillover effect of volatility are significant for 2 out of 4 firms. The coefficients of θ which indicate leverage effect are significant for 3 out of 4 firms.

Table 5-B documents the results of spillover effects in returns and volatilities from Hong Kong H share to Chinese A share for firms of high price discount during the whole sample period. Similar to table 5-A, the coefficients of α_1 which indicate spillover effect of price disparity are all significant at the 1% level. Likewise to table 5-A, the coefficients of δ are significant for 2 out of 4 firms. Again, similar to table 5-A, the coefficients of θ which indicate leverage effect are significant for 3 out of 4 companies, which imply there exists the spillover effect of leverage information.

The results from table 4-A to 5-B show that all coefficients of a_1, a_2, β, γ, δ, and θ are not zero. The log-likelihood statistics are rejected at the 1% significance level, indicating that the model appear to be well specified and appropriate. Overall, the results of panel A and panel B are essentially identical for the whole sample period. Thus, the empirical results indicate that spillover effects for firms of high price discount are similar to those of low price discount for the whole sample period.

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Table 6-A shows the results of spillover effects in returns and volatilities from Chinese A share to Hong Kong H share for firms of low price discount for the sub-period before December 2002. In the table, the coefficients of α_1 which indicate spillover effect of price disparity for DME firm (the least price discount firm) is not significant, and that for TTT

firm is weakly significant. The coefficients of δ that indicate spillover effect of volatility are not significant for all firms. The result implies that the transmission of volatility information is not existed. The coefficients of θ which indicate leverage effect are significant for 2 out of 4 firms.

Table 6-B presents the results of spillover effects in returns and volatilities from Chinese A share to Hong Kong H share for firms of high price discount for the sub-period before December 2002. Contrary to table 6-A, the coefficients of α_1 which mean spillover effect of price disparity are all significant at the 1% level. However, similarly to table 6-A, the coefficients of δ are significant for 1 out of 4 firms only. This implies that the spillover effect of volatility is not existed. In general, the coefficients of θ which indicate leverage effect are not significant. The result suggests that transmission of leverage information is not existed.

Table 7-A reports the results of spillover effects in returns and volatilities from Hong Kong H share to Chinese A share for firms of low price discount for the sub-period before December 2002. In the table, the coefficients of α_1 which indicate spillover effect of price disparity for DME firm is not significant, and that for TTB firm is weakly significant. The coefficients of δ that indicate spillover effect of volatility are significant for 2 out of 4 firms. The coefficients of θ which indicate leverage effect is significant for 1 out of 4 firms only.

Table 7-B documents the results of spillover effects in returns and volatilities from Hong Kong H share to Chinese A share for firms of high price discount for the sub-period before December 2002. Contrary to table 7-A, the coefficients of α_1 which indicate spillover effect of price disparity are all significant at the 1% level. However, the coefficients of δ are significant for 3 out of 4 firms. Again, the coefficients of θ which indicate leverage effect is significant for 1 out of 4 companies only, which imply that spillover effect of leverage information is not existed.

The results from table 6-A to 7-B show that all coefficients of a_1, a_2, β, γ, δ, and θ are not zero. The log-likelihood statistics are not accepted at the 1% significance level, showing that the model appear to be adequate. Overall, the results of panel A and panel B are significantly different for the pre-liberalization period. The empirical results indicate that spillover effects for firms of high price discount are bigger than those of low price discount for the pre-liberalization period.

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Table 8-A shows the results of spillover effects in returns and volatilities from Chinese A share to Hong Kong H share for firms of low price discount for the sub-period after December 2002. In the table, the coefficients of α_1 which indicate spillover effect of price

disparity are all significant at the 1% level. The coefficients of δ that indicate spillover effect of volatility are significant for 2 out of 4 firms. The coefficients of θ which indicate leverage effect are not significant at all.

