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An Econometric Test of Long Term Relationship between Hang Seng China AH A-share Index and Hang Seng China AH H-Share Index

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Abstract

If there are enough opportunities of arbitrage, the prices of an asset trading in different locations should not deviate from each other. Putting this premise upside down, an asset trading in different markets with substantial obstacle to arbitrage should have no ground to converge. Hence, the segregation of A-share and H-share market shall allow price divergence. However, empirical evidence shows long term relationship between A- and H-share markets. In this paper, an econometric analysis of a current data set demonstrates long term (in two years time) relationship between the two markets. To make the empirical result useful, further research should focus on what leads to temporary divergence of prices in different market. Even more important is to identify, with longer series of data, whether the relationship between the prices in the two markets is stable over time.

Keywords: Globalisation, Financial Institution, Financial Market
JEL Codes: F36, G12

1. Introduction

The proposition that the same asset trading in different market should be priced the same, adjusted for transaction cost due to differentiated arrangements across markets, should not arouse much controversy. As long as there is profitable arbitrage opportunity, market participants will take advantage of it. This would lead to equalization of prices across markets in different locations. In international financial market, same (or extremely similar) assets trading in different markets are not uncommon. Notable examples include crude oil futures (in New York and London), some Hong Kong stocks (in Hong Kong Stock Exchange and New York Stock Exchange in the form of ADR). Taken into account that the trading locations are in different time zone, the divergence of prices can be said to be insignificant. An interesting counter example on the prices of Tsarist bond traded in London and Paris in the period 1916 – 1919 showed that, in the absence of arbitrage opportunity due to stringent control due to war condition, the same bond exhibited substantial price differential in two markets.

The case of A-shares of Chinese companies traded in China and H-shares of these companies traded in Hong Kong lies between the two extreme. While there is no closure of foreign exchange market (as in the war condition of Tsarist bond story), the channel of arbitrage between two markets are obviously limited. Persistence price differential in two markets is expected. The aim of this study is to show that, albeit limited in arbitrage channel, the prices of the securities traded in the two markets exhibit long run relationship. This paper will demonstrate this long run relationship devising the methodology developed by Engle and Granger (1987) using a data set from July 2007 to June 2009.

When stock exchange in China re-opened in early 1990s, companies listed were mostly state-owned enterprises heading for ownership reform. The shares of these companies traded in China were A-shares, denominated in Yuen (Renminbi, "RMB" hereafter). Meanwhile, some of these China companies also listed in Hong Kong via H-shares, which are denominated in Hong Kong Dollar ("HKD" hereafter).

A-shares are traded either at Shanghai Stock Exchange ("SHSE" hereafter) or Shenzhen Stock Exchange ("SZSE" hereafter). There are restrictions on trading of A-shares. Priced in RMB, they are allowed to be traded by Chinese citizens and qualified institutional investors only. Meanwhile, with the same rights to shareholders as their A-share counterpart, H-shares are traded in Hong Kong Stock Exchange ("HKSE" hereafter) and priced in HKD. Hence, if there was channel of arbitrage, adjusted for exchange rate, the prices of the A-share and H-share of the same company should not exhibit substantial differential. In reality, due to exchange control on RMB and restriction on citizenship, A-share and H-share do show price differential.

Currently, RMB is only available for servicing current account. In other words, capital account of China is not liberalized yet. Theoretically, as all the RMB bought from foreign exchange market are for trade payment only, there should not be any remaining balance for putting into asset market in China.Furthermore, access to A-share market is restricted to Chinese citizens. Foreigners are not allowed to hold any securities account. Foreigners can assess A-share market only through the programme "Qualified Institutional Investor".

Qualified Institutional Investor" ('QFII" in short) is a programme of the PRC government to allow foreign institutional investors satisfying certain criteria and approved by PRC government to trade A-shares in stock exchange in China. This is the only official channel to trade A-shares by foreigners. Since the total amount to QFII is capped and is small relative to the total market capitalization of A-share market, the efficiency of arbitrage is expected to be relatively small.

The other side of the coin is that A-share investors in China have (at least in theory) no channel to arbitrage the H-share counterparts in their portfolio, except through approved institutions in "Qualified Domestic Institutional Investor" programme ("QDII" in short). Through this programme, approved institutions can invest in offshore markets in, for instance, foreign securities and bonds. In other words, Chinese individual investors can only indirectly access foreign asset market (including Hong Kong stock market obviously).

