



## Trading imbalances and the law of one price

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### ABSTRACT

We study trading and prices of Chinese (mainland)/Hong Kong dual-listed shares. Relative prices can diverge by a factor of two and exhibit significant variation over time. Order imbalances explain contemporaneous changes in relative prices at daily and weekly frequencies.

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### 1. Introduction

This paper studies trading and prices associated with a special type of dual-listed shares. We focus on Chinese (mainland) firms that list shares on one of the two mainland exchanges and, simultaneously, on the Hong Kong Stock Exchange. The well-publicized “AH Premium Index” tracks price disparities across the two exchanges and shows significant variation over time. At times, prices in the mainland are *double* those in Hong Kong.

Studying Chinese firms offers a number of advantages. First, the AH Premium Index is published each day by Hang Seng Indexes Company Ltd. and is featured in financial news reports (“A” and “H” denote shares listed in the mainland and Hong Kong respectively). Second, the two types of shares studied have the same dividend and voting rights. Third, the mainland and Hong Kong exchanges are in the same time zone, have similar operating hours, and have similar holidays. As Hong Kong is now part of the PRC, legal systems are converging. Fourth, many investors can trade both types of shares. Fifth, the shares are not fungible and trade only on the exchange where they are listed.

The main contribution of this paper is to link order imbalances with *changes* in relative prices (i.e., changes in the AH Premium Index).<sup>1</sup> For each stock, each week, and each exchange (type of shares), we calculate order imbalances as buyer-initiated minus

seller-initiated trades. We then show that the difference between aggregate order imbalances across exchanges is significantly related to changes in the AH Premium Index. When investors buy in the mainland (Hong Kong), the relative prices of A (H) shares rise. When investors sell, the relative prices fall on the respective exchange.

In a frictionless world, prices should be the same across exchanges. If there are constant frictions, such as a tax on one exchange, one expects price disparities to be constant over time. Alternatively, constant frictions could lead prices to trade within a narrow “no arbitrage band”. None of these possibilities apply to our study. The AH Premium Index is very volatile and has a 5.31% standard deviation of log-changes *per week*. This high level of volatility is surprising, since the index compares prices of share pairs issued by *the same set of companies*.

In the case of A-shares and H-shares, one system (the mainland) prohibits short sales. This “friction” prevents arbitrage against overvaluation of A-shares and provides a mechanism for order imbalances to be correlated with changes in relative prices. When investors buy heavily in the mainland, arbitrageurs cannot short A-shares (while buying H-shares to hedge). Thus, the AH Premium Index can rise above parity.

The short-sale ban in only one market leads to an asymmetric behavior of the AH Premium Index. When investors buy heavily in Hong Kong, arbitrageurs are able to short most H-shares and buy A-shares to hedge. Thus, prices in Hong Kong should not rise too

and currency fluctuations. Froot and Ramadorai (2008) use portfolio flows to study close-end funds. Mei et al. (2009) study a related set of price disparities amongst Chinese (mainland) A-shares and B-shares.

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<sup>1</sup> Published papers such as Froot and Dabora (1999) and De Jong et al. (2009) study dual-listed companies and seek to explain price disparities with traded factors

far above those in the mainland (the price difference will depend on the size of the no-arbitrage band mentioned earlier). We show that after May 2006, prices in Hong Kong are above those in the mainland for only 3.2% of the weeks in our sample. At most, Hong Kong share prices trade +3.8% above their mainland counterparts, while mainland shares trade +108.1% higher in January 2008 (i.e., more than double).

This paper proceeds as follows. Section 2 describes the data and provides overview statistics. Section 3 presents the paper's main regression results. Section 4 concludes and briefly outlines directions for future research. An associated Internet Appendix provides additional information and daily results (see: <http://dl.dropbox.com/u/6555606/AHindexInternetAppendix.pdf>).

