Return & Volatility Disparity, Slow Adjustment Process in Chinese Triple-Listed Firms

Lixian Liu

Abstract—**Chinese firms that cross-list in China A-share, Hong Kong and New York markets operate in a complex environment. Theoretically, when one firm is trading on multiple exchanges, the shares across exchanges are expected to be perfect substitutes and when they are not, arbitrage opportunity exists. Using quantitative methods, this study explores whether there are return and volatility disparities, which market is the dominant one, whether there is long-run relationship between these markets, and how at which prices are restored in equilibrium. Volatility discrepancies and a relatively slow adjustment process are observed. Although the majority of cross-listed Chinese firms are perfect substitutes, there is a window of arbitrage opportunity for a small subset of firms.**

Index Terms—**arbitrage, cointegration, cross-listing, equilibrium, error correction model**

I. Introduction

In an efficient market hypothesis framework, an asset price is the same regardless of the listing location. Financial market liberalization leads to the opening of new capital markets which in turn results in an increasing international portfolio investment, cross-listings, markets cointegration, information transmissions, and price discovery effects. These outcomes in the international capital markets provide opportunities to question the notion of homogeneous prices across locations. In a perfect capital market scenario where there is no transaction cost, no tax and perfect information, financial markets are undoubtedly integrated and hence are perfect substitutes for firm listings. Theoretically, if two markets are integrated and one firm is listed in both markets, there should not be any disparity in terms of asset prices and volatility. A thread of the cross-listing literature focuses on the benefits of firms engaging in such activity and shows that cross-listed firms experience a lower cost of the capital; enhance their trading liquidity; increase their corporate governance through the bonding theory; and can also increase its value. Within the same context, there is an alternative vein that studies whether it matters which location to cross-list and it is the intention of this study to contribute to the latter discussion.

Werner and Kleidon [1], showed that price disparity and volatility in asset prices exists for firms with multiple listings. Froot and Dabora [2] studied large 'Siamese twin' companies and argue that the location where their shares are traded can create price differentials. Earlier studies like Taylor and Tonks [3] explored similar avenues but focused on the market in aggregate and observed that the UK stock market index was cointegrated with the German, Dutch and Japanese markets indices. Subsequent studies like Ansotegui and Esteban [4], Fernandez-Serrano and Sosvilla-Rivero [5] and Shen et al. [6] sustain the discussion around the relationship that may exist between different markets. In addition, price discovery effect is another phenomenon that cannot be ignored when there are multiple exchanges involved into the model. The majority of the literature is focused on the well developed markets and there is a limited amount of research on emerging markets. Hence, another contribution of this paper is to use a different approach to contribute to the existing debate.

The Chinese triple-listed securities in local China A-share market, Hong Kong and New York markets provide an ideal ground to test for the hypotheses. Prior studies on international Chinese listings have focused on market segmentation, especially for China A-share market and Hong Kong H-share market; interactions among China-related market indices; cross-listed price discount for China B-shares to A-shares [7]; price discount of H-shares to A-shares [8]; and price discovery process for H-shares to N-shares [9]-[10]. Little is documented on the interdependence of the triple cross-listings among Mainland China, Hong Kong and the US. Due to the different classes of shares regime, shares issued by the same Chinese company could be traded in different markets and by different groups of investors, one can expect divergence is asset prices. However, with the opening A-share market to the Qualified Foreign Institutional Investors (end of 2002), market information processing and transaction executing are assumed to be improved in China A-share market accordingly. Given these mixed factors, it is important to test if these assets are perfect substitutes when they trade the different markets. This study attempts to answer the following questions about Chinese firms with multiple listings. Are these exchanges integrated? Is there a price or volatility disparity in asset prices when they are listed on multiple exchanges? Is there a dominant trading market for cross-listed firms? Is there a long-run equilibrium relationship between these exchanges? Is there a short-run equilibrium relationship between them? Can return in the

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L. Liu is with the Faculty of Business Government & Law, University of Canberra, Bruce, Canberra, 2617, Australia (e-mail: lixian.liu@canberra.edu.au).

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domestic exchange affect the other international exchanges (or vice-versa)?

The rest of the study is organized as follows. Data is briefly introduced in section II, section III explains the models and hypotheses, section IV contains empirical estimates and section V concludes.