Table 8-B presents the results of spillover effects in returns and volatilities from Chinese A share to Hong Kong H share for firms of high price discount for the sub-period after December 2002. Similarly to table 8-A, the coefficients of α_1 which indicate spillover effect of price disparity are all significant at the 1% level. Likewise to table 8-A, the coefficients of δ are significant for 2 out of 4 firms. However, the coefficients of θ which indicate leverage effect are significant for 2 out of 4 companies.

Table 9-A reports the results of spillover effects in returns and volatilities from Hong Kong H share to Chinese A share for firms of low price discount for the sub-period after December 2002. In the table, the coefficients of α_1 which indicate spillover effect of price disparity are all significant. The coefficients of δ that indicate spillover effect of volatility are significant for 2 out of 4 firms. The coefficients of θ which indicate leverage effect are not significant at all.

Table 9-B documents the results of spillover effects in returns and volatilities from Hong Kong H share to Chinese A share for firms of high price discount for the sub-period after December 2002. Similarly to table 9-A, the coefficients of α_1 which indicate spillover effect of price disparity are all significant. The coefficients of δ are significant for 2 out of 4 firms. The coefficients of θ which indicate leverage effect are not significant at all.

Generally, the magnitude of α_1 are much higher in the post-liberalization period than that in the pre-liberalization period. Thus, transmission effect of pricing information has increased in the post-liberalization period compared with in the pre-liberalization period.

The results from table 8-A to 9-B show that all coefficients of a_1, a_2, β, γ, δ, and θ are not zero. The log-likelihood statistics are rejected at the 1% significant level, indicating that the model appear to be adequate. Overall, the results of panel A and panel B are not different for the post-liberalization period. The empirical results indicate that spillover effects for firms of high price discount are similar to those of low price discount for the post-liberalization period.

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To summarize, this paper finds that the parameters showing spillover effect of price disparity are all significant. However, the parameters indicating spillover effect of volatility and those indicating spillover effect of leverage are not consistently significant. The results hold for cases from Hong Kong H share to Chinese A share markets and for cases from Chinese A share to Hong Kong H share markets. The results also holds for the whole period as well as the post-liberalization sub-sample period. The spillover of the pricing information is strong between two shares in the post-liberalization sub-sample period and all the sample periods both for the firms with high price discount or price disparity and for those with low price discount or price disparity. However, the spillover of the pricing information is relatively weak for the firms with low price discount, compared with high price discount or price disparity only in the pre-liberalization sub-sample period.

Therefore, this paper suggests that the effect of price discount or disparity on the transmission of pricing information between two shares is relatively stronger only in the pre-liberalization sub-sample period rather than in the post-liberalization sub-sample period. Thus, the price disparity can have a partial effect on the transmission of pricing information between class A and H shares of Chinese companies only in the pre-liberalization sub-sample period. Overall results show that transmission of pricing information is much stronger in the post-liberalization period compared with in the pre-liberalization period. We conclude that liberalization reforms have much more effect on the transmission of pricing information rather than price discount or disparity between two class of shares.

5. Summary and Conclusion

Stock markets in China has been growing rapidly following the opening of securities markets in the early 1990s. China established separate classes of shares for Chinese citizens and for foreigners. Domestic-only or A shares are listed in either Shanghai Stock Exchange (SHSE) or Shenzhen Stock Exchange (SZSE) and foreigner-only stocks are listed in Shanghai or Shenzhen (B shares) or in Hong Kong (H shares). The A shares, B shares, or H shares are legally identical, with the same voting rights and cash flow, except for who can own them. Contrary to many other countries, China's stock market has substantial and persistent price discounts on foreign-only B shares relative to domestic-only A shares, which is called 'Puzzles in the Chinese Stock Markets'. Similarly, H shares in Hong Kong market shows price discounts relative to A shares.

China allowed domestic investors to trade in B share stocks in February 2001. Qualified Foreign Institutional Investors (QFII) can trade in A-share stocks in December 2002. The liberalization reforms should impact the price disparity and transmission of information between Hong Kong and China markets.

