Return Variance of Dual-Listed Shares in China

by

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ABSTRACT

News drives stock market. For many securities, however, good news does not lift the market as much as the bad news depresses it. This research studies companies that are dual-listed in Mainland China exchanges and Hong Kong stock exchange. The main purpose of this paper is to examine negative shock's impact on the volatility of dual-listed shares in Shanghai and Hong Kong. This paper uses the threshold GARCH model to identify whether news impact on dual-listed stocks is asymmetric. In addition, the paper uses logistic regression to explore if the volatility asymmetry is consistent across dual-listed A-shares and H-shares. Empirical results show that knowing the volatility asymmetry of A-shares does not add explanatory power to the volatility asymmetry of dual-listed H-shares.

Key words: Asymmetry; Volatility; GARCH; TARCH; Hong Kong H-shares; China A-shares

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Table of Contents

1. Introduction

This paper attempts to discuss a problem related to China's segmented stock market: do dual-listed Hong Kong H-shares and Shanghai A-shares in two exchanges react differently to news, even though the two different shares are based on the same underlying company? Under the current regulation, Mainland Chinese citizens are only allowed to invest in A-shares and foreigners are only allowed to invest in H-shares. A-shares are traded in Shanghai Stock Exchange and Shenzhen Stock Exchange. H-shares are traded in Hong Kong Stock Exchange. The differences between two exchanges and two different investor bases provide a great opportunity to study the segmentation in China's stock markets.

Volatility is driven by news. Good news and bad news both have impacts on stock volatility. In many situations, the impact of good news and bad news on volatility are not the same. That is, a positive shock does not increase stock volatility as much as a negative shock of the same magnitude does. Many indices and securities have demonstrated this property. The purpose of this paper is to study the segmentation of Chinese stock markets by looking at volatility asymmetry of stocks dual-listed in Hong Kong and Shanghai. It proceeds as follows. Section 2 briefly introduces general backgrounds of A-shares and H-shares markets. Section 3 provides a literature review. Section 4 describes the research method and data. Section 5 presents results from threshold GARCH models. Section 6 studies the consistency of asymmetric volatility in dual-listed A-shares and H-shares using logistic regression. Section 7 offers conclusions.

2. Background

Financial markets around the globe have developed rapidly in the globalization trend. The markets around the globe have become increasingly more interconnected. The integration of different markets gives investors a better platform to diversify. On the one hand, investors try to

invest in different countries; on the other hand, companies also try to list in different exchanges to broaden their capital base and improve their competitiveness across different regions. With the increasing economic influence of China's economy, more and more Chinese companies are now listed in different exchanges around the globe.

China's stock market is segmented. In Mainland and Hong Kong, the same companies can issue A-shares, B-shares and H-shares. In addition to all the domestic exchanges, these companies also have options to list abroad. In the early 1990s,[*] China established two different classes of stocks, A-shares and B-shares, for Chinese and foreign investors, respectively. Firms can issue both A-shares and B-shares in Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE). These shares have similar voting rights and dividend payouts except for the ownership restriction. A-shares are denominated in Chinese RMB; B-shares listed in Shanghai Exchange are traded in US dollars and those listed in Shenzhen Exchange are traded in Hong Kong dollars since RMB is not directly convertible for foreign investors. These B-shares are designed to attract foreign capital. On February 19th, 2001, China Securities Regulatory Commission lifted the ownership restrictions on B-shares for domestic investors, they can invest in both A-shares and B-shares, but A-shares are still not available to foreign investors.

Compared to the Mainland stock markets, Hong Kong enjoys many advantages as a more established financial center. Shares listed in Hong Kong are referred to as "H-shares." Beginning in 1993, Chinese companies started to list in Hong Kong as H-shares. H-shares are available as investment products to Hong Kong residents and international investors. As one of the largest exchanges in the world and an important financial center, Hong Kong not only has a closer physical connection to China than the rest of the world, but also enjoys close ties to China in

[*] A shares started trading on December 1, 1990 when the Shenzhen Stock Exchange began to operate and the Shanghai Stock Exchange opened on December 19, 1990; B shares were introduced in February 1992 in both stock exchanges.

politics, culture and economic prosperity. Many Chinese companies list their own shares in Mainland as well as Hong Kong. Since the restriction rule on oversea listing for Chinese firms has been repealed, companies have more options. There are several reasons why H-shares are better choices than B-shares for this research. Companies choose exchange listings based on a variety of different factors. The requirement for B-share listing is more lenient, while H-shares have more stringent requirement. Additionally, H-shares are often leaders in their corresponding industries. Researchers have also brought up the issue that B-shares sometimes experience illiquidity issues (Chen, et al., 2001). For H-shares, Wang and Jiang (2004) argued that illiquidity is no longer a problem.

Since 2001, Chinese government has relaxed restrictions on Chinese citizen's trading of B-shares, but H-shares are still restricted to foreign investors and investors with authorized foreign currency accounts, so H-shares provide a much better segmentation due to strict ownership restrictions. Although B-shares are designed to attract foreign investors, they are listed in the same exchanges as A-shares (SSE and SZSE), and are subjected to the same regulations and market structures as A shares. Wang and Jiang (2004) and Li et al. (2006) wrote that ownership and listing locations are both important factors that reflect market segmentation. Thus, it is more reasonable to study the relationship between A-share and H-share volatility instead of A-share and B-share.

To study dual-listed A-shares' and H-shares' reactions news, we have to first define news. News has a more specific definition to financial markets than to other usage. In financial markets, news is usually referred to as an event or previously unknown information. There are two types of news: good news and bad news. Good news leads to upward movement in securities and bad news leads to downward movements. This study observes news impact to a security by

observing its returns, downward movement indicates bad news and vice versa. The shock is described using the residual divided by standard deviation:

$$\frac{\varepsilon_t}{\sqrt{h_t}}$$

Engle and Ng (1993) found that positive and negative returns have different levels of impact on volatility. Negative shocks tend to move volatility higher than positive shocks. This paper is going to examine this volatility asymmetry among a group of dual-listed A-shares and H-shares and study if there is a connection between the corresponding A-shares and H-shares.

3. Literature Review

Many researchers have published works related to Chinese stock market. Kim and Shin (2000) showed in their research that A-shares and B-shares markets seem to follow independent price dynamics. There are significant obstacles to information and capital flow between A-shares and B-shares market, but these obstacles began to diminish after the loosening of regulation in 2001.

Ahlgren et al. (2009) investigated whether it had the significant premium and integration between A-and B-shares. Their finding hinted that the relaxation of the investment restrictions declined the segmentation in Mainland Chinese stock markets. Besides, Chelly-Steeley and Qian (2005) estimated if volatility changes took place at the same time in the A- and B- shares. Their analysis inferred that there were integration between the A-shares markets (SSE and SZSE), but not between the A-and B-shares. Lee (2008) investigated the price premium between A-shares and H-shares.

Li, Yan and Greco (2005) used a two-factor model to explain the cross-section returns of A-shares and H-shares associated with the risk premium. They finding shows that the risk premium

associated with the segmented A-shares and H-shares markets have significant impact on the price premiums of dual-listed companies. Liu and Ouyang (2009) used pooled-panel TARCH model to examined the spillover effect of A-shares, B-shares and H-shares, and they found that the reasons for segmentation between A-shares and B-shares are different from A-shares and H-shares. The former reflects institution factors and investor's risk appetite; the later reflects is due to investor's recognition.

Many researchers have studied positive and negative stock returns impact on volatility. Engle (1982) found that volatility tend to cluster. That is, large squared returns tend to follow by large squared returns. Engle and Ng (1993) suggested using a news impact curve to measure the news impact on different conditional volatility models. This paper focuses on volatility asymmetry of dual-listed A-shares and H-shares.

4. Method and Data

4.1 Volatility Modeling

Engle (1982) introduced the autoregressive conditional heteroskedasticity (ARCH) model and Bollerslev (1986) introduced the generalized autoregressive conditional heteroskedasticity model (GARCH). It provides convenience to analyze the changing volatility of financial assets. These models capture the time-varying feature of volatility clustering and the extra kurtosis in the financial data. The GARCH model, however, weights positive and negative returns in the same way whereas they may have a different impact on the volatility.