II. DATA COLLECTION

In this paper, 11 triple-listed Chinese A-, H- (Chinese shares listed in Hong Kong), and N-shares (Chinese shares listed in New York) are examined. Daily total return index (RI) for all the triple listed Chinese shares, market indices and the foreign exchange rate used in this study are sourced from Datastream and collected for the period 1st January 1993 to 31st December, 2008.

III. METHODOLOGY

A number of methodologies are used to examine the research questions. Tukey [11] test is used to estimate the price and volatility disparity that may exists between asset prices when they have multiple listings. Adjusted model of Froot and Dabora [2] is applied to test which of the markets is dominant for Chinese triple-listed firms. The Johansen cointegration test [12] is used to determine whether long term equilibrium relationship exists and an error correction model analogous to Lieberman et al. [13] is used to estimate the short-run equilibrium. The error correction model (ECM) has the capability of testing the speed at which market revert back to equilibrium. The Granger [14] causality framework is also applied to examine the direction of information flows between various exchanges and is regarded as the price discovery test.

A. Disparity in Return and Volatility

The realised return of each Chinese company listed and traded in three markets is calculated as follows:

$$R_{it} = LN\left(\frac{RI_{it}}{RI_{it-1}}\right) \quad (1)$$

whereR_{it} is daily return for the stock *i* on day t and RI_{it} is total return index of stock *i* on day *t*. The null hypothesis is formed based on the efficient market paradigm whereby a firm's asset price does not vary in different listing locations. Further, the volatility of the two groups is expected to be the same in a perfect capital market and it is tested by using the F-test to compare the variance between them. The alternative hypothesis is that these two groups produce different returns or volatility. The *post hoc* Tukey [11] test is employed to test the hypothesis.

B. Market Integration Test

Analogous to the null hypothesis of Froot and Dabora [2], it is hypothesized that the log return differential should not be related with any of the independent variables, that is, the slope of the independent variables is not statistically different from zero. This state is viewed as market integration whereby the Chinese A-share market is integrated with the Hong Kong and New York as changes in the price differential are uncorrelated with the performance of the two markets. However, it is not necessary for the price differential to be correlated with exchange rate movements as the dependent variable is the difference between price changes of securities traded in different currencies. The alternative hypothesis suggests that the more trade on one market, the higher will be the estimated slope of that market. If we expect a Chinese cross-listed company to trade relatively more in China A than in New York, then the coefficient of the Chinese A-share market (SHA_t) will be larger than the coefficient of the lagged S&P. In addition, a shock to the overall Chinese local market is expected to be associated with an increase (decrease) in the local currency price of the Chinese A-share relative to the local currency price of the New York market. The implication is that the price differential is being driven to an extent by market-specific liquidity shocks or relative market sentiment. It is also expected that the coefficient to the local market will be positive and the foreign market would be negative. This alternative hypothesis implies that these markets are segmented and the returns of each dual-listed share are subject to the investors' sentiment so that the co-movement with the market depends on where the shares are traded. Similar to the coefficients of the market indexes, it is expected that the coefficients of the three exchange rates to be statistically insignificant for the market to the integrated. The equations for triple-listings are as follows:

$$R_{H-N,it} = \alpha + \tau_{i1} S\&P_{t-1} + \tau_{i2} Hang\ Seng_t + \tau_{i3} SHA_t + \tau_{i4} HK\$/US\$_t + \tau_{i5} RMB/US\$_t + \tau_{i6} HK\$/RMB_t + \varepsilon_{it} \quad (2.1)$$

$$R_{China\ A-H,it} = \alpha + \delta_{i1} S\&P_{t-1} + \delta_{i2} Hang\ Seng_t + \delta_{i3} SHA_t + \delta_{i4} HK\$/US\$_t + \delta\tau_{i5} RMB/US\$_t + \delta_{i6} HK\$/RMB_t + \varepsilon_{it} \quad (2.2)$$

$$R_{China\ A-N,it} = \alpha + \vartheta_{i1} S\&P_{t-1} + \vartheta_{i2} Hang\ Seng_t + \vartheta_{i3} SHA_t + \delta\vartheta_{i4} HK\$/US\$_t + \vartheta\tau_{i5} RMB/US\$_t + \vartheta_{i6} HK\$/RMB_t + \varepsilon_{it} \quad (2.3)$$

Where $R_{H-N,it}$ is the log return differential on Hong Kong and New York dual-listed shares of firm *i* at time and *t*. $S\&P_{t-1}$ is the log index returns of New York market at time *t-1*. $Hang\ Seng_t$ and SHA_t are the log index returns of Hong Kong and China Shanghai A market index at time *t* respectively. $RMB/US\$_t$, $HK\$/RMB_t$ and $HK\$/US\$_t$ are the log return of RMB/US$ exchange rate, log return of HK$/RMB exchange rate and log return of HK$/US$ exchange rate correspondingly. The market indices capture the local disturbances and the exchange rates control for the cross-border aspects of these markets. The time zone difference between the Chinese market and New York market is also controlled by using the lagged of the S&P.