This study investigates the spillover of pricing and volatility information with respect to dual-listed stocks both Chinese market and Hong Kong market. The spillover effect could be detected more clearly if trading hours of two markets is somewhat concurrent, which is the case between Hong Kong market and Chinese market.

Whereas most prior studies examine the transmission of information using stock market indices, this study analyzes the spillover effect at the firm-specific level. We believe that if price discount or price disparity for dual-listed stocks is large, the effect of price disparity on the transmission of information between two shares will be strong because of increasing price arbitrage.

This paper contributes in the following aspects. First, this is the first study to investigate the spillover effect directly by comparing companies of low price discount with those of high price discount. Second, we examine the transmission of information not for the whole sample period but also for the sub-sample period of pre- and post-liberalization period. Third, current study use the GJR-GARCH model to analyze the spillover effect. It is widely agreed that the GJR-GARCH model is appropriate to capture symmetric spillover effect as well as asymmetric spillover effect.

The empirical results of this paper show that the coefficients indicating spillover effect of price disparity are all significant, while the coefficients indicating spillover effect of volatility and those indicating spillover effect of leverage are not consistently significant. The results are consistent with cases from Hong Kong H share to Chinese A share markets and with cases from Chinese A share to Hong Kong H share markets. The results are hold both for the firms with high price discount or price disparity and for those with low price discount or price disparity during the whole period as well as the post-liberalization sub-sample period. However, during the pre-liberalization sub-sample period, the spillover of the pricing information is weak for the firms with low price discount.

Therefore, this paper finds that the effect of price discount or disparity on the transmission of pricing information between two shares holds only for the pre-liberalization sub-sample period rather than for the post-liberalization sub-sample period. Thus, the price disparity can have only partial effect on the transmission of pricing information between class A and H shares of Chinese companies only in the pre-liberalization sub-sample period. Overall empirical results shows transmission of pricing information is much stronger in the post-liberalization period compared with in the pre-liberalization period. Therefore, we conclude that Chinese liberalization reforms have much more effect on the transmission of pricing information rather than price discount or disparity between two class of shares. This study uses daily return data. However, using intraday return data would be more appropriate to capture the transmission effect.

<Table 4-A> Spillover effects in returns and volatilities from Chinese A shares to Hong Kong H shares during the whole sample period.

The mean and variance Spillover GJR-GARCH(1,1)-M model:

$$HK_{1,t} = a_{1,0} + a_{1,1}CA_{1,t} + a_{1,2}h_{1,t} + e_{1,t}$$

$$h_{1,t} = \omega_{1,0} + \beta_{1,1}h_{t-1} + \gamma_{1,2}e^2_{t-1} + \delta_{1,3}CAA_{1,t-1} + \theta_{1,4}e^2_{t-1}I_{1,t-1}$$

Where CA and HK stands for stock returns of Chinese A shares and Hong Kong H shares, respectively. CAA and HKK means squares of standard errors of Chinese A shares and Hong Kong H shares, respectively. $I_{1,t-1}$ is the residual. $I_{1,t-1}$ is a dummy variable

Panel A: Whole sample period.(1993.07.15-2009.06.01) : Firms of low price discount

	DME		TTB		GUA		MIS	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	0.002209	0.273601	0.007669	1.023971	0.019516	3.058173	0.003480	0.835627
a_1	0.177040	5.153214	0.242930	8.371278	0.287551	12.65655	0.290484	10.65928
a_2	0.047138	0.332308	0.013770	0.166328	-0.274860	-2.511124	0.032294	1.508261
ω	3.325247	2.847543	1.504360	5.323386	1.303200	4.411056	0.422331	3.358629
β	0.190294	3.070732	0.244286	4.697564	0.183199	6.704147	0.142621	6.086859
γ	0.629555	6.828258	0.605791	13.12283	0.750318	23.15667	0.823444	31.87033
δ	0.003664	0.168466	0.072397	2.157113	0.042307	2.229784	0.034111	2.501968
θ	0.024952	0.751015	0.080555	1.197004	-0.039503	-2.022096	-0.003807	-71764.5
LR(5) for H_2: $a_1=\beta=\gamma=\delta=\theta$ =0	62.48770		186.4100		592.5303		2.09E+09	
Log-liklihood	-8743.627		-8000.279		-8720.775		-8366.335	
Number of ob.s	3107		3107		3107		3107	