Volatility clustering refers to the observation that if the regression error has a large variance in one period, its variance tends to be large in the next period as well. While the returns themselves are not autocorrelated, the square of the returns often demonstrates significant autocorrelations.

This paper will discuss the time series of dual-listed stock prices by using GARCH (1,1) model, and threshold GARCH (TARCH). The TARCH model has significant advantage of allowing an asymmetric coefficient for previous news shocks. In finance, volatility measures financial asset's change of price over time. Linear models typically fail to explaining important characteristics such as kurtosis, skewness and volatility clustering. Therefore, GARCH provides a comfortable alternative to measure the volatility changes.

Bollerslev (1986) proposed a GARCH(p,q) random process. Following Bollerslev (1986), Akgiray (1989) explained a simple GARCH model is parsimonious and gives significant results. GARCH allows the conditional variance of a stock index to be dependent upon previous own lags. The GARCH (p,q) model is given by:

$$R_t = \mu + \varepsilon_t$$

$$s_t^2 = w + \sum_{t=1}^{q} a_t e_{t-1}^2 + \sum_{t=1}^{p} b_t s_{t-1}^2$$

where p is the number of the GARCH terms and q is the number of ARCH terms. Assume error e_t is normally distributed $N(0, s_t^2)$. s_t^2 is the conditional variance. R_t is the return for the financial data. The expectation for m and w is expected to be small. $a + b$ is expected to be close but slightly smaller than one.

News about volatility from prior period is measured by e_{t-1}^2, the lagged return error square from the previous period. The b measures the persistency of the volatility to a shock or the impact of old news on volatility.

Zakoian (1994) and Glosten, Jaganathan and Runkle (1993) introduced the Threshold-GARCH (TARCH). The standard formula for this model is:

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \gamma_j \varepsilon^2_{t-j} d_{t-j} + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2$$

Where $d_{t-j} = 1$, when $\varepsilon_{t-j} < 0$ and $d_{t-j} = 0$ otherwise. $e_t < 0$ indicates bad news and $e_t > 0$ indicates good news. The TARCH model, thus, is commonly used to describe the different impact on conditional variance from positive and negative shocks. Good news adds the conditional variance by a_i whereas bad news adds $a_i + \gamma$. If g^1 0, the news impact is asymmetric.

In this research, I am applying the GARCH (1,1) and TARCH (1,1,1) model. The GARCH model includes on GARCH term and one ARCH term:

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

The TARCH model includes one GARCH term, one ARCH term and one threshold order:

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \gamma \varepsilon^2_{t-1} d_{t-1} + \beta_1 \sigma_{t-1}^2$$

4.2 Data

By the end of 2003, there are 29 companies that are dual-listed in Hong Kong and Mainland exchanges. 6 of the companies are listed in Shenzhen and 23 are listed in Shanghai. This paper selects 23 of the Shanghai-listed companies whose prices have been available since 2003 to perform the research. *Table 1* shows the names of the China-incorporated companies and stock tickers of these dual-listed companies. The data for this research includes daily close price of the 23 dual-listed companies in both Shanghai and Hong Kong exchanges covering the period from 1/1/2003 to 4/5/2012.

Closing prices and the indices are from Bloomberg Terminal. Daily returns are calculated using logarithm returns:

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

First, I calculated the logarithm returns from the close prices of all the companies for the past 10 years. Then I calculated descriptive statistics including mean, standard deviation, skewness and kurtosis. Furthermore, in order to see if the distribution is normal, I used Jarque-Bera test:

$$JB = \frac{n}{6}\left(S^2 + \frac{1}{4}(K-3)^2\right)$$

where n is the number of observations; S is the skewness of the sample, and K is the kurtosis of the sample:

$$S = \frac{\hat{\mu}_3}{\hat{s}^3} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^3}{\left(\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right)^{\frac{3}{2}}}$$

$$K = \frac{\hat{\mu}_4}{\hat{s}^4} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^4}{\left(\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right)^{2}}$$

where $\hat{\mu}_3$ and $\hat{\mu}_4$ are the estimate for the third and fourth central moments, respectively. $\bar{x}$ is the sample mean. $\hat{s}^2$ is the sample variance.

The descriptive data in *Table 2* shows that most of the distributions of the returns are slightly skewed and show fat tails. Jarque-Bera statistics are significant for all the stocks. The histograms with normal fit are shown in *Table 3*.

5. Empirical Result

5.1 GARCH and TARCH Output

As shown in *Table 5*, the sum of ARCH coefficient (alpha) GARCH coefficient (beta) in a GARCH(1,1) model is very close to one, indicating that volatility shocks are quite persistent. The coefficient of the lagged squared returns (alpha) is positive and statistically significant for most specifications. Strong GARCH effects are apparent for both financial markets. Also, the coefficient of lagged conditional variance (beta) is significantly positive and less than one, indicating that the impact of previous news on volatility is significant. *Table 6* reports the TARCH (1,1,1) coefficients and Schwarz criteria for the estimation. Among all the 23 dual-listed companies, 9 out of 23 H-shares and 7 out of 23 A-shares have significant volatility asymmetry at 1% level. This means that variance of these shares react to positive shocks and negative shocks. For example, 1138 HK Equity (China Shipping Development Co. Ltd.) has on average a 0.0723% (t-stats around 5.869) higher daily variance when there is a negative shock compared to a positive shock of the same level. *Table 7* shows the details of asymmetric terms' coefficients from the TARCH (1,1,1) output.

The following table shows a tabulated result of all the A-shares and H-shares. Among all 23 companies dual-listed in Shanghai and Hong Kong, 30.43% of H-shares have asymmetric volatility and 39.13% of A-shares have asymmetric volatility. Only 2 out of the 23, or 8.70% companies have asymmetric volatility in both A-shares and H-shares (Jiangsu Expressway Co. Ltd. and Maanshan Iron and Steel Co. Ltd.) while 9 companies out of 23, or 39.13% do not show volatility asymmetry in H-shares or A-shares.

Tabulated statistics: H-share, A-share

Tabulated	statistics:	H-share,	A-share
Rows:	H-share	Columns:	A-share
	0	1	All
0	9	5	14
	64.29%	35.71%	100%
	56.25%	71.43%	60.87%

1	7	2	9
	77.78%	22.22%	100%
	43.75%	28.57%	39.13%
All	16	7	23
	69.57%	30.43%	100%
	100%	100%	100%

For companies with insignificant TARCH asymmetric term, their TARCH variance estimates and GARCH estimates are similar. These companies do not show a significant asymmetric volatility when experience negative shocks. For example, the t-test for 548 HK Equity (Shenzhen Expressway Co. Ltd.) has a p-value close to 0.91, and the TARCH estimate and GARCH estimate are hard to distinguish. *Figure 1* shows the stock price (green) over the observed period and the corresponding annualized TARCH(blue) and GARCH(red) output.