All the regression models are tested for financial time series econometric problems like non-normality, autocorrelation, autoregressive conditional heteroscedasticity (ARCH) effects,

by taking the appropriate steps like using AR and MA terms to correct for autocorrelation and applying a GARCH (1,1) to overcome ARCH issues. Standard tests and residual diagnostics of the reported results revealed no major concerns with the above econometric models.

C. Johansen Cointegration Test

There are two popular approaches to examine cointegration namely Engle-Granger [15] approach and Johansen cointegration [12] for estimating a number of cointegrated vectors. Although the Engle-Granger approach is relatively easy to use, one of its major drawbacks is that it can estimate only up to one cointegrating relationship between the variables. However, in the triple-listing case of this study, there are three variables (stock RI series in China A-share, Hong Kong, and New York markets) in the state and therefore there could be potentially be up to two linearly independent cointegrating relationships. Thus, it is appropriate to examine the issue of cointegration within the Johansen Vector Auto Regression (VAR) framework to see what the number of cointegrating vectors is for the triple-listed Chinese securities. A VAR with *k* lags containing these three variables is set up and can be compactly written as:

$$RI_t = \beta_0 + \beta_1 RI_{i,t-1} + \beta_2 RI_{i,t-2} + \cdots + \beta_k RI_{i,t-k} + \mu_{it} \quad (3)$$

where $RI_t = \begin{bmatrix} RI_{it}^{China\ A} \\ RI_{it}^{H} \\ RI_{it}^{N} \end{bmatrix}$

D. Error Correction Model

In addition to learning about a potential long-run relationship between markets, ECM is applied to investigate how the deviation of the current state from its long-run relationship (if any) is incorporated in the short-run dynamics. In other word, the ECM enables us to test whether the behaviour of the identical cross-listed securities can be modelled as a chase of long-run equilibrium plus an error correction and when applied to our dataset it shows how the Chinese home stock exchange contributes to the price discovery when Chinese securities cross-list in other international and domestic exchanges.

Using the unit root tests and cointegration tests, these 11 Hong Kong-New York dual-listed Chinese shares are *I*(1) stationary and cointegrated. The return correction within these 11 dual-listed cases using error correction model could be further examined.

As there is no overlap trading time between Hong Kong and New York market, this creates the data synchronization problem. Thus, the time difference between China-Hong Kong and New York requires additional adjustments and the models for the dual-listings traded in Hong Kong and New York is written as:

$$\Delta RI_{it}^{HK} = \beta_0 + \beta_1 \Delta RI_{it}^{NY} + \beta_2 (RI_{it-1}^{NY} - RI_{it-2}^{HK}) + \beta_3 \Delta S\&P_t + \beta_4 \Delta Hang\ Seng_t + \mu_{it} \quad (4.1)$$

$$\Delta RI_{it}^{NY} = \beta_0 + \beta_1 \Delta RI_{it}^{HK} + \beta_2 (RI_{it-2}^{HK} - RI_{it-1}^{NY}) + \beta_3 \Delta S\&P_t + \beta_4 \Delta Hang\ Seng_t + \mu_{it} \quad (4.2)$$

where RI_{it-2}^{HK} is the adjustment term.

Equations 4.1 and 4.2 explain the behavior of stock returns in the Hong Kong and New York markets respectively. The above two error correction models explore the relationship between the price behaviors of Chinese firms that are dually traded on these two markets. These models test for any systematic linkages between the returns and can be regarded as a test for potential short-term arbitrage profit. In addition, these models have the capability of determining which of these markets is dominant. The underlying assumption of these models is that all the series, the error correction terms [$(RI_{it-1}^{Hong\ Kong} - RI_{it-1}^{New\ York})$and $(RI_{it-1}^{Hong\ Kong} - RI_{it-1}^{New\ York})$] and error terms (μ_{it}^1 and μ_{it}^2) are stationary in first differences. The other assumptions within this model are the linear dependence between the returns of these two markets and the error correction term. Given that the trading time of these two markets are not overlapped, the return is observed at the same time and is proxied by the lagged values of these returns. The variance inflation factor (VIF) was estimated to check if this is a major problem within the model. β_0 is the intercept and β_1 shows how the return change in Hong Kong relates to New York for a particular firm that is dually listed on these two markets. β_2 is the speed of adjustment back to equilibrium of constant prices and theoretically is expected to be negative. β_3 and β_4 is the beta of the market.