**2. Data**

Our weekly data begin 03-Jan-2006 and end 30-Apr-2009, for a total of 173 weeks. Weeks are defined from Wednesday to Wednesday (close of market).

*Stock Market Data.* We obtain stock prices, returns, trading volumes, and exchange rates from Datastream. All monetary values are converted to United States dollars (USD), because Chinese mainland-listed A-shares are quoted in renminbi (RMB) and Hong Kong-listed H-shares are quoted in Hong Kong dollars (HKD). The numbers of tradable shares ( $Shrs_{i,t}^A$  and  $Shrs_{i,t}^H$ ) on both exchanges are obtained from the Hang Seng Indexes Company Ltd.

*AH premium index.* The Hang Seng Indexes Company produces an index of price disparity between companies' A-share and H-share prices.<sup>2</sup> The index formula is:

$$AH\ Index_t = \frac{Value\ of\ stocks\ based\ on\ A\ -\ share\ prices}{Value\ of\ stocks\ based\ on\ H\ -\ share\ prices} \times 100$$

$$= \frac{\sum_i [(Shrs_{i,t}^A + Shrs_{i,t}^H) \times P_{i,t}^A]}{\sum_i [(Shrs_{i,t}^A + Shrs_{i,t}^H) \times P_{i,t}^H]} \times 100. \tag{1}$$

Weekly prices, converted to USD, are  $P_{i,t}^A$  and  $P_{i,t}^H$  in the Chinese mainland and in Hong Kong, respectively. Hang Seng launched the index on 27-Jun-2007 but provides data back to 03-Jan-2006. As of 30-Apr-2009, the AH Index contains stock pairs of 42 companies.

Fig. 1 shows the published index's history. On average over our sample period, A-share prices are 32.74% above H-share prices, as indicated by the 132.74 average value. The index is highly volatile with a 26.23 standard deviation. For 10% of the weeks in our sample, the index is below 96.60 and for another 10% of the weeks it is above 165.38.

$$\Delta AH\ Index_t = \ln \left( \frac{AH\ Index_t}{AH\ Index_{t-1}} \right). \tag{2}$$

Eq. (2) defines  $\Delta AH\ Index_t$  as the log change of the AH Premium Index. The average weekly value of  $\Delta AH\ Index_t$  is 0.25%, matching the upward drift in Fig. 1. More importantly, the volatility of  $\Delta AH\ Index_t$  is 5.31% per week. In a frictionless world, one would expect  $\Delta AH\ Index_t$  to be zero over all time periods.

*Stock-Level Differences in AH Premia.* Although this paper focuses on the (aggregate) AH Premium Index, we note there exist stock-level differences in AH premia. Briefly, a stock pair's AH premium



**Fig. 1.** The figure depicts the AH Premium Index. The index is published by the Hang Seng Indexes Company Ltd. and shows the price ratio of Chinese mainland-listed A-shares to Hong Kong-listed H-shares. An index value of 100 indicates price parity. Data are weekly starting 03-Jan-2006 and ending 30-Apr-2009.

**Table 1**  
Correlations of index-level changes ( $\Delta AH\ Index_t$ ), order imbalances ( $OIB_t^{A-H}$ ), and lags of each. P-values are shown in parentheses.

	$\Delta AH\ Index_t$	$\Delta AH\ Index_{t-1}$	$OIB_t^{A-H}$	$OIB_{t-1}^{A-H}$
$\Delta AH\ Index_t$	1.000			
(p-value)	–			
$\Delta AH\ Index_{t-1}$	–0.106	1.000		
(p-value)	(0.17)	–		
$OIB_t^{A-H}$	0.367	–0.134	1.000	
(p-value)	(0.00)	(0.08)	–	
$OIB_{t-1}^{A-H}$	0.058	0.367	0.180	1.000
(p-value)	(0.45)	(0.00)	(0.02)	–

is inversely related to its market capitalization. On average, small stocks have larger and more volatile price differences. Likewise, companies with more volatile A-share prices are more likely to have larger AH premia. In the time series dimension, the cross-sectional variation of stock-level AH premia has grown over time, as small companies have been included in the index. Our Internet Appendices E, H7, H8, and H9 provide additional stock-level results.