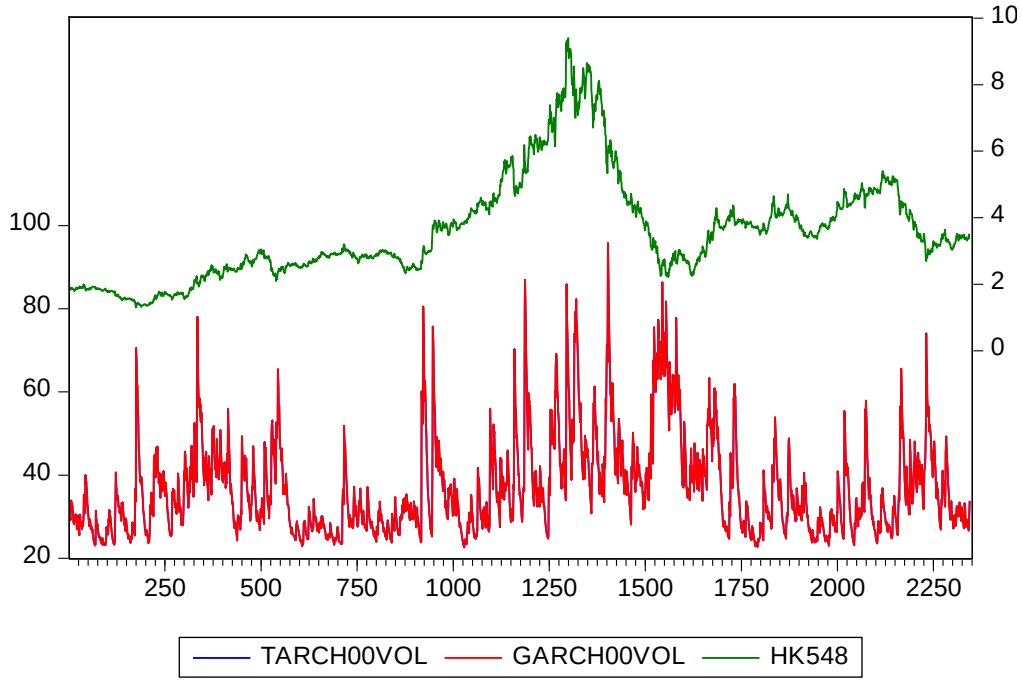

Figure 1

Figure 2 shows only annualized TARCH(red) and GARCH(blue) plots.

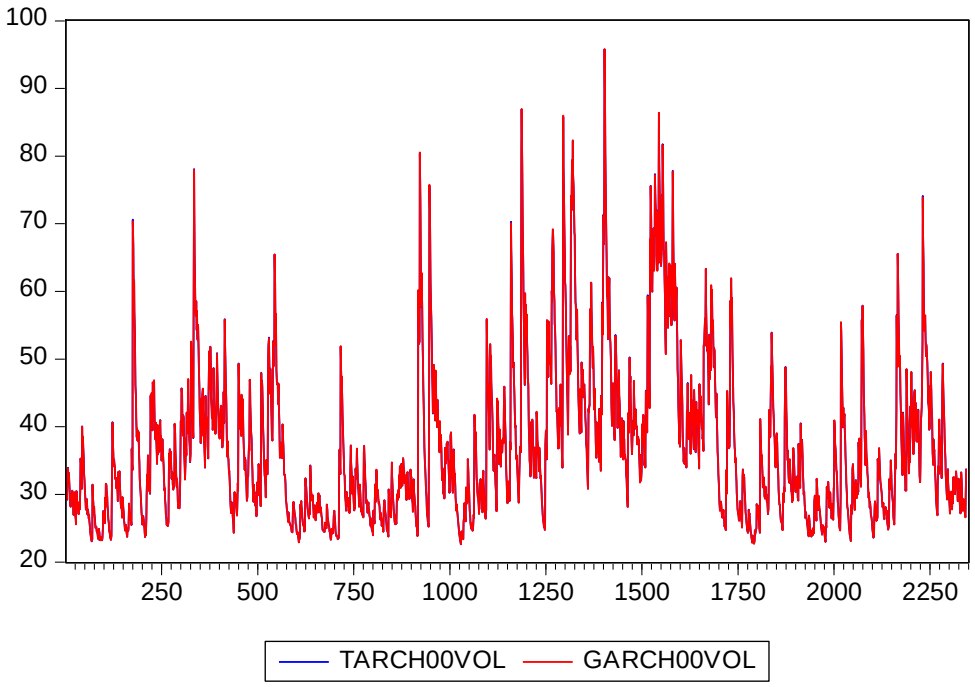

Figure 2

For companies with significant TARCH asymmetric term, their TARCH variance estimates and GARCH estimates are different. Comparing to positive shocks, these companies have higher return variance estimate when experiencing negative shocks. For example, the t-test for 600377 CH Equity (Jiangsu Expressway Co. Ltd.) has a p-value close to 0, and the daily TARCH estimate and GARCH estimate are quite different. *Figure 3* shows the stock price (green) over the observed period and the corresponding annualized TARCH(blue) and GARCH(red) output.

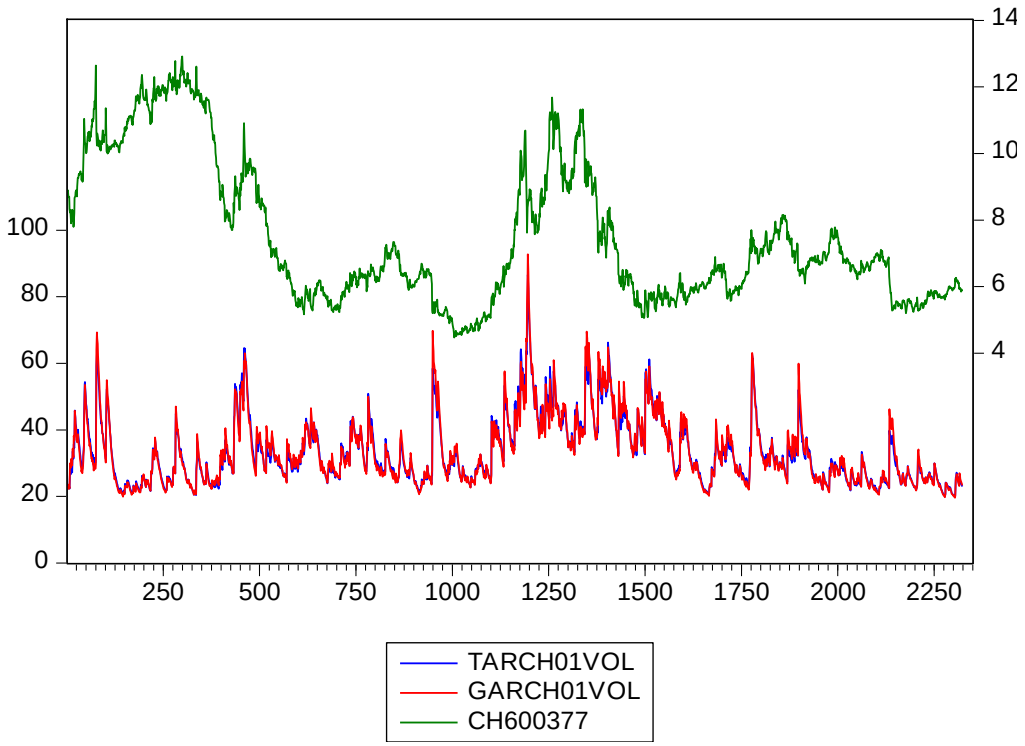

Figure 3

Figure 4 shows only annualized TARCH(red) and GARCH(blue) output.