In short, QFII and QDII are (in theory) the only arbitrage channels available for investors in A- and H-share. With restriction on foreign exchange market and upper limit (on QFII), obviously efficient arbitrage channel between A-shares and H-shares does not exist.

2. Liturature Review

Previous studies have indentified long term convergence between A-share and H-share prices(Peng, Miao, & Chow, 2007). The convergence is more obvious after the implementation of QDII(Birtch & McGuinness, 2008). A study has shown higher volatility of A-share comparing to H-share(Miao & Peng, 2007). Some studies have also identified persistence discount on H-share comparing to A-share(Wang & Jiang, 2004). The primary purpose of this study is to explore the long term relationship between A-share and H-share with a recent data set dating from July 2007 to June 2009.

3. Methodology
3.1 Data Description

The author uses the data series Hang Seng China AH (A) Index and Hang Seng China AH (H) index compiled by Hang Seng Indexes Company. The two indexes are designed to track the price performance of the largest and most liquid Mainland China companies listed both A-share and H-share. The data period is from 9-July-2007 to 30-June-2009. Daily closing indexes are used in this study.

Hong Kong (where H-shares are traded), Shanghai and Shenzhen (where A-shares are traded) are in the same time zone (GMT +8). Weekly trading days are Monday to Friday. Trading hours of China and Hong Kong are overlapping to a large extent: for Hong Kong it is 10:00 a.m. to 4:00 p.m. , for Shanghai and Shenzhen it is 9:30 a.m. to 3:00 p.m.. Public holidays in Hong Kong and China mostly do not coincide. To ensure consistency, if data are absent due to holidays, the closing index of the previous trading day is assumed to prevail. The Excel spread sheet attached contains the data series adjusted for holidays. Total there are 502 records in each series.

Diagram 1 and Diagram 2 are the plots of Hang Seng China AH (A) Index and Hang Seng China AH (H) Index adjusted for holidays, denoted “ADA” and “AHA” respectively. Visual inspection of the plots series reveals both A-share and H-share indexes exhibit random walk processes. Since they seem to co-move in a regular pattern, a test of stationarity of the two series is warranted.

Diagram 1: Plot of Hang Seng AH (A) Index in the data period

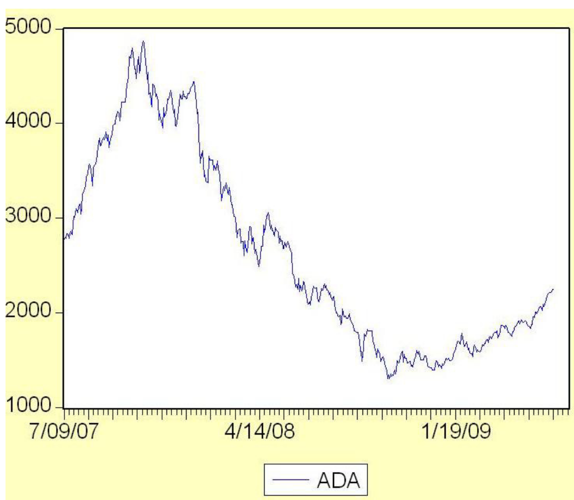
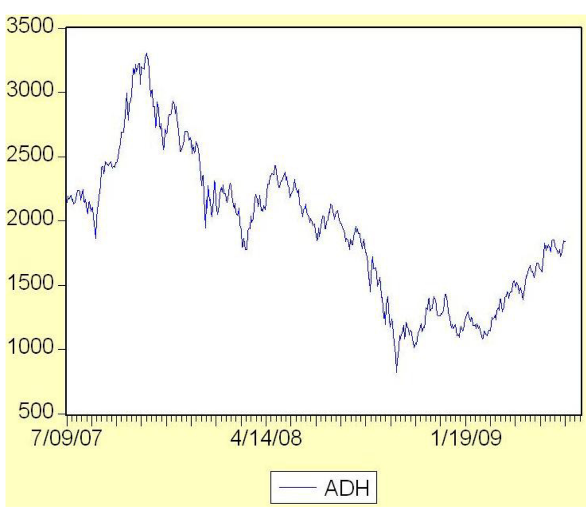


Diagram 2: Plot of Hang Seng AH (H) Index in the data period



3.2 Testing Stationarity of ADA using Augmented Dickey-Fuller Test

Analysis of correlogram of ADA shows that there are both auto-correlation and partial correlation problems in the time series. Taking natural log and first difference is the usual strategy to solve the problems, making the resulting series suitable for further analysis.