<Table 4-B>

Panel B: Whole sample period.(1993.07.15-2009.06.01) : Firms of High price discount

	LGC		NET		NNP		BPM	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	-0.005388	-0.832802	0.001772	0.575514	0.009140	1.250745	0.000464	0.058573
a_1	0.137613	8.668421	0.366219	8.109146	0.299229	10.60139	0.217437	8.272110
a_2	0.235863	2.303057	-0.128872	-2.800504	-0.162668	-1.066155	-0.013549	-0.133207
ω	0.707442	5.786206	-0.008068	-1.177496	1.753336	2.171233	2.015278	4.110949
β	0.158348	6.907695	0.197090	7.084551	0.132669	4.625835	0.203347	5.281107
γ	0.838396	40.19217	0.707099	17.36290	0.785127	16.72463	0.594885	9.646272
δ	0.008039	2.224650	0.540969	2.556975	-0.020478	-0.641786	0.119138	2.644042
θ	-0.015372	-23.58967	0.074694	3.631461	0.079819	1.060880	-0.004699	-6.744777
LR(5) for H_2: $a_1=\beta=\gamma=\delta=\theta=0$	4456.305		1213.184		239.6017		255.6381	
Log-liklihood	-7956.845		-8913.181		-8969.650		-8262.142	
Number of ob.s	3107		3107		3107		3107	

<Table 5-A> Spillover effects in returns and volatilities from Hong Kong H shares to Chinese A shares during the whole sample period.

The mean and variance Spillover GJR-GARCH(1,1)-M model:

$CA_{1,t} = a_{1,0} + a_{1,1}HK_{1,t} + a_{1,2}h_{1,t} + e_{1,t}$

$h_{1,t} = \omega_{1,0} + \beta_{1,1}h_{t-1} + \gamma_{1,2}e^2_{t-1} + \delta_{1,3}HKK_{1,t-1} + \theta_{1,4}e^2_{t-1}I_{1,t-1}$ Where CA and HK stands for stock returns of Chinese A shares and Hong Kong H shares, respectively. CAA and HKK means squares of standard errors of Chinese A shares and Hong Kong H shares, respectively. $I_{1,t-1}$ is the residual. $I_{1,t-1}$ is a dummy variable.

Panel A: Whole sample period.(1993.07.15-2009.06.01) : Firms of low price discount

구 분	DME		TTB		GUA		MIS	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	0.005746	0.696189	0.000486	0.044073	0.011780	1.323977	0.014846	0.753984
a_1	0.015560	3.798381	0.109969	8.168422	0.141166	12.52341	0.119311	10.50363
a_2	-0.007377	-0.154307	0.025962	0.507113	-0.074017	-1.073017	-0.151530	-1.078033
ω	0.138171	17.86451	0.163118	2.880968	0.779170	4.154782	2.417259	2.377939
β	0.109560	20.16165	0.124850	6.084772	0.167976	8.237393	0.148771	4.738651
γ	0.884875	213.2433	0.807823	22.24197	0.725635	20.19400	0.535059	4.820589
δ	-0.001811	-23.19578	0.019026	1.456127	0.019412	4.326197	0.005097	1.032486
θ	0.000759	8.751957	0.001759	0.146436	-0.010811	-17.02746	-0.005039	-9.623602
LR(5) for H_2: a_1=β=γ=δ=θ =0	71113.66		1163.245		770.6892		95.39213	
Log-liklihood	-7067.977		-6729.091		-7601.155		-7225.701	
Number ofob.s	3107		3107		3107		3107	