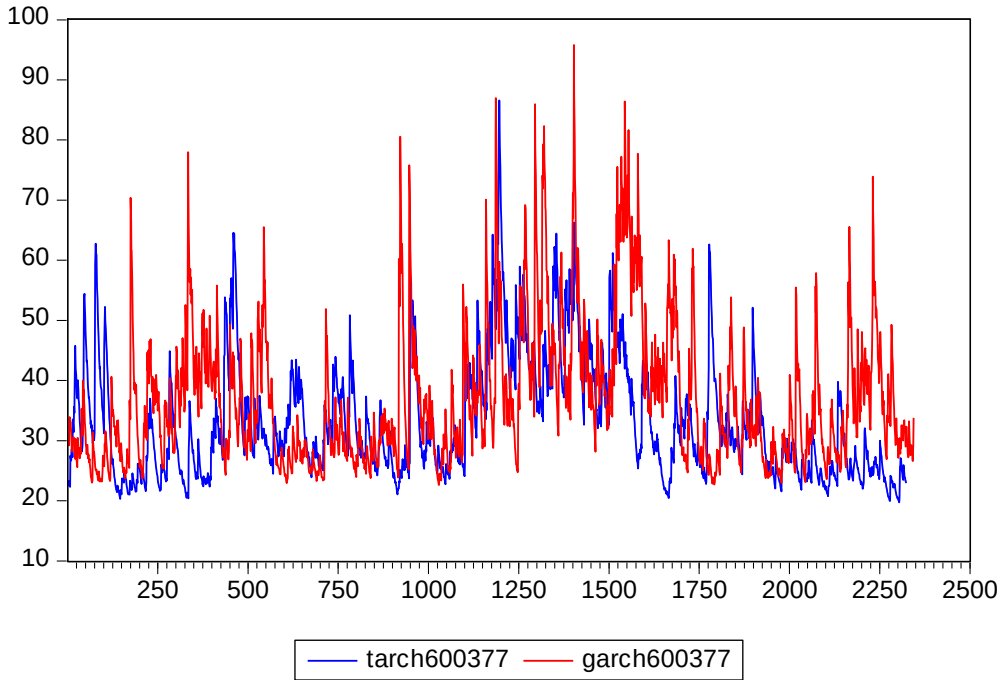

Figure 4

600377 CH Equity, as shown in the figure, has a significantly different GARCH estimate.

5.2 News Impact Curve

Volatility is difficult to validate because it is unobserved, but volatility models can be applied to estimate the reaction to news and validate the adequacy of the model. Engle and Ng (1993) suggested a news impact curve to standardize the measure for news impact on volatility. Because TARCH and GARCH model describe asymmetric volatility and symmetric volatility, respectively, it is intuitive to observe the difference between TARCH and GARCH estimate models. The news impact curve plots a series of news scenarios against resulting model estimates. As shown in the GARCH formula, it is symmetric about zero, so it is indifferent to positive and negative shocks on volatility. A standard GARCH (1,1) model with to news impact variable $z = \frac{\varepsilon}{\sigma}$ should be a quadratic curve centered at 0:

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

A TARCH (1,1,1) model has an asymmetric term. The slope of TARCH model for negative shock is different compared to the slope of good news:

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \gamma \varepsilon^2{}_{t-1} d_{t-1} + \beta_1 \sigma_{t-1}^2$$

$$Where\, d_{t-1} = 0,\ when\ \varepsilon_{t-1} > 0\ and\ d_{t-1} = 1,\ when\ \varepsilon_{t-1} < 0$$

Putting the TARGH model graph together with GARCH model, it will be easier to see the asymmetric impact of news. To plot the news impact curve, the goal is to plot σ^2 against the news impact $z = \frac{\varepsilon}{\sigma}$, where

$$\log \sigma_t^2 = \hat{\omega} + \hat{\beta} \log \sigma^2{}_{t-1} + \hat{\alpha} |z_{t-1}| + \hat{\gamma} z_{t-1}$$

Last period's variance $\sigma^2{}_{t-1}$ is fixed and obtained using corresponding models. The one period

variance with different level of impact is shown in the following *Figure 5* using 600377 HK Equity (Jiangsu Expressway Co. Ltd.).

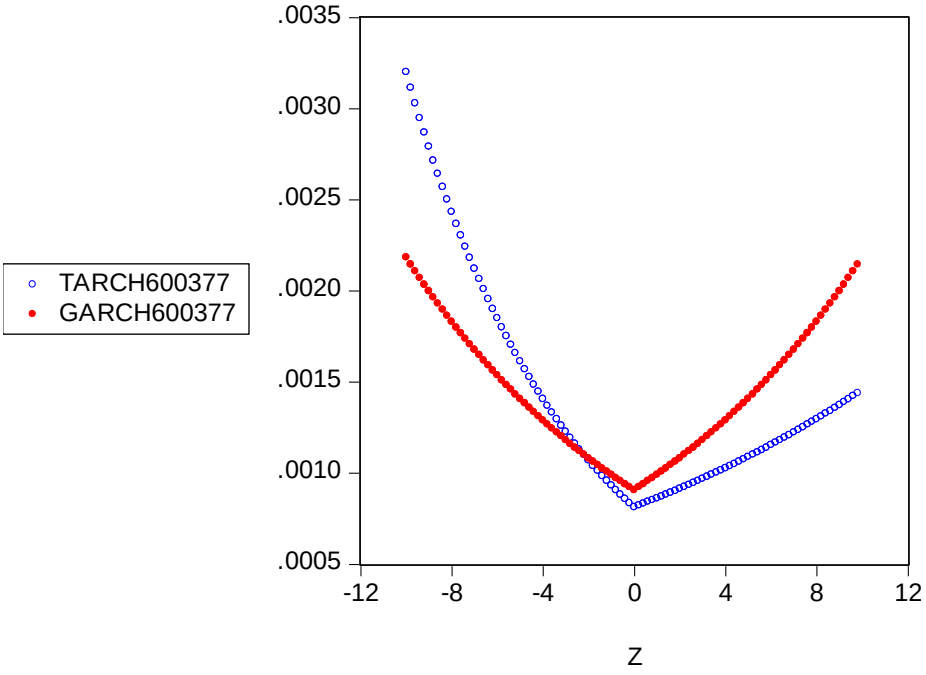

Figure 5

The two curves demonstrate the general characteristics of the impact curves. GARCH model is symmetric around zero while TARCH is asymmetric for this stock. As a comparison, I also made a news impact curve for 548 HK Equity (Shenzhen Expressway Co. Ltd.) in *Figure 6*. Because 548 HK Equity does not have significant gamma (coefficient in front of the asymmetric TARCH term), the GARCH curve and TARCH curve are quite similar to each other and both demonstrate symmetric volatility pattern.

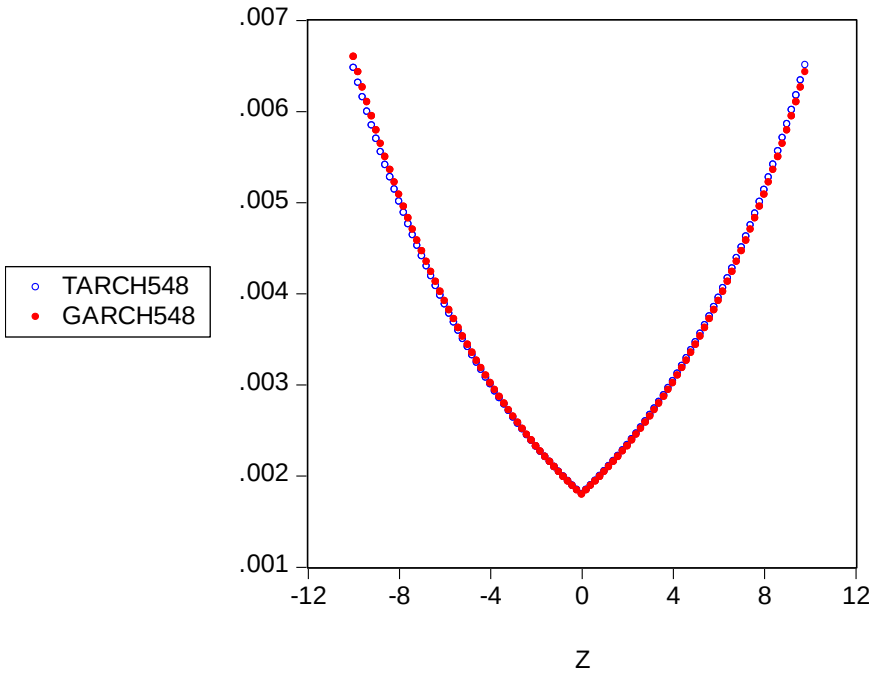

Figure 6

Among all 23 companies dual-listed in A-shares market and H-shares market, 7 A-shares and 9 H-shares show asymmetry. Next, I will show if knowing the asymmetry of a company's A-share gives and explanatory power to the asymmetry of H-shares.

6. Logistic Regression

6.1 Method

Logistic regression is used to predict dichotomous (0/1) outcome. The statistical model for logistic regression is:

$$\ln\left(\frac{\hat{p}}{1-\hat{p}}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n$$

Where $\hat{p}$ is the probability of the outcome being 1 and 1- $\hat{p}$ is the probability of the outcome being 0. $\beta_1, \beta_2 \ldots \beta_n$ are parameters of the logistic regression. $x_1, x_2 \ldots x_n$ are the explanatory variables. $\frac{\hat{p}}{1-\hat{p}}$ is the odds of outcome being 1.