A more precise test of stationarity of the series ADA and DLADA is to use Augmented Dickey-Fuller Test. To rule out any inconsistency, the series are put into test in three specifications: with intercept, with intercept and trend, and none of them. The test statistics on ADA are displayed below (Table 1):

Table 1: ADF Test statistic of ADA series

	ADF Test Statistics	1% Critical Value
with Intercept	-0.7059	-3.4457
with Intercept and Trend	-1.7068	-3.9807
with neither intercept nor trend	-0.5934	-2.5698

In all three cases, the ADF test statistics are larger than the MacKinnon critical value at 1% level of significance. Therefore null hypothesis is not rejected. The series ADA has a unit root and the series is non-stationary. Therefore, it is required to further process the data series in order that they can be used for further analysis.

A data series DLADA is derived from taking natural log and first difference of ADA, and then apply ADF test on it under all three cases. The result is as followed (Table 2):

Table 2: ADF Test statistic of DLADA series

	ADF Test Statistics	1% Critical Value
with Intercept	-15.7209	-3.4457
with Intercept and Trend	-15.7106	-3.9807
with neither intercept nor trend	-15.7346	-2.5698

In all the three cases, the ADF test statistics are smaller than the MacKinnon critical value at 1% level of significance. Therefore null hypothesis is rejected. The series DLADA does not have unit root and is stationary. It could be devised for futher analysis.

3.4Testing Stationariy of ADH Using Augmented Dickey-Fuller Test

Next let's check the stationarity of the series ADH. The principle is the same as in unit-root rest on ADA and DLADA. Firstly ADF test is devised on checking unit-root on ADH. The test statistics of the three cases are displayed below (Table3).

Table 3: ADF Test statistic of ADH series

	ADF Test Statistics	1% Critical Value
with Intercept	-1.2581	-3.4457
with Intercept and Trend	-1.8092	-3.9807
with neither intercept nor trend	-0.5998	-2.5698

In all three cases, the ADF test statistics are larger than the MacKinnon critical value at 1% level of significance. Therefore null hypothesis is not rejected. The series ADH has a unit root and the series is non-stationary. As in the case of ADA, the author take natural log and first difference on ADH to arrive at DLADH series, then apply ADF test again. The result is as followed (Table 4):

Table 4: ADF Test statistic of DLADH series

	ADF Test Statistics	1% Critical Value
with Intercept	-15.7209	-3.4457
with Intercept and Trend	-15.7106	-3.9807
with neither intercept nor trend	-15.7346	-2.5698

In all three cases, the ADF test statistics are larger than the MacKinnon critical value at 1% level of significance. Therefore null hypothesis is not rejected. The series DLADA do not have a unit root and the series is stationary. It is then possible to proceed to check whether there is long term relationship between the two series by means of co-integration test.

4. Co-intergration Test

There are two common approaches to test cointegration. One is the Engle-Granger two-stage method, the other is the Johansen Test. The results above shows that that the series ADA and ADH are integrated of order one, i.e. I(1). This satisfies the prerequisite of devising Engle-Granger co-integration test. (This is actually the first stage of Engle-Granger method.) The next step is to proceed by estimating the following equation and then extract the series of residual terms, μ:

$$\mathrm{ADH} = \alpha + \beta(\mathrm{ADA}) + \mu$$

then check if the μ series is stationary. Johansen Test is devised for this purpose. The test result is presented in Table 5.

Table 5: Johansen Test statistic of DLADA and DLADH

Eigenvalues	Likelihood Ratio	5% Critical Value	1% Critical Value	Hypothesized No. of CE(s)
0.1953	189.0713	15.41	20.04	None **
0.1512	81.3156	3.76	6.65	At most 1 **

** denotes rejection of the hypothesis at 1% significance level
L.R. test indicates 2 cointegratign equations at 5% significance level

It is shown that there is at most 1 cointergrating equations for DLADA and DLADH. That means that the two series have long term relationship. According to the Granger representation theorem, when the two series are conintegrated, there must also be an error correction model (ECM) that describes the short-run dynamics of the cointetraged variables toward their equilibrium value. So the next step is to construct an error correction model which describes how the two series are related.