<Table 5-B>

Panel B: Whole sample period.(1993.07.15-2009.06.01) : Firms of High price discount

구 분	LGC		NET		NNP		BPM	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	-0.008412	-0.072549	-0.053588	-1.699325	-0.138450	-0.912321	-0.244826	-1.580547
a_1	0.108391	8.691403	0.120084	10.88692	0.111597	9.477303	0.140348	8.979078
a_2	-0.008412	-0.072549	-0.053588	-1.699325	-0.138450	-0.912321	-0.244826	-1.580547
ω	1.059432	1.652918	0.045916	6.247615	2.121423	1.668533	1.535185	1.707939
β	0.127994	6.038508	0.127471	8.149657	0.174468	6.442030	0.142946	6.009577
γ	0.739826	11.78789	0.853192	55.08195	0.586753	5.332544	0.656214	7.647856
δ	0.013068	0.850810	0.009906	5.726946	0.007679	1.284744	0.025007	3.152169
θ	-0.006997	-2.478367	-0.001099	-7.288382	-0.001414	-0.594126	-0.005971	-3.670160
LR(5) for H_2: $a_1=\beta=\gamma=\delta=\theta=0$	137.6379		8348.236		36.75007		283.0316	
Log-liklihood	-7661.213		-7204.954		-7752.475		-7639.460	
Number of ob.s	3107		3107		3107		3107	

<Table 6-A> Spillover effects in returns and volatilities from Chinese A shares to Hong Kong H shares during pre-liberalization sub-sample period. The mean and variance Spillover GJR-GARCH(1,1)-M model:

$HK_{1,t} = a_{1,0} + a_{1,1}CA_{1,t} + a_{1,2}h_{1,t} + e_{1,t}$

$h_{1,t} = \omega_{1,0} + \beta_{1,1}h_{t-1} + \gamma_{1,2}e^2_{t-1} + \delta_{1,3}CAA_{1,t-1} + \theta_{1,4}e^2_{t-1}I_{1,t-1}$ Where CA and HK stands for stock returns of Chinese A shares and Hong Kong H shares, respectively. CAA and HKK means squares of standard errors of Chinese A shares and Hong Kong H shares, respectively. $I_{1,t-1}$ is the residual. $I_{1,t-1}$ is a dummy variable

Panel A: Pre-liberalization sub-sample period. (1993.07.15-2002.11.30) : Firms of low price discount

	DME		TTB		GUA		MIS	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	0.005395	0.621781	0.005180	0.259168	0.017879	2.118778	0.007429	0.944349
a_1	0.098541	1.545835	0.035809	1.819269	0.202826	6.264275	0.215828	3.513080
a_2	-0.287895	-1.442886	-0.007461	-0.087012	-0.499750	-2.541193	-0.193371	-1.211921
ω	3.172306	3.343857	0.402603	2.687021	2.198407	3.120186	1.029793	2.627558
β	0.189788	3.746816	0.169218	4.717644	0.184058	4.964412	0.154434	3.768229
γ	0.697254	10.03101	0.734276	12.85040	0.738927	14.89931	0.784260	15.10579
δ	0.009744	0.248007	0.001802	0.325811	0.042332	1.367428	0.145679	1.403707
θ	-0.155830	-3.239826	0.010285	0.820827	-0.076520	-3.890332	-0.021183	-0.145916
LR(5) for H_2: a_1=β=γ=δ=θ =0	131.1233		201.4737		438.5317		-4098.838	
Log-liklihood	-4156.987		-3034.549		4157.598		429.7013	
Number of ob.s	1412		1412		1412		1412	

<Table 6-B>

Panel B: Pre-liberalization sub-sample period. (1993.07.15-2002.11.30) : Firms of high price discount

