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Choice of Information Learning: Evidence from Revisiting Price Discovery during the 2006 Dual Listing Craze in China

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Abstract

Extant studies have proposed information choice models to explain the home bias puzzle. In this paper, we explore information asymmetries among local and non-local investors which are captured by market microstructure variables to explain the repercussions of their information choices. We examine the short-run price dynamics, co-integrating relations, and price discovery processes of cross-listed Chinese firms. Using high-frequency data over the year 2006 of dual listing craze in history, we find that the local A-share market contributes to the price discovery for 68% to 75% of the firms, which is far more than the contribution of the non-local H-share market. Our results support the learning choice model and suggest that local Chinese investors may be endowed with a small home information advantage and their learning choices magnify information asymmetry. As such, the local stock market incorporates new information faster and contributes more to the price discovery of dual-listed firms in mainland China.

Keywords

Learning Choice, Home Bias, Price Discovery, Asymmetric Information

1. Introduction

Why do investors overinvest in domestic stocks? Researchers extensively study the determinants of home bias, including turnover (Tesar & Werner, 1995), transaction costs (Glassman & Riddick, 2001), corporate governance (Dahlquist et al., 2003), information costs (Ahearne et al., 2004), and the real exchange rate risks (Fidora et al., 2007) of foreign assets versus those of domestic assets[1]. Recently, Nieuwerburgh & Veldkamp (2009) use an information choice model to show that learning choice is one factor that causes home bias. In this paper, we apply the information share model of Hasbrouck (1995) to explore how information is incorporated into the prices of dual-listed firms. An overinvestment in domestic stocks, which is characterized by a high percentage of domestic assets over the total market capitalization, suggests that investors may have forgone the potential benefits of international diversification. Even after taking transaction costs into account, Li et al. (2003) show that the diversification benefit is substantial. The evidence against an international portfolio theory creates the home bias puzzle. Is this bias a result of a concentrated ownership structure? Most companies in emerging markets are family-owned or closely-held, and controlling shareholders may enjoy the significant private benefits of control and may be reluctant to sell their shares; however, Dahlquist et al. (2003) use a world float portfolio to adjust for concentrated ownership structures, and they show that a home bias still prevails.

Prior studies argue that home bias could be caused by a prior information advantage. A counter-argument to this explanation is that information asymmetry and, consequently, home bias could be eliminated when investors can learn (Nieuwerburgh & Veldkamp, 2009). However, in some countries, such as China, citizens can only invest in their own country's stock markets, and only after 2006 have channels been created to allow them to invest overseas. Restrictions that Chinese investors face in their local stock market lower their opportunity costs for acquiring costly information of local firms that are listed on China's stock markets. This creates a comparative advantage for Chinese investors in obtaining information about local firms, which amplifies the information asymmetry. Chinese mainland investors have no learning choice, in contrast to non-local investors outside mainland China, who possess an abundance of learning choices. Because information learning is costly, it is plausible that non-local investors would choose to free-ride on local investors' information about Chinese stocks (and profit in non-local stock markets) because of 1) the non-local investors' initial information disadvantage and 2) the magnification of the repercussions of this comparative information disadvantage by local institutional features[2]. As Nieuwerburgh and Veldkamp (2009) suggest, home investors are more likely to have a higher learning index in comparison to non-local investors. Therefore, Chinese investors who are investing in local stock markets should learn more than non-local investors in non-local stock markets for dual-listed firms, thus amplifying the Chinese investors' information advantage. We, therefore, expect that the price discovery, which we investigate via the information share model, should primarily be driven by the local stock markets.

[1]See Demirgüç-Kunt and Huizinga (1995), Noronha et al. (1996), and follow-up studies on approaching the home bias puzzle.

[2]Our argument also alludes to the ramifications of information market creation, as modeled by Veldkamp (2006).