E. Granger Causality Test

For Chinese firms that are cross-listed in international markets, China is the home market where information releases occurs and this may lead one to believe that China is the dominant market. These information releases can be transmitted into the other international market. Another possibility is that information release on the international markets may impact on the Chinese domestic market. Granger [14] causality allows us to study which of the above outcome prevails in for Chinese cross-listed firms. In particular, the direction of information flows is examined, and whether any market, China A-share market, Hong Kong or New York can be viewed as dominant and the following models are estimated:

$$RI_{it}^{China\ A} = \alpha^{China\ A} + \sum_{j=1}^{p} \beta_j^{China\ A} RI_{it-j}^{China\ A} + \sum_{j=1}^{p} \gamma_j^{China\ A} RI_{it-j}^{HK} + \varepsilon_t^{China\ A} \quad (5.1)$$

$$RI_{it}^{HK} = \alpha^{HK} + \sum_{j=1}^{p} \beta_j^{HK} RI_{it-j}^{China\ A} + \sum_{j=1}^{p} \gamma_j^{HK} RI_{it-j}^{HK} + \varepsilon_t^{HK} \quad (5.2)$$

Where p is autoregressive lag length, j = 1, 2,…, p. $\sum_{j=1}^{p} \beta_j^{China\ A} RI_{i_{t-j}}^{China\ A}$ is the summation of all the lagged values of firm *i*'s RI dual-listed on A-share market. $\sum_{j=1}^{p} \gamma_j^{China\ A} RI_{i_{t-j}}^{HK}$ is the summation of all the lagged values of firm *i*'s RI dual-listed on Hong Kong market. $\varepsilon_t^{China\ A}$ and ε_t^{HK}

are the respective error terms and are independently distributed.

IV. Empirical results

This section reports the empirical results of the various methodologies discussed above. Table 1 shows the return and volatility analysis of Chinese firms that are triple-listed in China A-share, Hong Kong and New York markets. The daily average returns of firms listed in these markets are 0.01%, 0.01%, and 0.02% respectively. As shown in Panel C and D of Table 1, all the p-values imply that there is no statistical difference in the mean returns across these three different markets. In other words, there is no return disparity for Chinese firms that have multiple listings and that they have the same intrinsic price across listings. Such finding is consistent with the efficient market hypothesis and the perfect capital market theories that asset prices are the same regardless of the exchange listings. However, I cannot conclude the same when it comes to volatility of these triple-listings (see Panel B in Table 1) that the Levene test statistics support the difference in volatility. In that sense, there is evidence against market integration as such occurrence should not prevail if the markets were to be integrated. Although Werner and Kleidon [1] used different methodology and dataset, the findings in this study is consistent with them in that there exist disparity in volatility.

TABLE 1
RETURN AND VOLATILITY COMPARISON

Panel A: Sample Statistics			
	China A	**Hong Kong**	**New York**
Mean Returns	0.0001	0.0002	0.0002
Standard Deviation of Returns	0.0242	0.0254	0.0247

Panel B: Test of Homogeneity of Vairances		
	Levene Statistic	p-value
	22.2110	0.0000

Panel C: Comparison of Mean Return		
	F-statistic	p-value
F-test	0.0150	0.9850

Panel D: Multiple Comparison			
		Mean difference	p-value
China A	Hong Kong	-0.0001	0.992
	New York	-0.0001	0.985
Hong Kong	China A	0.0001	0.992
	New York	0.0000	0.999
New York	China A	0.0001	0.985
	Hong Kong	0.0000	0.999