6.2 Empirical Result

This paper studies whether the volatility asymmetry of A-shares adds any predictive power to the volatility asymmetry of H-shares, so I used the asymmetric coefficient's t-statistics of A-share as the explanatory variable x_1 and ran a logistic regression against the asymmetry of H-shares (0/1, significant at 1% level). The result is shown in *Table 8*. Hosmer-Lemeshow value is well above 10% so logistic regression is an appropriate model. However, the G-statistics (equivalent of F-statistics in an OLS regression) is around 0.58, which is far from any significance level. Therefore knowing the t-stats for A-shares do not add any explanatory power to the asymmetry of dual listed H-shares.

I also used the asymmetry of A-share as the explanatory variable x_1. x_1=1 means the corresponding A-share has significant volatility asymmetry. x_1=0 means A-shares do not significant volatility asymmetry. The outcome of 1 means the corresponding dual-listed H-share has significant volatility asymmetry and 0 means the dual-listed H-share does not have significant volatility asymmetry. The logistic regression result is shown in *Table 9*.

The G-statistics from the output is small and the p-value is around 0.48, so the regression fails to reject the hypothesis that there is a direct correlation between A-share's asymmetry and its dual-listed H-share's asymmetry. That is, knowing the volatility asymmetry from A-share does not add any predictive power to H-share's volatility asymmetry.

7. Conclusion

The relationship between A-shares market in Mainland China and H-shares market in Hong Kong has always been an intriguing. Over the years, many researchers have written papers about the segmentation between these two markets. Many indicated the segmentation exists in prices of

these dual-listed companies. This paper focuses on the impact of negative shocks on volatility and whether or not such impact is consistent across the dual-listed A-shares and H-shares.

I examined the volatility asymmetry among 23 dual-listed companies in Shanghai and Hong Kong (23 A-shares and 23 H-shares). The threshold GARCH model shows that dual-listed A-shares and H-shares do not necessarily have the same volatility asymmetry, even though they are from the same underlying company. The logistic regression fails to reject the hypothesis that A-shares volatility asymmetry adds reasonable explanatory power to H-share's volatility asymmetry. Negative shocks for one company may cause volatility of its A-shares to go up more significantly than when there are positive shocks. Since a significant volatility asymmetry in a company's A-share does not add any explanatory power to its dual-listed H-share asymmetry, this lack of relationship between the volatility of dual-listed shares indicates, to some extent, the segmentation of the A-shares market in Mainland and H-shares market in Hong Kong.

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9. Appendix

Table 1

Hong Kong Listed H-shares	Shanghai Listed A-shares	Company Name
902 HK Equity	600011 CH Equity	Huaneng Power International, Inc.
995 HK Equity	600012 CH Equity	Anhui Expressway Co. Ltd.
1138 HK Equity	600026 CH Equity	China Shipping Development Co. Ltd.
386 HK Equity	600028 CH Equity	China Petroleum and Chemical Corporation
1055 HK Equity	600029 CH Equity	China Southern Airlines Co. Ltd.
670 HK Equity	600115 CH Equity	China Eastern Airlines Corporation Ltd.
1171 HK Equity	600188 CH Equity	Yanzhou Coal Mining Co. Ltd.
874 HK Equity	600332 CH Equity	Guangzhou Pharmaceutical Co. Ltd.
358 HK Equity	600362 CH Equity	Jiangxi Copper Co. Ltd.
177 HK Equity	600377 CH Equity	Jiangsu Expressway Co. Ltd.
548 HK Equity	600548 CH Equity	Shenzhen Expressway Co. Ltd.
914 HK Equity	600585 CH Equity	Anhui Conch Cement Co. Ltd.
168 HK Equity	600600 CH Equity	Tsingtao Brewery Co. Ltd.
317 HK Equity	600685 CH Equity	Guangzhou Shipyard International Co. Ltd.
338 HK Equity	600688 CH Equity	Sinopec Shanghai Petrochemical Co. Ltd.
553 HK Equity	600775 CH Equity	Nanjing Panda Electronic Co. Ltd.
300 HK Equity	600806 CH Equity	Jiaoda Kunji High-Tech Co. Ltd.
323 HK Equity	600808 CH Equity	Maanshan Iron and Steel Co. Ltd.
187 HK Equity	600860 CH Equity	Beiren Printing Machinery Holdings Ltd.
1033 HK Equity	600871 CH Equity	Sinopec Yizheng Chemical Fibre Co. Ltd.
1065 HK Equity	600874 CH Equity	Tianjin Capital Environmental Protection Co. Ltd.
1072 HK Equity	600875 CH Equity	Dongfang Electrical Machinery Co. Ltd.
1108 HK Equity	600876 CH Equity	Luoyang Glass Co. Ltd.

Table 2

Tickers	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
HK902RET	0.000258	0.025827	-0.067615	6.943705	1514.289
HK955RET	0.000455	0.024883	0.062598	5.784921	684.2124
HK1138RET	0.000484	0.039311	0.250173	10.11371	4788.871
HK386RET	0.000888	0.026793	0.091323	7.64613	2116.046
HK1055RET	0.000413	0.036673	0.892593	12.31149	7318.601
HK670RET	0.000428	0.037318	2.108636	32.80114	84210.34
HK1171RET	0.001006	0.034754	-0.194044	9.412543	4018.794
HK874RET	0.000465	0.030102	0.537727	6.713366	1406.14
HK358RET	0.001235	0.038622	0.513227	9.607475	4335.233
HK177RET	0.000623	0.025933	0.304191	9.314082	3893.004
HK548RET	0.000257	0.024046	0.185266	6.158843	987.5339
HK914RET	0.001491	0.037075	0.64733	8.26187	2848.252
HK168RET	0.001318	0.028413	0.890484	10.29271	5419.524
HK317RET	0.000948	0.039047	0.56289	8.132011	2704.132
HK338RET	0.000555	0.032411	-0.086049	6.044724	907.1338
HK553RET	-0.000253	0.038502	0.209205	16.08315	16591.79
HK300RET	0.000387	0.037067	1.368537	19.05447	25573.33
HK323RET	0.000481	0.035492	0.72452	8.650839	3312.418
HK187RET	-0.0000562	0.035594	0.83186	10.81814	6216.082
HK1033RET	0.000301	0.036782	0.611496	9.401604	4134.354
HK1065RET	0.000121	0.030823	0.284504	7.041842	1621.598
HK1072RET	0.001524	0.037956	-0.272683	17.50678	20319.24
HK1108RET	0.00019	0.034273	5.048673	122.2697	1380786
600011 CH Equity	-0.0000732	0.025038	-0.337598	7.471075	1988.413
600012 CH Equity	0.000342	0.028311	6.027564	160.9273	2208644
600026 CH Equity	0.000148	0.030125	-0.158895	5.510874	603.1828
600028 CH Equity	0.000337	0.024973	-0.207296	9.501216	4153.589
600029 CH Equity	0.000496	0.033627	0.621598	11.25001	5667.274
600115 CH Equity	-0.0000689	0.030749	-0.049823	5.430604	550.1057
600188 CH Equity	0.000573	0.030697	-0.064301	4.954313	373.5186
600332 CH Equity	0.000068	0.030504	-0.150961	4.70417	281.8126
600362 CH Equity	0.000741	0.034307	0.289824	5.724304	752.1858
600377 CH Equity	-0.000175	0.021702	-0.341864	7.111148	1680.453
600548 CH Equity	-0.000229	0.025979	-0.857307	15.6101	15810.82
600585 CH Equity	0.000873	0.029488	0.014516	4.96522	374.7045
600600 CH Equity	0.000656	0.023762	0.303101	8.311981	2748.888
600685 CH Equity	0.00057	0.03452	0.027439	4.319778	170.9202
600688 CH Equity	0.00023	0.024753	0.109226	4.028396	107.8148
600775 CH Equity	-0.000317	0.035012	-0.435946	8.167478	2659.336
600806 CH Equity	0.000178	0.034419	1.010063	17.72825	21308.3
600808 CH Equity	-0.0000722	0.028312	-0.683916	15.14643	14542.26
600860 CH Equity	-0.000271	0.033375	-0.44983	7.315547	1890.701
600871 CH Equity	0.000127	0.027664	0.042888	3.911319	81.55172
600874 CH Equity	-0.000151	0.030599	-0.432242	6.70706	1410.323
600875 CH Equity	0.00076	0.030963	-0.093024	4.804976	317.4567
600876 CH Equity	-0.000072	0.032326	-0.149064	5.265915	503.3907