This paper explores the process of how information is incorporated into prices for each pair of 17 firms that has one legal entity traded in the A-share market of the Shanghai Stock Exchange (SSE) and the other traded in the H-share market of the Hong Kong Stock Exchange (HKEx) during the 2006 craze of dual listing. By employing the information share model (Hasbrouck, 1995), we find that, in both statistical and economic terms, the A-shares of SSE firms play a more dominant role in the price discovery than the H-shares of the Hong Kong market. The A-shares contribute 68% to 75% of the price discovery, whereas the H-shares of HKEx firms contributed only 2% to 11%. Our findings support the learning choice hypothesis (Nieuwerburgh & Veldkamp, 2009) in that home investors, on average, choose to learn more about and buy more home assets, whereas non-local investors restrain from competing in the information market. As such, mainland stock markets incorporate new information faster and markedly contribute to price discovery. We find consistent results for each month of the year in our sample, which suggests that our major result is not driven by a seasonality effect, such as the January effect.

The local market dominance of price discovery may be due to infrequent trading of stocks or differences in trading mechanisms. This unique setup of A-H stock markets enables us to analyze local and non-local investors while controlling for firm fundamentals and microstructure differences. Our findings of the dominance of the local market in the contribution of price discovery cannot be driven by non-synchronous trading as the trade size and turnover in both markets are similar. Also, the local market dominance is not driven by the heterogeneity of trading mechanisms because both exchanges are pure order-driven markets.

The novelty of this paper is twofold. One contribution is that we show that the local market dominates the price discovery process in 2006 during China's stock market boom period. We examine several explanations for the home bias puzzle during the period from January 2006 to December 2006, when China's stock market experienced a dramatic price appreciation. First, this boom period would serve as a natural field experiment setting for understanding the investors learning choices. Second, we describe how quickly information flows between different markets during this boom period. Third, our results show that the home investors move first, and their behavior influences the non-local investors. Our findings not only help with explaining the home bias puzzle but also have important implications for portfolio diversifications among A and H shares. This information-based model helps to enhance the understanding of the phenomenon and loosen the international capital flow constraints. The investors could learn both domestic and non-local information. The non-domestic inventors could learn information from home investors as well.

The other novelty of our paper lies in explaining the home bias puzzle by investigating learning choice in two of the largest order-driven emerging markets with dual-listed firms. We contribute to the price discovery and the learning choice literature as follows. First, we are among the first to investigate the price discovery from the historical and theoretical perspective in two of the largest order-driven emerging markets with dual-listed firms. Second, our analysis of the A- and H-share markets demonstrates that local investors dominate the price discovery of these dual-listed firms. Third, we provide direct evidence of the ability of local investors in exploiting local information by measuring their contribution to price discovery while previous studies focus on their portfolio returns. Fourth, we uncover the unobservable learning choice of investors through price discovery. Our results describe how quickly information could flow from the local market to the non-local market, and how trading behaviors of local investors causally affect non-local investors. Hence, the home bias can be explained by learning choice.

The rest of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the institutional background and data. Section 4 explains the empirical framework. Our results are presented in Section 5. Section 6 concludes the paper.

2. Price Discovery and Information Choice

Home bias models are based on international capital flow constraints when this strand of literature initiates. But, as the capital flow constraints decrease among countries, the home bias persists, thus information-based models are used to explain the phenomenon. These models usually assume that information is not flowing freely across markets; hence, investors may choose to learn only information about their own country's stocks. Nieuwerburgh and Veldkamp (2009) develop an information choice model to predict how investors choose to learn about domestic and non-local information. They demonstrate that home investors optimally choose to learn domestic information even if they can learn non-local information. This is because home investors have a comparative advantage in collecting domestic information. If two different investors have their initial information advantage, the information asymmetry between the local investor and the non-local investor would be further magnified because of the comparative advantage of the former in collecting information. If the information share of domestic shareholders is substantially higher than that of non-local investors, the non-local investors will choose not to learn the domestic information; therefore, our results would support this learning choice model.