Following Froot and Dabora [2], Equation 2 tests whether the log return differential on Hong Kong and New York of a Chinese firm is influenced by the lagged market returns in United States, Hong Kong and China and by three different exchange rates. If we consider the results for Aluminium (see the first company in Table 2), we find that all of the other coefficients are statistically different from zero except the exchange rates coefficients. The domestic Chinese market is represented by Shanghai A market index (SHA) and has a negative coefficient of 0.079. This implies that that domestic disturbance has a negative impact on the return differentials of Aluminium. Interestingly, it is observed that the market in New York (represented by the lagged values of S&P) has similar negative influence but with a larger magnitude (1.023). Surprisingly, the market return in Hong Kong is positive (0.601). Based on the size of the coefficients, we can conclude that relatively speaking there is more trade in Hong Kong than the other two markets for Aluminium. If we rank the markets in order of relative trade, Hong Kong comes first, followed by China A and then the New York market. I report similar findings within the remaining 10 Chinese companies whereby the New York market is where the Chinese cross-listing firms are least traded in the relative sense and that return differential are inversely related to the US market. Hong Kong on the other hand appears to have a positive influence on the return differentials and is the dominant market for the trading of the cross-listed Chinese firms. The local market is in the middle of New York and Hong Kong on the basis of trade. This evidence supports the alternative hypothesis that these three markets are not integrated and can be classified as segmented.

TABLE 2
FROOT & DABORA INTEGRATION TEST RESULTS

	intercept	$S\&P_{t-1}$	Hang Seng	SHA	HK$/ US$	RMB/ US$	RMB/ HK$
Aluminium	0	-1.023***	0.601***	-0.079***	1.422	-0.082	1.046*
t-statistics	*(-0.647)*	*(-25.79)*	*-17.92*	*(-3.15)*	*-1.22*	*(-0.17)*	*-1.73*
China Eastern Airlines	0	-0.892***	0.659***	0.089***	7.412***	0.223	0.184
t-statistics	*(-0.436)*	*(-30.74)*	*-37.42*	*-4.9*	*-19.94*	*-0.98*	*-0.296*
China Life Insurance	0	-1.094***	0.584***	-0.014	0.584	-0.942***	0.105
t-statistics	*(-0.519)*	*(-33.13)*	*-26.49*	*(-0.69)*	*-0.66*	*(-4.05)*	*-0.32*
China Petrol and Chemical	0	-0.751***	0.470***	0.008	-1.191	-0.808***	0.879*
t-statistics	*(-0.593)*	*(-31.98)*	*-20.52*	*-0.4*	*(-1.17)*	*(-3.25)*	*-1.96*
China Southern Airlines	0	-0.781***	0.440***	-0.01	-1.987**	-0.564*	0.38
t-statistics	*-0.015*	*(-26.40)*	*-23.77*	*(-0.42)*	*(-2.30)*	*(-1.93)*	*-0.83*
China United Telecom	0	-1.261***	0.684***	-0.043**	2.522**	-0.490***	-0.537
t-statistics	*(-0.649)*	*(-50.31)*	*-30.04*	*(-2.31)*	*-2.17*	*(-2.68)*	*(-1.21)*
Guangshen Railway	0	-0.594***	0.345***	0.01	1.267***	-0.251	0.477
t-statistics	*(-0.099)*	*(-26.80)*	*-21.99*	*-0.62*	*-3.62*	*(-0.83)*	*-1.09*
Huaneng Power	0	-0.0688***	0.389***	-0.017	1.475*	-0.856***	1.393***
t-statistics	*(-0.339)*	*(-28.76)*	*-19.3*	*-1.09*	*-1.87*	*(-5.11)*	*-4.51*
Petro China	0	-0.626***	0.402***	-0.011	-0.17	-0.255	1.354***
t-statistics	*(-0.716)*	*(-26.18)*	*-18.94*	*(-0.57)*	*(-0.20)*	*(-0.66)*	*-2.79*
Sinopec Shanghai	0	-0.670***	0.419***	-0.009	-0.202	-0.09	-0.011
t-statistics	*-0.195*	*(-26.42)*	*-26.86*	*(-0.71)*	*(-0.49)*	*(-1.64)*	*(-0.07)*
Yanzhou	0	-0.617***	0.397***	-0.052**	0.088	-0.046	1.052**
t-statistics	*(-0.490)*	*(-19.15)*	*-15.75*	*(-2.41)*	*-0.11*	*(-0.10)*	*-2.16*

*t statistics is shown in parenthesis, * denotes rejection at 10% significant level,*
*** denotes rejection at 5% significant level, *** denotes rejection at 1% significant level*

Table 3 reports the empirical results of Johansen cointegration test [12] for the triple-listed Chinese shares. Overall, the null hypothesis that $r = 0$ is rejected in all cases in both the case of the trace test and maximum Eigen value test, and the null of no cointegrating vectors is rejected at the 5% significance level. When we look at the results where we test for the null hypothesis of at most one cointegrating vectors ($r=1$), and at most two cointegrating vectors($r=2$), both the trace statistic and max-Eigen statistic is now well below the five per cent critical value, suggesting that the null should not be rejected indicating that there are at least one cointegrating vectors.