Table 3

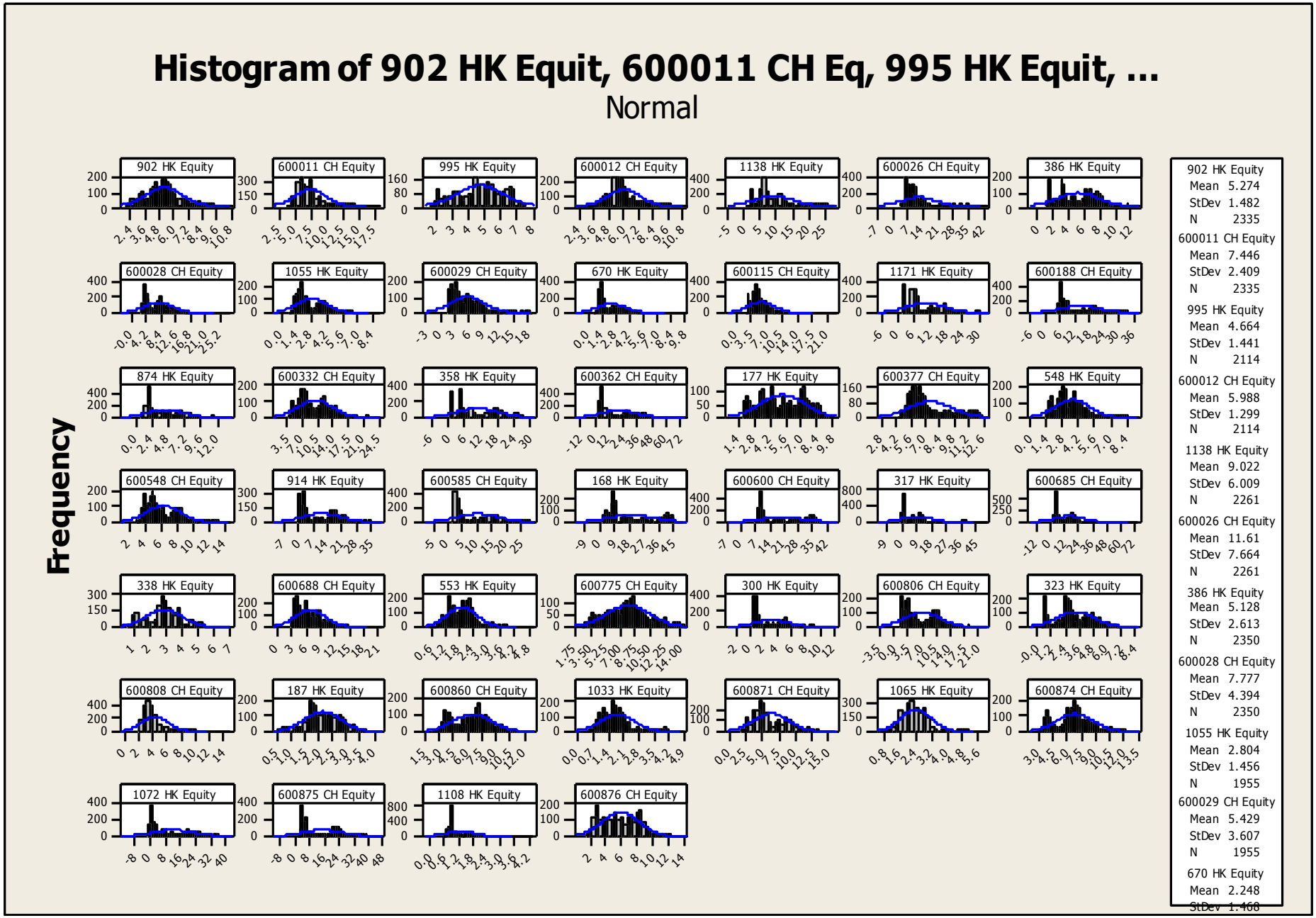
Histogram of 902 HK Equit, 600011 CH Eq, 995 HK Equit, ...
Normal
Frequency
902 HK Equity
600011 CH Equity
995 HK Equity
600012 CH Equity
1138 HK Equity
600026 CH Equity
386 HK Equity
600028 CH Equity
1055 HK Equity
600029 CH Equity
670 HK Equity
600115 CH Equity
1171 HK Equity
600188 CH Equity
874 HK Equity
600332 CH Equity
358 HK Equity
600362 CH Equity
177 HK Equity
600377 CH Equity
548 HK Equity
600548 CH Equity
914 HK Equity
600585 CH Equity
168 HK Equity
600600 CH Equity
317 HK Equity
600685 CH Equity
338 HK Equity
600688 CH Equity
553 HK Equity
600775 CH Equity
300 HK Equity
600806 CH Equity
323 HK Equity
600808 CH Equity
187 HK Equity
600860 CH Equity
1033 HK Equity
600871 CH Equity
1065 HK Equity
600874 CH Equity
1072 HK Equity
600875 CH Equity
1108 HK Equity
600876 CH Equity
902 HK Equity
Mean 5.274
StDev 1.482
N 2335
600011 CH Equity
Mean 7.446
StDev 2.409
N 2335
995 HK Equity
Mean 4.664
StDev 1.441
N 2114
600012 CH Equity
Mean 5.988
StDev 1.299
N 2114
1138 HK Equity
Mean 9.022
StDev 6.009
N 2261
600026 CH Equity
Mean 11.61
StDev 7.664
N 2261
386 HK Equity
Mean 5.128
StDev 2.613
N 2350
600028 CH Equity
Mean 7.777
StDev 4.394
N 2350
1055 HK Equity
Mean 2.804
StDev 1.456
N 1955
600029 CH Equity
Mean 5.429
StDev 3.607
N 1955
670 HK Equity
Mean 2.248
StDev 1.468