However, international finance theories provide inconclusive evidence of why individuals tilt their portfolios toward local stocks. Grinblatt and Keloharju (2000) show that foreign investors in these markets can earn abnormal profits and seem to be more informed. Recently, Seasholes and Zhu (2010) find that local investors do not generate abnormal returns, therefore implying that there is no information advantage for domestic investors when they trade. Ivković and Weisbenner (2005) find that individual households can exploit locally available, non-public information to earn excess returns. Massa and Simonov (2006) document evidence that investors tilt their portfolio towards stocks that are most closely related to them including local stocks and conclude that information is driving these decisions. During our sample period (January 2006 to December 2006), because of Mainland China's capital flow restrictions, local investors in China could not invest in the H-share market traded at the HKEx. According to the temporary regulations on Chinese domestic investment during that period, only a few large foreign financial institutions were able to invest in China through the Qualified Foreign Institutional Investor program. During this period, foreign investors could invest in H-shares freely. Therefore, if foreign institutions are better informed, we should observe an even distribution of the information shared between the two markets.

Many studies investigate cross-border listings and price discovery in U.S. equity markets, such as Hasbrouck (1995), Smith and Sofianos (1997), and Eun and Sabherwal (2003), Stoll and Whaley (1990) and Chan (1992) examine the causal relationships between financial markets to analyze price discovery[3]. The price discovery of cross-border listings has yet to be fully explored, however, because of differences in the institutional settings of exchanges in various regions, such as the trading hours, exchange rate differentials, transaction costs, and price limits of individual markets. Examining cross-border listed companies in the Hong Kong and mainland stock markets mitigates most of the above differences. While many researchers study causal relations and price discovery processes in developed markets, such as the New York Stock Exchange (NYSE), relatively few studies are devoted to emerging markets. Chui and Kwok (1998) and Chan et al. (2008) both examine the correlation between the local A-share and foreign B-share markets. Wong et al. (2009) study the informed trading and liquidity in the SSE. The unique institutional setting in Chinese stock markets—A-share, B-share, and H-share markets—provides a natural setting to research the price information for single security with several prices[4]. In particular, we focus on Chinese A-share and H-share markets because the B-share market has a particularly low liquidity relative to its A- and H-share counterparts.

3. Sample Data and Institutional Background

At the sample period year of 2006, there were 1,421 and 1,165 firms traded in the A-share and H-share market, respectively. Our sample comprises 17 A-H dual-listed state-owned enterprises (SOEs) that maintain close and strong relationships to the Chinese government. Although they only account for 1% of total firm number in each market, these 17 large-cap stocks match the requirement made by Nieuwerburgh and Veldkamp (2009) in their theoretical model that local investors are endowed with an initial information advantage. Since SOEs operations are mainly in China, we expect that local Chinese investors may have an

[3]Mech (1993) and Hameed (1997) argue that stock price information on the reaction rate difference is the fundamental reason for the lead-lag relationships.

[4]A-, B-, and H-shares are three types of shares that are issued by Chinese firms. Trading A-shares is restricted to domestic investors. B-shares can only be traded by foreign investors in February 2001. Offshore stocks that are listed and traded in the HKEx but issued by companies that operate and have headquarters in mainland China are H-shares.

information advantage over foreign investors. The high-frequency data that are used in this study are obtained from two sources. The high-frequency transactions prices, transaction volumes, and quotes of A-share firms are obtained from the CSMAR high-frequency database, which contains all of the stock trades and quote updates for each trading day, sorted by symbol and stamp time. We directly obtained the intra-day trade and quote records of China H-shares from the HKEx. The trade record is a collection of data files that contain intra-day trade information recorded by the exchange. The quote record is a collection of data files that contain intra-day quote information for both the bid and ask sides of the market recorded by the exchange.

There are two unique advantages of studying dual-listed firms in mainland China and Hong Kong. First, both types of shares are substantially traded in their markets, and they have a long period of simultaneous trading hours[5]. Second, both Hong Kong's and China's stock markets are order-driven markets, i.e., markets without designated market makers to provide liquidity. This enables us to compare our results with previous studies from specialist markets, such as the NYSE. This also creates a unique opportunity to investigate the short-run price dynamics, co-integrating relations, and price discovery processes of cross-listed firms based on Hasbrouck's (1995) information share theory.