구 분	LGC		NET		NNP		BPM	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	0.002950	0.353275	-0.001422	-0.327558	0.016676	1.643342	0.000916	0.067499
a_1	0.185176	4.158664	0.244502	4.367130	0.155484	2.415648	0.148966	3.222223
a_2	-0.117200	-0.628034	0.000118	0.154247	-0.544726	-1.812847	-0.047924	-0.223588
ω	1.778716	2.597620	6.25E-06	2.371813	4.143507	3.031571	2.194708	2.524806
β	0.158441	3.763124	0.266078	14.05199	0.132243	3.680404	0.130111	3.099232
γ	0.765557	12.67373	0.693305	92.96825	0.696761	10.14292	0.716466	8.527691
δ	0.003242	0.070626	0.584781	20.66442	0.224633	1.751331	-0.013296	-0.305587
θ	0.109977	1.159964	-0.000741	-0.889181	0.021874	0.129622	0.200408	0.955503
LR(5) H_2: $a_1=\beta=\gamma=\delta=\theta=0$	139.7214		14004.31		139.7214		78.50075	
Log-liklihood	-4185.293		-3696.078		-4384.188		-3936.333	
Number of ob.s	1412		1412		1412		1412	

<Table 7-A> Spillover effects in returns and volatilities from Hong Kong H shares to Chinese A shares during pre-liberalization sub-sample period. The mean and variance Spillover GJR-GARCH(1,1)-M model:

$$CA_{1,t} = a_{1,0} + a_{1,1}HK_{1,t} + a_{1,2}h_{1,t} + e_{1,t}$$

$h_{1,t} = \omega_{1,0} + \beta_{1,1}h_{t-1} + \gamma_{1,2}e_{t-1}^{2} + \delta_{1,3}HKK_{1,t-1} + \theta_{1,4}e_{t-1}^{2}I_{1,t-1}$ Where CA and HK stands for stock returns of Chinese A shares and Hong Kong H shares, respectively. CAA and HKK means squares of standard errors of Chinese A shares and Hong Kong H shares, respectively. $I_{1,t-1}$ is the residual. $I_{1,t-1}$ is a dummy variable.

Panel A: Pre-liberalization sub-sample period.(1993.07.15-2009.06.01) : Firms of low price discount

구 분	DME		TTB		GUA		MIS	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	-0.039976	-0.784600	-0.007461	-0.087012	-0.026238	-0.307127	-0.074789	-1.365561
a_1	0.006179	1.429683	0.032609	1.588269	0.055585	4.823341	0.035705	5.015528
a_2	0.032326	2.108636	0.005180	0.259168	0.002409	0.155469	0.002007	0.149500
ω	0.152293	3.226160	0.402603	2.687021	1.027029	3.759111	0.526212	3.197192
β	0.122175	3.573827	0.169218	4.717644	0.295920	6.247337	0.307004	5.951404
γ	0.867473	25.96678	0.734276	12.85040	0.540119	9.967942	0.579105	9.234175
δ	-0.001259	-2.331368	0.001802	0.325811	0.001452	0.520928	0.011047	2.701672
θ	-0.000362	-0.485284	0.010285	0.820827	0.008547	0.953738	-0.004052	-2130.768
LR(5) H_2: $a_1=\beta=\gamma=\delta=\theta=0$	2020.302		201.4737		83.19595		15978961	
Log-liklihood	-2809.185		-3034.549		-3175.335		-2935.758	
Number of ob.s	1412		1412		1412		1412	

<Table 7-B>

Panel B: Pre-liberalization sub-sample period.(1993.07.15-2009.06.01) : Firms of high price discount