TABLE 3
JOHANSEN COINTEGRATION TEST RESULTS

Pair Series	r	Trace Test Statistics	Critical Value 5%	Max-Eigen Test Statistic	Critical Value 5%
Aluminium	0	102.766***	29.797	94.085***	21.132
	1	8.681	15.495	8.673	14.265
	2	0.009	3.841	0.009	3.841
China Eastern Airlines	0	249.620***	29.797	239.346***	21.132
	1	10.274	15.495	6.837	14.265
	2	3.437	3.841	3.437	3.841
China Life Insurance	0	91.159***	29.797	86.629***	21.132
	1	4.53	15.495	4.072	14.265
	2	0.458	3.841	0.458	3.841
China Petrol and Chemical	0	172.245***	29.797	160.789***	21.132
	1	11.456	15.495	8.853	14.265
	2	2.603	3.841	2.603	3.841
China Southern Airlines	0	173.126***	29.797	160.610***	21.132
	1	12.516	15.495	11.241	14.265
	2	1.274	3.841	1.274	3.841
China United Telecom	0	138.868***	29.797	131.513***	21.132
	1	7.355	15.495	7.106	14.265
	2	0.249	3.841	0.249	3.841
Guangshen Railway	0	65.292***	29.797	52.374***	21.132
	1	12.918	15.495	12.894	14.265
	2	0.024	3.841	0.024	3.841
Huaneng Power	0	50.498***	29.797	37.300***	21.132
	1	13.198	15.495	8.328	14.265
	2	4.870**	3.841	4.870**	3.841
Petro China	0	59.239***	29.797	51.846***	21.132
	1	7.392	15.495	5.098	14.265
	2	2.294	3.841	2.294	3.841
Sinopec Shanghai	0	63.355***	29.797	53.572***	21.132
	1	9.783	15.495	7.125	14.265
	2	2.659	3.841	2.659	3.841
Yanzhou Coal	0	50.386***	29.797	41.533***	21.132
	1	8.853	15.495	6.748	14.265
	2	2.105	3.841	2.105	3.841

** denotes statistical significance at the 10% level, ** denotes statistical significance at the 5% level, *** denotes statistical significance at the 1% level*
r denotes the number of cointegration vectors under the null hypothesis

Table 4 and 5 provide the results for the 11 Chinese firms that are dual-listed in Hong Kong and New York market estimating equation 4.1 and 4.2. Shares traded in China A-share market are excluded as they are not cointegrated to any other two markets. On average the coefficient of β_1 is between 0.6-0.7, which implies that for dually listed companies on Hong Kong and New York market, a change in return on Hong Kong market will alter the returns of these dual listed companies in New York market by 60 to 70%. The ECM effect captures the speed at which the return of dual listed companies traded on Hong Kong is restored in equilibrium. ECM coefficients from Table 4 and Table 5 are mixed with negative and positive number. The minimum and maximum values are -0.094 and 0.146. Such level of adjustment rate can be considered as low as Lieberman et al. [13] observe an ECM effect of around 0.3 between the US market and Tel Aviv Stock Exchange, and hence it is concluded that dually traded Chinese firms tend to have a relatively slow adjustment process to equilibrium.

TABLE 4
RESULTS OF THE ERROR CORRECTION MODEL (EQUATION 4.1)