The sample period that is considered here ranges from January 1st, 2006 to December 31st, 2006. To avoid the infrequent trading problem and non-synchronous trading problems, we included firms in the Hang Seng China AH Premium Index, which includes the largest and most liquid Mainland China companies with both A- and H-share listings[6]. This Premium Index comprises firms that have A-shares that are listed on the SSE or the Shenzhen Stock Exchange (SZSE) and H-shares that are listed on the Main Board of the HKEx[7]. In December 2006, 24 companies were listed on the Premium Index. Because of additions and deletions in the Premium Index of constituent stocks, our final sample consists of 17 firm pairs that are listed on both SSE/SZSE and the HKEx. The reason we choose the year 2006 is because of two historical events. First, the Industrial and Commercial Bank of China had by that time the largest initial public offering on the above-mentioned two exchanges in 2006, which created a craze for speculation on dual listing. Second, the AH Premium Index can be backdated to January 2006 and its official launch date is July 9th, 2007. As a result, the information

[5]These are two perfectly segmented markets, yet their pricing schemes would be different, as indicated by the A-H share index premium, which indicates that the A-share prices, on average, have a significant premium over shares of the same stock that are listed on the Hong Kong H-share stock market; however, the two price series are co-integrated.

[6]See the selection criteria of the Hang Seng China AH Premium Index description in the Hang Seng Indices Company Limited, http://www.hsi.com.hk/HSI-Net/HSI-Net.

[7]The second board, Growth Enterprise Market, does not require growth companies to have achieved a record of profitability as a condition of listing. The future performance of growth companies particularly those without a profit track record are susceptible to great uncertainty. Because of the higher risks involved, GEM is designed for professional and informed investors. It works on the basis of *caveat emptor* or buyers beware. See the HKEx GEM website, http://www.hkgem.com/aboutgem/e_default.htm.

learning behaviors during the year 2006 are more market-oriented during this test running period. As our focus lies on informed investment decisions made by market participants, high-frequency transactions, which aim at exploiting mispricing across the A-shares and H-shares market in 2006 for the same underlying firm, provide a good laboratory to study our hypothesis of price discovery based on information learning.

Table 1 reports the summary statistics for the key variables we use in the subsequent analysis from January 1st, 2006 to December 31st, 2006. The A-H share premium index includes 17 firms, dual-listed on both SSE/SZSE and the HKEx in 2006, and there are a total of 2,156,373 transaction records for the two price series during this period.

4. Methodology

4.1. Forming the Synchronized Price Series for A- and H-Shares

While Hong Kong and mainland China are in the same time zone, the trading hours for the SSE/SZSE and HKEx are different. The SSE/SZSE have regular trading hours that range from 9:30 am to 11:30 am and from 1:00 pm to 3:00 pm, whereas the HKEx has trading hours of 10:00 am to 12:30 pm and 2:30 pm to 3:55 pm. Therefore, the common regular trading hours for both are 10:00 am to 11:30 am and 2:30 pm to 3:00 pm. We included only the transaction records for the trading hours between 10:05 am and 11:25 am in the morning session and between 2:35 pm and 2:55 pm in the afternoon session because these are the common trading hours. Stoll and Whaley (1990) argue that the opening transaction in higher volume stocks is likely to reflect an opening auction of trading. For this reason, Chan et al. (2008) delete the first and last 15 minutes in both the morning and afternoon sessions. Likewise, in our sample, we excluded the first and last 5 minutes in both the morning and afternoon sessions and paired the remaining trades in the common trading hours (10:05 am to 11:25 am in the morning session and 2:35 pm to 2:55 pm in the afternoon session). For each stock, we form the two price series using the minimal span procedure, as described in Harris (1995). That is, we form synchronous pairs of transaction prices for each stock sample between 10:05:00 and 11:25:00 and between 14:35:00 and 14:55:00. The advantage of this method is that it matches trades that are closest by time, which better represents the paired series than using a fixed time interval. We normalize the two price series for each firm in the same currency (RMB). We convert the Hong Kong dollar (HKD) to RMB.