Table 4

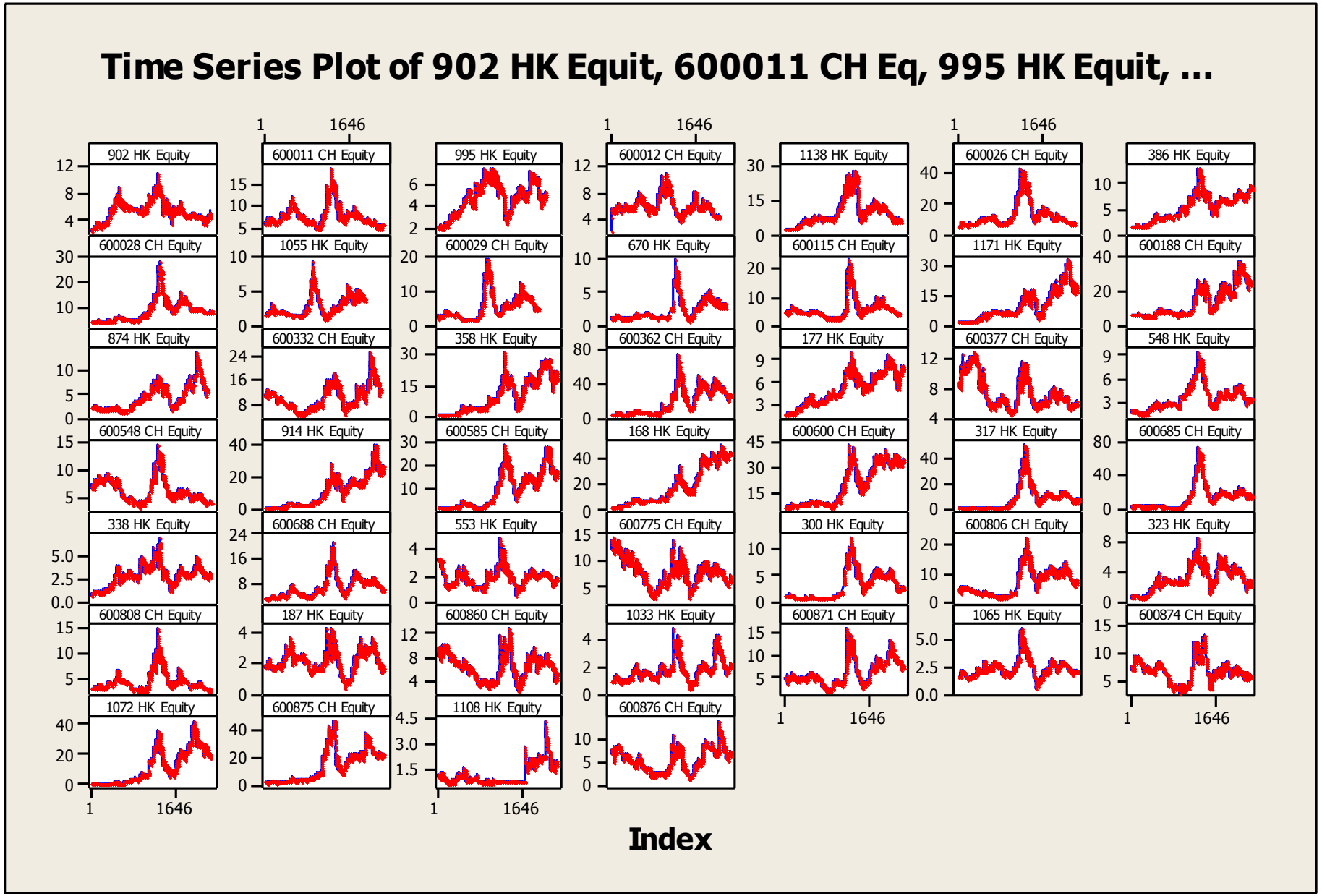
Time Series Plot of 902 HK Equit, 600011 CH Eq, 995 HK Equit, ...
902 HK Equity
600011 CH Equity
995 HK Equity
600012 CH Equity
1138 HK Equity
600026 CH Equity
386 HK Equity
600028 CH Equity
1055 HK Equity
600029 CH Equity
670 HK Equity
600115 CH Equity
1171 HK Equity
600188 CH Equity
874 HK Equity
600332 CH Equity
358 HK Equity
600362 CH Equity
177 HK Equity
600377 CH Equity
548 HK Equity
600548 CH Equity
914 HK Equity
600585 CH Equity
168 HK Equity
600600 CH Equity
317 HK Equity
600685 CH Equity
338 HK Equity
600688 CH Equity
553 HK Equity
600775 CH Equity
300 HK Equity
600806 CH Equity
323 HK Equity
600808 CH Equity
187 HK Equity
600860 CH Equity
1033 HK Equity
600871 CH Equity
1065 HK Equity
600874 CH Equity
1072 HK Equity
600875 CH Equity
1108 HK Equity
600876 CH Equity
1
1646
Index

Table 5

	GARCH Coefficient			
	Omega	**Alpha**	**Beta**	**Schwarz criterion**
HK1033	7.31E-05	0.134271	0.814874	-3.950124
HK1055	8.53E-05	0.168325	0.7793	-3.932928
HK1065	1.18E-05	0.078572	0.911095	-4.333988
HK1072	0.00042	0.241036	0.484083	-3.781894
HK1108	0.00033	0.117671	0.617373	-3.980266
HK1138	1.22E-05	0.064335	0.927614	-3.965036
HK1171	2.70E-05	0.110763	0.868158	-4.142558
HK168	5.05E-06	0.022802	0.970833	-4.363797
HK177	1.15E-05	0.088004	0.896641	-4.676843
HK187	6.21E-06	0.03938	0.956816	-4.047341
HK300	5.46E-05	0.094687	0.869993	-3.873506
HK317	9.59E-05	0.176811	0.770343	-3.845671
HK323	1.74E-05	0.066302	0.919968	-4.064789
HK338	3.71E-05	0.077013	0.88744	-4.129619
HK358	2.83E-05	0.095334	0.889208	-3.919661
HK386	1.24E-05	0.081158	0.899403	-4.677948
HK548	3.10E-05	0.130292	0.821364	-4.752379
HK553	0.00023	0.112682	0.737581	-3.758705
HK670	1.26E-05	0.116609	0.886245	-4.069139
HK874	2.39E-05	0.048562	0.926795	-4.224594
HK902	6.41E-06	0.080602	0.912531	-4.751617
HK914	7.33E-05	0.127463	0.820716	-3.920174
HK995	3.85E-05	0.127544	0.816118	-4.630923
CH600011	1.65E-05	0.088046	0.886972	-4.710533
CH600012	7.89E-05	0.156648	0.715089	-4.670903
CH600026	1.12E-05	0.059417	0.928812	-4.311009
CH600028	9.23E-06	0.094921	0.897211	-4.772209
CH600029	5.14E-05	0.112581	0.839321	-4.113804
CH600115	9.59E-06	0.059995	0.929473	-4.37109
CH600188	8.24E-06	0.079928	0.914883	-4.319209
CH600332	1.50E-05	0.085263	0.902012	-4.279147
CH600362	1.00E-05	0.071671	0.921957	-4.12459
CH600377	1.38E-05	0.087746	0.886705	-4.946124
CH600548	1.35E-05	0.080781	0.904434	-4.598529
CH600585	6.45E-06	0.051626	0.942156	-4.347642
CH600600	4.65E-06	0.054468	0.937849	-4.8492
CH600685	2.28E-05	0.082494	0.899672	-4.02918
CH600688	1.92E-05	0.063579	0.90586	-4.610471
CH600775	1.38E-05	0.047647	0.942017	-3.976224
CH600806	3.08E-05	0.090577	0.890201	-3.996445
CH600808	1.71E-05	0.100314	0.885758	-4.499996
CH600860	1.22E-05	0.043497	0.945506	-4.136321
CH600871	2.54E-05	0.100676	0.868782	-4.422222
CH600874	1.16E-05	0.100313	0.893284	-4.379408
CH600875	1.94E-05	0.075193	0.905	-4.244658
CH600876	2.27E-05	0.113923	0.869699	-4.185085