	LGC		NET		NNP		BPM	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	0.022790	0.256946	-0.000102	-0.040165	-0.106117	-1.08439	0.013708	0.122391
a_1	0.053234	3.253329	0.070669	4.097602	0.040314	3.261268	0.055045	2.950001
a_2	0.022790	0.256946	-0.000102	-0.040165	-0.106117	-1.08439	0.013708	0.122391
ω	0.931817	3.912567	0.000203	0.980761	0.703685	3.783244	0.899935	3.583087
β	0.271105	6.744099	0.470063	2.181183	0.221790	6.117583	0.195002	5.587331
γ	0.522207	6.552234	0.536494	9.060153	0.628204	11.63604	0.644826	10.99474
δ	0.027138	2.307403	0.055595	2.565888	0.008604	2.192822	0.023938	3.271034
θ	0.061446	1.438693	0.025070	1.359663	0.004713	1.225577	-0.004600	-9.274368
LR(5) for H_2: $a_1=\beta=\gamma=\delta=\theta=0$	109.2334		238.8068		163.761**		187.0681	
Log-liklihood	-3350.824		-2915.807		-3214.728		3284.062	
Number of ob.s	1412		1412		1412		1412	

<Table 8-A> Spillover effects in returns and volatilities from Chinese A shares to Hong Kong H shares during post-liberalization sub-sample period. The mean and variance Spillover GJR-GARCH(1,1)-M model:

$HK_{1,t} = a_{1,0} + a_{1,1}CA_{1,t} + a_{1,2}h_{1,t} + e_{1,t}$

$h_{1,t} = \omega_{1,0} + \beta_{1,1}h_{t-1} + \gamma_{1,2}e_{t-1}^2 + \delta_{1,3}CAA_{1,t-1} + \theta_{1,4}e_{t-1}^2 I_{1,t-1}$ Where CA and HK stands for stock returns of Chinese A shares and Hong Kong H shares, respectively. CAA and HKK means squares of standard errors of Chinese A shares and Hong Kong H shares, respectively. $I_{1,t-1}$ is the residual. $I_{1,t-1}$ is a dummy variable

Panel A: Post -liberalization sub-sample period.(2002.12.01-209.06.01) : Firms of low price discount

구 분	DME		TTB		GUA		MIS	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	-0.024376	-1.543743	-0.013091	-0.679491	0.029067	2.652249	0.013725	1.284577
a_1	0.202217	5.127257	0.267663	8.912774	0.318125	12.03810	0.324016	13.87482
a_2	0.568915	2.700352	0.195038	1.506150	-0.209995	-1.467092	0.010016	0.119738
ω	4.454202	3.105312	1.131348	3.439441	1.374476	3.384799	0.023505	1.779874
β	0.125682	1.310968	0.140315	3.550792	0.193195	4.204529	0.051174	7.932584
γ	0.406450	2.129709	0.627653	9.653939	0.674950	10.80461	0.932029	126.1518
δ	0.172011	1.981288	0.072767	2.364137	0.071739	2.571486	0.018767	6.483785
θ	0.010221	0.270755	0.056882	1.301653	-0.028617	-1.204233	-0.002269	-22.45680
LR(5) for H_2: a_1=β=γ=δ=θ =0	23.10198		79.59721		205.4001			
Log-liklihood	-4541.280		-3993.206		-4533.023		-4215.634	
Number of ob.s	1695		1695		1695		1695	

<Table 8-B>

Panel B: Post -liberalization sub-sample period.(2002.12.01-209.06.01) : Firms of high price discount

	LGC		NET		NNP		BPM	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	-0.010748	-0.800218	-0.000266	-0.039049	0.013873	0.882743	0.010335	1.050928
a_1	0.147019	5.529475	0.046439	2.787075	0.321808	11.44445	0.232892	7.921508
a_2	0.333992	3.508240	-0.041457	-0.314259	-0.157709	-0.754295	-0.079665	-0.888539
ω	0.605237	4.971441	5.807653	3.823921	4.380666	2.716264	1.521202	4.532172
β	0.145801	4.967656	0.254013	3.212124	0.153753	2.890563	0.306757	5.878637
γ	0.840746	29.43345	0.180134	1.560194	0.369020	3.713293	0.432921	7.024026
δ	0.000818	0.179694	0.917890	2.032888	0.060351	1.615065	0.174588	3.642029
θ	-0.013253	-7.263017	0.038089	0.349076	0.188021	1.568797	-0.002126	-3.301077
LR(5) H_2: $a_1=\beta=\gamma=\delta=\theta=0$	3275.679		120.5251		32.16127		104.9082	
Log-liklihood	-3676.269		-4803.723		-4489.871		-4237.116	
Number of ob.s	1695		1695		1695		1695	