The average exchange rate during the data sample period of 2006 for HKD to RMB is 0.96 to 1, according to the records of financial data from the Bank of China[8]. For our sample, there are a total of 1,449,222 trades for A-shares and 707,151 trades for H-shares, which add to a total of 2,156,373 trades. The final sample contains 17 pairs of A-share and H-share price series of dual-listed firms with 199 firm-month observations and 320,274 paired trades. Table 2 reports

[8]See http://www.bankofchina.com.

Table 1. Summary statistics.

Company Name	Stock Code		Daily Trades		Trade Size (1)	
	A-Share	H-Share	A-Share	H-Share	A-Share	H-Share
HUANENG POWER	CH600011	HK902	1161	745	11,101	33,101
ANHUI EXPRESS WAY	CH600012	HK995	855	123	8577	17,587
CHINA SHIP DEV	CH600026	HK1138	1580	490	10,330	21,028
HUADIAN POWER	CH600027	HK1071	1223	309	11,215	27,833
SINOPEC CORP	CH600028	HK386	1817	2097	26,765	57,518
CHINA SOUTH AIR	CH600029	HK1055	1392	458	20,183	22,797
YANZHOU COAL	CH600188	HK1171	1349	840	8898	29,147
GUANGZHOU PHAR	CH600332	HK874	657	55	4004	18,039
JIANGXI COPPER	CH600362	HK358	1613	1800	7640	17,682
JIANGSU EXPRESS	CH600377	HK177	661	351	4855	22,762
SHENZHEN EXPRESS	CH600548	HK548	639	171	7914	20,139
ANHUI CONCH	CH600585	HK914	515	237	5132	10,038
TSINGTAO BREW	CH600600	HK168	967	146	5495	8278
GUANGZHOU SHIP	CH600685	HK317	1111	169	5324	11,588
MAANSHAN IRON	CH600808	HK323	1330	888	15,637	35,519
TIANJIN CAPITAL	CH600874	HK1065	870	141	5255	20,783
DONGFANG ELEC	CH600875	HK1072	741	204	2697	7883
Total			18,481	9224	161,022	381,722

	Trade Size (2)		Daily Volume		Daily Turnover	
	A-Share	H-Share	A-Share	H-Share	A-Share	H-Share
HUANENG POWER	74,057	183,827	12,887,995	24,669,440	85,976,285	137,000,606
ANHUI EXPRESS WAY	47,089	92,510	7,336,428	2,161,869	40,278,514	11,372,047
CHINA SHIP DEV	80,384	141,835	16,318,731	10,305,395	126,981,993	69,510,583
HUADIAN POWER	39,293	64,216	13,711,005	8,605,301	48,037,659	19,853,951
SINOPEC CORP	232,763	283,055	48,643,641	120602168	423,029,267	593,504,453
CHINA SOUTH AIR	65,634	55,489	28,089,812	10429999	91,347,077	25,387,203
YANZHOU COAL	59,554	171,630	12,004,926	24,472,030	80,351,396	144,099,680
GUANGZHOU PHAR	34,462	78,733	2,629,342	992,064	22,631,628	4,329,969
JIANGXI COPPER	103,180	120,987	12,322,205	31,818,811	166,411,741	217,717,411
JIANGSU EXPRESS	32,728	106,065	3,210,711	7,996,026	21,641,198	37,259,233
SHENZHEN EXPRESS	33,386	71,280	5,058,557	3,451,703	21,339,424	12,217,235
ANHUI CONCH	80,771	144,690	2,643,166	2,374,980	41,600,353	34,233,228