*Order Imbalance Data.* Order imbalance data come from the Thomson–Reuters Tick History (TRTH) database, which contains trades and quotes for stocks listed around the world. For the 42 stock pairs in the AH Premium Index, and during our 2006 to 2009 sample period, the TRTH database contains over 556 million trades of A-shares and over 61 million trades of H-shares.

To calculate order imbalances we transform trading data using the following six steps: Step (1) for each stock  $i$ , each day  $k$ , and each exchange, we compute the buyer-initiated volume and seller-initiated volume. Step (2) For a mainland-listed stock, order imbalances are  $OIB_{i,k}^A = (Buy_{i,k}^A - Sell_{i,k}^A) / Shrs_{i,t}^A$  and are winsorized at the 0.5% and 99.5% levels. A similar calculation is done for each Hong Kong-listed stock. Step (3) For each day and exchange, we calculate a value-weighted order imbalance measure. Weights are proportional to stock  $i$ 's market capitalization on day  $k-11$ . Step (4) We standardize the daily exchange-level order imbalances by subtracting the average daily order imbalance over days  $k-11$  to  $k-70$  and dividing by the standard deviation of order imbalances over the same interval. Step (5) Weekly order imbalances are the sum of daily  $OIB$  in week  $t$ . Step (6) Each week  $t$  we compute  $OIB_t^{A-H}$  as the difference between the mainland and Hong Kong order imbalances. This variable has a mean of  $-0.0863$  and a standard deviation of 3.8816.

*Correlations.* Table 1 shows correlations of  $\Delta AH\ Index_t$  and  $OIB_t^{A-H}$  as well as lags of each. The correlation of  $\Delta AH\ Index_t$  is 0.367 with  $OIB_t^{A-H}$  and 0.058 with  $OIB_{t-1}^{A-H}$ . The former is statistically

<sup>2</sup> See: <http://www.hsi.com.hk/HSI-Net/HSI-Net> for information about the index. Our Internet Appendix A gives a list of the companies' names, market capitalizations, and industries. Appendices B to D provide information about the AH Premium Index, including the number of constituents over time and notes on constructing the index. We are able to replicate the index using Hang Seng's methodology.

**Table 2**  
Regression analysis. The table shows the results from six regressions denoted Reg1 to Reg6. All variables are weekly.  $\Delta AH Index_t$  is the log change of the AH Premium Index.  $OIB_t^{A-H}$  is the difference in A-share and H-share order imbalances.  $T$ -statistics are based on Newey–West standard errors with four lags.  $\Delta AH Index_t = \alpha + \beta_1 OIB_t^{A-H} + \beta_2 OIB_{t-1}^{A-H} + \beta_3 \Delta AH Index_{t-1} + \varepsilon_t$ .

Coef	Units	Reg1	Reg2	Reg3	Reg4	Reg5	Reg6
$OIB_t^{A-H}$	× 10,000	50.021			50.238		48.446
( $t$ -stat)		(5.21)			(5.07)		(4.76)
$OIB_{t-1}^{A-H}$	× 10,000		7.851		−1.203	15.345	2.364
( $t$ -stat)			(0.88)		(−0.11)	(1.56)	(0.20)
$\Delta AH Index_{t-1}$	× 1			−0.106		−0.147	−0.065
( $t$ -stat)				(−1.47)		(−1.90)	(−0.86)
Const	× 1	0.0029	0.0025	0.0026	0.0028	0.0029	0.0030
( $t$ -stat)		(0.78)	(0.69)	(0.66)	(0.77)	(0.70)	(0.77)
Obs (# Wks)		172	172	171	172	171	171
$R^2$		0.13	0.00	0.01	0.13	0.02	0.14

significant at all conventional levels, while the latter is not.  $OIB_t^{A-H}$  is positively autocorrelated, with a 0.180 coefficient.