5. Error Correction Model

To construct an ECM for series DLADA and DLADH, the author needs to estimated this equation first:

$$\mathrm{ADH_t} = \alpha + \beta(\mathrm{ADA_t}) + \mu_t$$

And then extract the series of the residual term, μ. With the residual series, the following model is estimated:

$$\mathrm{DLADH_t} = \alpha + \mu_{t-1} + \beta(\mathrm{DLADA_t})$$

The result is as in Table 6:

Table 6: Error Correction Model with Constant Term

Variable	Coefficient	Std. Error	t-Statistic	Probability
α	< 0.0001	0.0012	0.0450	0.9641
μ_{t-1}	< -0.0001	< 0.0001	-2.4084	0.0164
β	0.8345	0.0477	17.5123	< 0.0001

The constant term is extremely small and its t-statistic is less than two, hence statistically insignificant. Therefore the author drops the constant term and estimated a model without one:

$$DLADH_t = \mu_{t-1} + \beta(DLADA_t)$$

The result is as in Table 7:

Table 7: Error Correction Model without Constant Term

Variable	Coefficient	Std. Error	t-Statistic	Probability
μ_{t-1}	< -0.0001	< 0.0001	-2.4108	0.0163
β	0.8344	0.0476	17.5316	< 0.0001

The error correction model can be rewritten as

$$\Delta Log(ADH_t) = \alpha_1 ecm_{t-1} + \alpha_2 \Delta Log(ADA_t) + \xi_t$$

Where Δ is the firt difference oprator, $ecm_{t-1}$is the one-period lagged value of the error the regression

$$ADH_t = \alpha + \beta(ADA_t) + \mu_t$$

andξ_t is error term. In the error correction model, α_1 can be interpreted as the estimates of the speed of return to long term trend after a deviation. $\alpha_2$is the estimates of the short run effect of any change in ADA on ADH. Substituting the output values into the error correction model, it becomes

$$\Delta Log(ADH_t) = -0.0000144(ecm_{t-1}) + 0.834[\Delta Log(ADA_t)] + \xi_t$$
$$(-2.411) \qquad\qquad (17.532)$$

From the error correction model equation, the value of ADH depends on ADA and the equilibrium error term. If the equilibrium error term is not zero, the model is out of equilibrium. The negative sign of ecm_{t-1} suggests that, if ADH_t is above its equilibrium value, it will decrease in the next period to restore to long term equilibrium. The absolute value of α_1 determines how quickly the model return to long term equilibrium.

6. Conclusion

This paper attempts to find out the long term relationship between the prices of shares of Chinese companies traded both as A-share and H-share. First, test of stationarity prepares data series for further analysis. After verifying the stationarity of the data series derived by take natural log and first difference, Johansen Test of cointegraion is used. It is shown that, during the data period, the A-share index and H-share index shows long term convergence. The relationship between the two indexes can be described by an error correction model.

Earlier in this paper, an extreme case of segregation of two markets in which the same asset is traded (the Tzarist bond) when channel of arbitrage is virtually absent due to onset of World War I. The price of this bond is substantially different in London and Paris. It is especially the case when we compare it with the price differential of crude oil future in New York and London, Stocks traded in Hong Kong Stock Exchange their ADR counterparts in New York Stock Exchange. The case of the share prices of companies listed both as A-share and H-share is in the midway. While there is no complete freedom for investors to access the two markets simultaneously, arrangements such as QDII and QFII do provide channel of arbitrage to some extent. Convergence of the two indexes should not be a surprise.

More interesting is the fact that, while A-share and H-share indexes show long term convergence, prices of A-shares persistently shows premium over their H-share counterparts. Some authors point out that this premium, while usually positive, is very volatile, partly due to volatility in A-share markets. Given the current institutional restriction on China capital market and foreign exchange control, the presence of A-share premium would imply a substantial wealth effect if the obstacles of arbitrage are suddenly lifted. The change in nominal wealth due to change in share prices in the two market could be destabilizing both for the economy and the society of China and Hong Kong.

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