Continued

TSINGTAO BREW	64,158	82,677	5,313,471	1,212,256	62,040,289	12,107,970
GUANGZHOU SHIP	50,366	66,433	5,917,384	1,957,423	55,977,250	11,221,781
MAANSHAN IRON	60,920	103,349	20,802,509	31,532,233	81,044,323	91,748,566
TIANJIN CAPITAL	25,284	43,005	4,572,216	2,934,626	21,999,508	6,072,604
DONGFANG ELEC	52,479	105,338	1,997,587	1,609,641	38,868,468	21,508,082
Total	1,136,508	1,915,119	203,459,686	287,125,965	1,429,556,373	1,449,144,602

Note: This table reports the summary statistics of each A-share and H-share pair of our sample firms from January 1st, 2006 to December 31st, 2006. There are 17 pairs of firms that are listed on both the SSE/SZSE and the HKEx during 2006. "Daily Trades" corresponds to the average number of trades in each day of 2006, which is equal to the total number of trades/number of trading days. "Trade Size (1)" corresponds to the trade size as measured by the number of shares and is equal to the average number of shares in each trade. "Trade Size (2)" corresponds to the trade size as measured by the turnover and is equal to the average turnover of each trade. "Daily Volume" equals the average number of shares that are traded each day. "Daily Turnover" equals the average turnover that is traded in each day.

Table 2. Co-integration test of the A- and H-shares.

Month	Lags	Tau	5% Sig.
Jan.	1	−2.7865	6/17
Feb.	1	−2.9029	7/17
Mar.	1	−2.7380	5/15
Apr.	1	−3.1376	8/17
May	1	−1.9400	0/17
Jun.	1	−2.8518	7/17
Jul.	1	−2.0763	5/16
Aug.	1	−2.5582	7/17
Sep.	1	−2.6453	6/17
Oct.	1	−2.4419	5/16
Nov.	1	−2.4975	4/16
Dec.	1	−2.6235	6/17
		−2.6000	66/199

Note: This table reports the results of the co-integration tests of the A-share and H-share price series from January 1st, 2006 to December 31st, 2006. We follow Chan et al. (2007) in testing co-integration by testing the stationarity of the price differential across the A-share and H-share prices for a stock *j* in period *t*. We use an augmented Dickey and Fuller (1981) unit root test and the Dickey et al. (1984) limiting distribution for seasonal unit roots. The 5% left tail critical value of the unit root null hypothesis is −2.86. For each firm-month observation, we compute the cross-sectional average of the test statistics Tau, following Chan et al. (2008). A significant Tau implies that the prices are co-integrated. The last column presents the number of tests that are significant at the 5% level out of the 16 or 17 cross-listed pairs for the month under concern.

the results of the co-integration test of the A-share and H-share price series from January 1st, 2006 to December 31st, 2006. We follow Chan et al. (2007) in testing the co-integration by looking at the stationarity of the price differential across the A-share price ($P_{j,t}^{A}$) and the H-share price ($P_{j,t}^{H}$) for stock *j* in period *t*, which is denoted by $y_{j,t} = P_{j,t}^{A} - P_{j,t}^{H}$. We use an augmented Dickey and Fuller (1981) unit root test and the Dickey et al. (1984) limiting distribution for seasonal unit roots.

4.2. Information Share

In this section, we examine the short-term dynamics of the price series in each firm-month observation regarding the co-integrating relations of the A-share and H-share price pairs and the price discovery process using the Hasbrouck (1995) information share method. Hasbrouck (1995) breaks down the common factor variance, and new information in each market on the common factors contributes to the variance ratio to define the price discovery. The effective prices of A-shares and H-shares are facilitated by effective information that is obtained from the two markets, and fluctuations therein are a result of newly incorporated information. The newly incorporated information may arise from the existing A-share market, from the H-share market, or simultaneously from both markets. If it is simultaneously generated from the two markets, then the price discovery for assets of the two markets is a joint decision based on the information. When newly incorporated information of the market impacts the asset prices, the market prices of assets contribute to the price discovery. Hasbrouck (1995) identifies a positive and statistically significant correlation between the NYSE contribution to price discovery and its market share by trading volume by employing the information share model. He finds that the information share of the NYSE is around 92.7% and that the NYSE's contribution is significantly positively correlated with its trading volume market share in medium-size trades but not with shares in small or large trades. Our paper presents an econometric model of a firm that is listed in both the A-share and H-share markets.