<Table 9-A> Spillover effects in returns and volatilities from Hong Kong H shares to Chinese A shares during post-liberalization sub-sample period. The mean and variance Spillover GJR-GARCH(1,1)-M model: $CA_{1,t} = a_{1,0} + a_{1,1}HK_{1,t} + a_{1,2}h_{1,t} + e_{1,t}$

$h_{1,t} = \omega_{1,0} + \beta_{1,1}h_{t-1} + \gamma_{1,2}e_{t-1}^2 + \delta_{1,3}HKK_{1,t-1} + \theta_{1,4}e_{t-1}^2 I_{1,t-1}$ Where CA and HK stands for stock returns of Chinese A shares and Hong Kong H shares, respectively. CAA and HKK means squares of standard errors of Chinese A shares and Hong Kong H shares, respectively. $I_{1,t-1}$ is the residual. $I_{1,t-1}$ is a dummy variable.

Panel A: Post -liberalization sub-sample period.(2002.12.01-209.06.01) : Firms of low price discount

	DME		TTB		GUA		MIS	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	0.003825	0.376429	0.004831	0.518198	0.001459	0.115389	0.000389	0.002439
a_1	0.092850	5.009414	0.186405	8.122985	0.275278	12.38782	0.312477	10.56814
a_2	-0.103467	-1.077042	0.032563	2.114176	0.016852	0.133755	-0.084497	-0.038726
ω	0.145100	1.839380	-0.039900	-3.234599	0.537283	2.750701	24.34675	8.054336
β	0.081207	4.821946	0.089282	4.614644	0.118358	5.890429	-0.006476	-1.690886
γ	0.910375	50.53407	0.894026	41.31730	0.780881	20.97566	-0.752332	-3.803250
δ	-0.007008	-1.447580	0.026768	1.983675	0.030422	3.265706	-0.005519	-0.600760
θ	0.011818	1.667389	-0.004157	-0.306952	0.019595	0.991590	-0.049423	-1.291500
LR(5) for H_2: a_1=β=γ=δ=θ =0	4366.064		8864.138		535.7075		52.11751	
Log-liklihood	-4243.723		-3636.720		-4330.943		-4274.885	
Number of ob.s	1695		1695		1695		1695	

<Table 9-B>

Panel A: Post -liberalization sub-sample period.(2002.12.01-209.06.01) : Firms of high price discount

	LGC		NET		NNP		BPM	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistsi	Coefficient	z-Statistic
a_0	0.009128	0.385997	0.001624	0.195741	-0.000735	-0.033480	0.028445	1.190163
a_1	0.224331	7.304003	0.081020	2.726121	0.313946	12.79442	0.262032	10.44527
a_2	-0.109979	-0.499193	0.018698	0.937503	0.018635	0.078738	-0.289469	-1.171585
ω	0.656726	0.927399	0.017411	3.068831	5.178421	1.916575	1.662098	1.126683
β	0.062535	3.042737	0.147246	6.676775	0.135276	2.998484	0.123745	3.758302
γ	0.873757	14.45563	0.876625	52.17022	0.332547	1.683367	0.654014	5.476848
δ	-0.005517	-0.258278	-0.000252	-1.247699	0.055662	3.358497	0.037613	2.784344
θ	-0.007314	-0.350348	-0.000103	-0.646913	-0.002916	-0.990508	0.036016	1.291587
LR(5) H_2: $a_1=\beta=\gamma=\delta=\theta$ =0	344.9123		6351.403		39.24289		27.46854	
Log-liklihood	-4253.249		-3727.250		-4404.510		-4297.874	
Number of ob.s	1695		1695		1695		1695	

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