	Intercept β_0	ΔRI_{it}^{NY} β_1	ECM effect β_2	S&P β_3	Beta β_4
Aluminum	0.000	0.610***	0.031***	-0.843***	1.045***
	(-1.322)	(37.369)	(2.049)	(-20.253)	(31.451)
China Eastern Airlines	0.009***	0.705***	-0.094***	-0.601***	0.658***
	(8.561)	(53.329)	(-9.467)	(-16.148)	(25.139)
China Life Insurance	0.000	0.441***	0.040***	-0.573***	1.042***
	(-0.988)	(27.433)	(2.786)	(-16.501)	(43.825)
China Petrol and Chemical	-0.001	0.532***	0.019	-0.493***	0.857***
	(-1.350)	(37.813)	(1.607)	(-17.012)	(37.014)
China Southern Airlines	0.000	0.710***	-0.060***	-0.694***	0.629***
	(-1.359)	(56.126)	(-5.940)	(-18.930)	(25.000)
China United Telecom	-0.001***	0.545***	0.038***	-0.723***	0.996***
	(-2.685)	(39.671)	(3.085)	(-23.048)	(44.125)
Guangshen Railway	-0.002***	0.649***	-0.018***	-0.571***	0.540***
	(-3.224)	(49.869)	(-4.028)	(-19.292)	(26.453)
Huaneng Power	0.000	0.653***	-0.018**	-0.616***	0.597***
	(-1.324)	(45.075)	(-1.957)	(-18.289)	(24.797)
Petro China	0.002	0.540***	-0.017	-0.485***	0.748***
	(1.695)	(36.375)	(-1.466)	(-17.913)	(35.65)
Sinopec Shanghai	0.002***	0.739***	-0.028***	-0.734***	0.657***
	(3.791)	(67.752)	(-5.122)	(-23.896)	(32.17)
Yanzhou Coal	-0.003***	0.682***	-0.041***	-0.481***	0.652***
	(-4.117)	(51.612)	(-5.236)	(-13.746)	(23.745)

* denotes statistical significance at the 10% level,
** denotes statistical significance at the 5% level and
*** denotes statistical significance at the 1% level

TABLE 5
RESULTS OF THE ERROR CORRECTION MODEL (EQUATION 4.2)

	Intercept β_0	ΔRI_{it}^{HK} β_1	ECM effect β_2	Beta β_3	Hang Seng β_4
Aluminum	0.000	0.708***	0.030*	1.280***	-0.333***
	(-0.584)	(37.369)	(1.85)	(32.327)	(-7.602)
China Eastern Airlines	-0.015***	0.679***	0.146***	0.819***	-0.204***
	(-13.964)	(53.329)	(15.336)	(23.347)	(-7.291)
China Life Insurance	0.001	0.828	-0.039*	1.249	-0.529
	(1.976)	(27.433)	(-1.962)	(31.728)	(-10.786)
China Petrol & Chemical	0.000	0.754***	0.003	0.933***	-0.298***
	(0.060)	(37.813)	(0.232)	(30.382)	(-8.560)
China Southern Airlines	0.001	0.724***	0.098***	0.990***	-0.223***
	(1.551)	(56.126)	(9.629)	(28.516)	(-8.054)
China United Telecom	0.001	0.762***	-0.025*	1.323***	-0.441***
	(1.507)	(39.671)	(-1.707)	(43.700)	(-12.453)
Guangshen Railway	0.002***	0.663***	0.015***	0.792***	-0.180***
	(2.750)	(49.869)	(3.408)	(27.884)	(-8.019)
Huaneng Power	0.002***	0.638***	0.032***	0.935***	-0.175***
	(2.924)	(45.075)	(3.661)	(30.581)	(-6.723)
Petro China	-0.001	0.681***	0.018	0.864***	-0.226***
	(-0.970)	(36.375)	(1.387)	(32.062)	(-7.764)
Sinopec Shanghai	-0.002***	0.721***	0.031***	0.946***	-0.240***
	(-4.371)	(67.752)	(5.749)	(32.84)	(-10.780)
Yanzhou Coal	0.005***	0.715***	0.063***	0.720***	-0.135***
	(6.607)	(51.612)	(7.999)	(20.878)	(-4.389)

* denotes statistical significance at the 10% level,
** denotes statistical significance at the 5% level and
*** denotes statistical significance at the 1% level

Granger causality is applied to examine the information flows for Chinese dual- and triple-listings. The Akaide and Schwarz Bayes Information Criteria are used when choosing the optimal number of lags. Granger's F-statistics for the null hypothesis are reported in Table 6. Panel B of Table 6 shows that 9 out of 11 pairs showing high rejection rates of the null hypothesis that there is no causality from Hong Kong to China A. Panel A of Table 6 also demonstrates that New York also

takes the influential market position to dual-listed Chinese A-shares.

One implication derived from the Granger causality test suggests that the overseas part in the cross-listing securities have the price influence power more than their counterpart of China A-shares. Even the New York Chinese ADRs could affect the dual-listed Mainland Chinese securities to some extent. This result is not consistent with the argument of dominant-satellite proposed by Garbade and Silber [16], while in the case of Chinese cross-listing, the foreign market acted as the dominate market while China domestic market as the satellite one.