### 3. Empirical results

We use regression analysis to test relations between order imbalances and changes in the AH Premium Index:

$$\Delta AH Index_t = \alpha + \beta_1 OIB_t^{A-H} + \beta_2 OIB_{t-1}^{A-H} + \beta_3 \Delta AH Index_{t-1} + \varepsilon_t. \quad (3)$$

Table 2 presents the regression results. In Regression 1, we see that  $\Delta AH Index_t$  and  $OIB_t^{A-H}$  are highly correlated. The 5.21  $t$ -statistic is based on Newey–West standard errors with four lags.

We estimate the economic significance of the 50.021 coefficient in Regression 1. Because the reported value has been multiplied by 10,000, we multiply 0.0050021 by 3.8816, the standard deviation of  $OIB_t^{A-H}$ , to get a price impact of 1.94%. The result is economically significant. A one standard-deviation shock to order imbalance difference is associated with a 1.94% change in the index at a weekly frequency. Regressions 2 to 6 include lagged order imbalances and lagged index changes as explanatory variables. Neither variable is statistically significant at the 5%-level.

To summarize: the difference in order imbalances across exchanges,  $OIB_t^{A-H}$ , is highly correlated with changes in relative prices,  $\Delta AH Index_t$ . Internet Appendix H6 shows the same relations hold at a daily frequency.

### 4. Conclusions and directions for future research

This paper studies trading and prices associated with a special type of dual-listed shares. The AH Premium Index tracks equity prices of Chinese companies that have shares listed in the mainland (“A” shares) and Hong Kong (“H” shares). The index varies significantly over time.

We show that the difference in order imbalances across the two exchanges is economically and statistically related to changes in the AH Premium Index. When investors in the mainland buy (sell) shares, the index rises (falls). A similar, but opposite, effects happen when Hong Kong investors buy and sell. This paper shows that a one standard deviation change in order imbalance difference is associated with a 1.94% change in the AH Premium Index (at a weekly frequency!) Regression analysis produces coefficients with  $t$ -statistics of 4.76 and greater.

Our results have implications for future studies of trading and asset prices. Thinking about the supply-side of liquidity, both the mainland and Hong Kong exchanges may experience frictions such as limited risk-bearing capacity. As in Grossman and Miller (1988), risk sharing may not be immediate, resulting in a positive correlation between order imbalances and price changes

(or changes in relative prices). Hendershott and Seasholes (2007) provide evidence of liquidity supplier effects on the New York Stock Exchange (NYSE).

On the demand side of liquidity, there are two avenues that might provide insights into our findings. First, wealth shocks in one country may cause certain investors to trade on the local exchange. Some investors may receive paychecks at the end of the month and want to invest the money. Index funds may receive inflows or redemptions. Cohorts of investors may need to send children to college. These correlated demand shocks (from investors on a given exchange) may explain changes to the AH Premium Index.

Second, investors in one country may be hit with “broad waves of [positive] investor sentiment” that cause them to push up the prices of stocks on the local exchange—see Baker and Wurgler (2007). However, not all sentiment waves are consistent with our results. A positive, market-wide sentiment shock (say in the mainland) would cause all investors to want to buy. But all investors cannot be buyers at the same time on the same exchange. In such cases, prices may rise, but turnover should be low. Counterfactually, both exchanges experience high turnover. Thus, a sentiment wave should move the AH Index and induce trading if it hits only a subset of investors in a given market.

We suggest future research focus on whether sentiment drives order imbalances. Or, whether there are macro-economic factors that generate the desire to trade within a given population.

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### Appendix. Supplementary data

Supplementary material related to this article can be found online at doi:10.1016/j.econlet.2011.03.017.

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