Table 6

	TARCH Coefficient				
	Omega	Alpha	Gamma	Beta	Schwarz Criteria
HK1033	7.26E-05	0.12572	0.018842	0.81494	-3.947103
HK1055	8.37E-05	0.15097	0.025982	0.78472	-3.929442
HK1065	1.18E-05	0.06689	0.027181	0.91012	-4.332239
HK1072	0.0004	0.18947	0.094705	0.5079	-3.780698
HK1108	0.00033	0.11902	-0.00399	0.61558	-3.976869
HK1138	1.26E-05	0.02584	0.072329	0.93178	-3.975086
HK1171	2.69E-05	0.11133	-0.00103	0.86815	-4.13924
HK168	4.04E-05	0.05952	0.026325	0.87963	-4.360323
HK177	1.35E-05	0.06894	0.04466	0.89044	-4.675864
HK187	6.54E-06	0.04312	-0.00908	0.95681	-4.044558
HK300	5.45E-05	0.09451	0.000204	0.8701	-3.870158
HK317	9.60E-05	0.16701	0.022417	0.77006	-3.842676
HK323	1.83E-05	0.047	0.039189	0.92033	-4.065662
HK338	4.14E-05	0.0602	0.03888	0.88107	-4.128672
HK358	2.83E-05	0.0945	0.001731	0.88923	-3.916333
HK386	1.27E-05	0.07975	0.004098	0.89835	-4.674671
HK548	3.11E-05	0.12968	0.001554	0.82111	-4.749069
HK553	0.00022	0.09067	0.053837	0.74035	-3.757179
HK670	1.26E-05	0.11573	0.001867	0.8863	-4.065687
HK874	2.32E-05	0.0422	0.013863	0.92759	-4.221919
HK902	6.46E-06	0.0691	0.025968	0.9115	-4.749543
HK914	5.85E-05	0.04988	0.114042	0.855	-3.930306
HK995	3.69E-05	0.09223	0.063802	0.8231	-4.630521
CH600011	1.60E-05	0.0984	-0.02271	0.88868	-4.707932
CH600012	7.64E-05	0.188	-0.05954	0.71906	-4.668312
CH600026	1.06E-05	0.06498	-0.01449	0.93131	-4.308284
CH600028	8.46E-06	0.11069	-0.05324	0.9065	-4.775017
CH600029	5.21E-05	0.10648	0.013696	0.83808	-4.110115
CH600115	9.61E-06	0.05967	0.000938	0.92933	-4.367637
CH600188	8.22E-06	0.08261	-0.00673	0.91539	-4.315989
CH600332	1.53E-05	0.1094	-0.04402	0.89996	-4.278978
CH600362	1.03E-05	0.07727	-0.01499	0.92297	-4.121875
CH600377	1.19E-05	0.09761	-0.03939	0.90033	-4.945598
CH600548	1.16E-05	0.10141	-0.05812	0.91503	-4.603356
CH600585	6.45E-06	0.05144	0.000436	0.94213	-4.344312
CH600600	5.17E-06	0.06547	-0.01737	0.93441	-4.846699
CH600685	2.24E-05	0.08813	-0.01371	0.90096	-4.026243
CH600688	1.88E-05	0.07508	-0.02301	0.90624	-4.608385
CH600775	1.36E-05	0.04906	-0.00345	0.94251	-3.972928
CH600806	3.00E-05	0.07603	0.028426	0.89146	-3.994018
CH600808	1.21E-05	0.12852	-0.09979	0.91127	-4.521343
CH600860	1.21E-05	0.06578	-0.03371	0.94129	-4.136598
CH600871	2.53E-05	0.10535	-0.00899	0.8687	-4.419007
CH600874	1.11E-05	0.08169	0.032258	0.89579	-4.377621
CH600875	1.97E-05	0.07229	0.00643	0.90442	-4.241402
CH600876	2.13E-05	0.12724	-0.03183	0.87358	-4.183071

Table 7

Hong Kong Listed H-shares	RESID(-1)^2*(RESID(-1)<0)	Std. Error	z-Statistic	Prob.
902 HK Equity	0.025968	0.0092	2.367297	0.018
995 HK Equity	0.063802	0.01798	3.548783	4.00E-04
1138 HK Equity	0.072329	0.01232	5.869808	0
386 HK Equity	0.004098	0.01144	0.358092	0.72
1055 HK Equity	0.025982	0.02313	1.123445	0.261
670 HK Equity	0.001867	0.01169	0.159708	0.873
1171 HK Equity	-0.001031	0.01466	-0.07034	0.944
874 HK Equity	0.013863	0.00708	1.95917	0.05
358 HK Equity	0.001731	0.01115	0.155252	0.877
177 HK Equity	0.04466	0.01626	2.746069	0.006
548 HK Equity	0.001554	0.01428	0.108813	0.913
914 HK Equity	0.114042	0.01562	7.300026	0
168 HK Equity	0.026325	0.01006	2.617853	0.009
317 HK Equity	0.022417	0.02192	1.022679	0.307
338 HK Equity	0.03888	0.01181	3.292283	0.001
553 HK Equity	0.053837	0.0153	3.519979	4.00E-04
300 HK Equity	0.000204	0.00883	0.023076	0.982
323 HK Equity	0.039189	0.01013	3.868313	1.00E-04
187 HK Equity	-0.009084	0.00533	-1.70472	0.088
1033 HK Equity	0.018842	0.01449	1.300469	0.193
1065 HK Equity	0.027181	0.01077	2.523775	0.012
1072 HK Equity	0.094705	0.016	5.918849	0
1108 HK Equity	-0.003988	0.02081	-0.19165	0.848
600011 CH Equity	-0.022709	0.01388	-1.63632	0.102
600012 CH Equity	-0.059539	0.02669	-2.23045	0.026
600026 CH Equity	-0.01449	0.00954	-1.51898	0.129
600028 CH Equity	-0.05324	0.00778	-6.84441	0
600029 CH Equity	0.013696	0.01972	0.694544	0.487
600115 CH Equity	0.000938	0.01035	0.090642	0.928
600188 CH Equity	-0.006728	0.01076	-0.6253	0.532
600332 CH Equity	-0.044023	0.01373	-3.20578	0.001
600362 CH Equity	-0.014987	0.00991	-1.51274	0.13
600377 CH Equity	-0.039386	0.0103	-3.82224	1.00E-04
600548 CH Equity	-0.05812	0.0061	-9.53306	0
600585 CH Equity	0.000436	0.00741	0.058871	0.953
600600 CH Equity	-0.017369	0.00835	-2.07923	0.038
600685 CH Equity	-0.01371	0.01319	-1.03958	0.299
600688 CH Equity	-0.023005	0.01172	-1.9629	0.05
600775 CH Equity	-0.003445	0.00908	-0.37944	0.704
600806 CH Equity	0.028426	0.01607	1.768637	0.077
600808 CH Equity	-0.099789	0.0059	-16.9121	0
600860 CH Equity	-0.033708	0.00927	-3.63533	3.00E-04
600871 CH Equity	-0.008988	0.01661	-0.54099	0.589
600874 CH Equity	0.032258	0.01186	2.719861	0.007
600875 CH Equity	0.00643	0.01186	0.54236	0.588
600876 CH Equity	-0.031829	0.0147	-2.16483	0.03

Table 8

Binary Logistic Regression: H-asym versus A-asym

Link Function: Logit

Response Information

Variable	Value	Count	
H-asym	1	9	(Event)
	0	14	
	Total	23	

Logistic Regression Table

Predictor	Coef	SE Coef	Z	P	Odds Ratio	95% CI Lower	95% CI Upper
Constant	-0.251314	0.503953	-0.50	0.618			
A-asym							
1	-0.664976	0.976713	-0.68	0.496	0.51	0.08	3.49

Log-Likelihood = -15.153
Test that all slopes are zero: G = 0.483, DF = 1, P-Value = 0.487

Measures of Association:
(Between the Response Variable and Predicted Probabilities)

Pairs	Number	Percent	Summary Measures	
Concordant	35	27.8	Somers' D	0.13
Discordant	18	14.3	Goodman-Kruskal Gamma	0.32
Ties	73	57.9	Kendall's Tau-a	0.07
Total	126	100.0		

Table 9

Binary Logistic Regression: H-asym versus A-t

Link Function: Logit

Response Information

Variable	Value	Count	
H-asym	1	9	(Event)
	0	14	
	Total	23	

Logistic Regression Table

Predictor	Coef	SE Coef	Z	P	Odds Ratio	95% CI Lower	95% CI Upper
Constant	-0.636488	0.505593	-1.26	0.208			
A-t	-0.0808992	0.108897	-0.74	0.458	0.92	0.75	1.14

Log-Likelihood = -15.103
Test that all slopes are zero: G = 0.582, DF = 1, P-Value = 0.445

Goodness-of-Fit Tests

Method	Chi-Square	DF	P
Hosmer-Lemeshow	4.4463	8	0.815

Table of Observed and Expected Frequencies:
(See Hosmer-Lemeshow Test for the Pearson Chi-Square Statistic)

	Group										
Value	1	2	3	4	5	6	7	8	9	10	Total
1											
Obs	0	1	1	1	0	1	2	1	1	1	9
Exp	0.6	0.7	0.7	1.1	0.7	0.8	1.2	0.8	0.8	1.7	
0											
Obs	2	1	1	2	2	1	1	1	1	2	14
Exp	1.4	1.3	1.3	1.9	1.3	1.2	1.8	1.2	1.2	1.3	
Total	2	2	2	3	2	2	3	2	2	3	23

Measures of Association:
(Between the Response Variable and Predicted Probabilities)

Pairs	Number	Percent	Summary Measures	
Concordant	70	55.6	Somers' D	0.13
Discordant	53	42.1	Goodman-Kruskal Gamma	0.14
Ties	3	2.4	Kendall's Tau-a	0.07
Total	126	100.0		