TABLE 6
GRANGER CAUSALITY TEST RESULTS

Panel A:	**Pairwise Granger Causality**		**Pairwise Granger Causality**	
	H_o: No causality from China A to New York		**H_o: No causality from New York to China A**	
	F-Statistic	Prob.	F-Statistic	Prob.
Aluminum	1.931	0.104	6.977 ***	0.000
China Eastern Airlines	1.175	0.320	15.205 ***	0.000
China Life Insurance	1.408	0.230	5.394 ***	0.000
China Petrol and Chemical	1.206	0.306	6.287 ***	0.000
China Southern Airlines	2.280 *	0.059	13.695 ***	0.000
China United Telecom	1.046	0.382	3.893 ***	0.004
Guangshen Railway	3.448 ***	0.009	1.212	0.305
Huaneng Power	1.148	0.332	6.982 ***	0.000
Petro China	0.717	0.581	3.934 ***	0.004
Sinopec Shanghai	1.637	0.162	1.889	0.110
Yanzhou Coal	0.955	0.431	5.971 ***	0.000

Panel B:	**Pairwise Granger Causality**		**Pairwise Granger Causality**	
	H_o: No causality from China A to Hong Kong		**H_o: No causality from Hong Kong to China A**	
	F-Statistic	Prob.	F-Statistic	Prob.
Aluminum	1.982 *	0.096	3.494 ***	0.008
China Eastern Airlines	1.003	0.405	8.749 ***	0.000
China Life Insurance	1.012	0.400	0.242	0.914
China Petrol and Chemical	2.595 **	0.035	6.287 ***	0.000
China Southern Airlines	1.331	0.256	9.380 ***	0.000
China United Telecom	1.324	0.259	3.028 **	0.017
Guangshen Railway	2.919 **	0.021	0.773	0.543
Huaneng Power	1.516	0.195	4.081 ***	0.003
Petro China	0.637	0.637	0.624	0.646
Sinopec Shanghai	0.833	0.504	2.496 **	0.041
Yanzhou Coal	1.164	0.325	3.554 ***	0.007

Panel C:	**Pairwise Granger Causality**		**Pairwise Granger Causality**	
	H_o: No causality from Hong Kong to New York		**H_o: No causality from New York to Hong Kong**	
	F-Statistic	Prob.	F-Statistic	Prob.
Aluminum	6.435 ***	0.000	137.622 ***	0.000
China Eastern Airlines	66.311 ***	0.000	27.663 ***	0.000
China Life Insurance	3.230 **	0.012	88.449 ***	0.000
China Petrol and Chemical	12.386 ***	0.000	80.723 ***	0.000
China Southern Airlines	30.197 ***	0.000	47.973 ***	0.000
China United Telecom	6.389 ***	0.000	146.943 ***	0.000
Guangshen Railway	16.178 ***	0.000	68.092 ***	0.000
Huaneng Power	9.332 ***	0.000	155.145 ***	0.000
Petro China	9.268 ***	0.000	141.044 ***	0.000
Sinopec Shanghai	28.365 ***	0.000	56.800 ***	0.000
Yanzhou Coal	36.414 ***	0.000	31.055 ***	0.000

** denotes statistical significance at the 10% level, ** denotes statistical significance at the 5% level,*
**** denotes statistical significance at the 1% level*

V. CONCLUSION

This study revisits the theories surrounding cross-listed firms by using different methodologies and a more recent data set. The findings support the prior literature in that there exist volatility discrepancies; Hong Kong remains the dominant stock market for Chinese cross-listed firms; and most of the Chinese cross-listed firms are cointegrated between Hong Kong and New York. With a growing Chinese economy and the increase in the number of Chinese cross-listed firms, a new pattern is emerging. Some instances are observed where these assets are no longer perfect substitutes indicating that arbitrage opportunities cannot be ruled out. Another contribution of this research is that there is a slow adjustment process to equilibrium. This implies that the corrections for price difference across markets can be slow across the Chinese cross-listed firms and this indicates a potential for arbitrage profit. Further research is required to test the significance of these arbitrage profits possibilities.

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Lixian Liu is an assistant professor in Finance at the University of Canberra, Australia at present. She completed PhD in economics and finance at RMIT University in Australia 2011, and commenced her first academic appointment at the Australia National University in 2009, later at the University of South Australia in 2010. Her research interests are international cross-listing, corporate governance, and market linkage via cross-listing.