We employ the information share model used by Hasbrouck (1995) as the measure of the relative contribution of the A-share price and the H-share price to the common price discovery process. Hasbrouck's starting point is that if a security trades in two different markets, then its prices in the two markets should be co-integrated. The shared information is a nonlinear function of the VAR coefficients and the disturbance covariance matrix. Accordingly, this study adopts Hasbrouck's (1995) route of addressing the issue of statistical significance by considering cross-sectional estimates of the information share and related measures. In our study, two price variables are closely related to single security transaction prices in A-share and H-share markets. Assume that there are n price variables that are closely related to a single security, such as transaction prices in n markets. These variables can be collected in a $(n \times 1)$ column vector

p_t. Each price series is assumed to be integrated of order 1; i.e., it contains a random walk component. The price changes are assumed to be covariance stationary. This implies that they may be expressed as the vector moving average:

$$\Delta p_t = \psi(L) e_t,$$

where e_t is a zero-mean vector of serially uncorrelated disturbances with a covariance matrix Ω, and ψ is a polynomial in the lag operator. Suppose that there exists a non-stationary autoregressive representation of order k for the price levels:

$$A(L) p_t = k + e_t \text{ and } A(L) = I - A_1 L - A_2 L - A_k L^k.$$

Then, according to the Granger Representation Theorem, there exists an error correction model (ECM) of the following form:

$$\Delta p_t = \alpha\left(\beta' p_{t-1} - E\beta' p_t\right) + \Gamma_1 \Delta p_{t-1} + \Gamma_2 \Delta p_{t-2} + \cdots + \Gamma_{k-1} \Delta p_{t-k+1} + e_t. \quad (1)$$

The correspondence between the ECM and the level VAR is given by

$$\alpha\beta' = -A(1) \text{ and } \Gamma_i = -\sum_{i=j+1}^{k} A_i \text{ for } j = 1, 2, \cdots, k-1.$$

The $E\beta' p_t$ term in equation (1) captures systematic differences in the prices. It enters into the model in a nonlinear way with other parameters including α.

$$p_t = p_0 + \psi\left(\sum_{s=1}^{t} e_s\right)\iota + \psi^*(L) e_t \quad (2)$$

The common trends representation of the model (2) contains a single random walk term that is common to all prices. The increment ψe_t is the component of the price change that is permanently impounded into the security price and is presumably caused by new information. The variance of this term is $\psi \Omega \psi'$. The proportion of this for market *j* relative to the total variance is defined as market *j*'s information share:

$$S_j = \frac{\psi_j^2 \Omega_{jj}}{\psi \Omega \psi'}.$$

For the n market prices given by the factor structure,

$$e_t = F z_t.$$

where z_t is an ($n \times 1$) vector of random variables with $E z_t = 0$ and $Var(z_t) = I$, and F is the Cholesky factorization of Ω. The market share of the innovation variance attributable to z_j may be computed as[9]

$$S_j = \frac{\left(\left[\psi^F\right]_j\right)^2}{\psi \Omega \psi'},$$

where $\left[\psi^F\right]_j$ is the j^{th} element of the row matrix ψ^F.

5. Empirical Results

The results of this paper can be summarized as follows. Both the A- and H-share

[9]See Hasbrouck (1995) for more details.

price series are non-stationary and co-integrated. In the multiple markets, A-shares contribute more in the intra-day price formation. This is consistent with the view of other studies (Demirgüç-Kunt & Huizinga, 1995; Noronha et al., 1996), which contend that segmented markets are less efficient, especially for non-local investors, because of the information transmission. Our result supports the theoretical prediction of Nieuwerburgh and Veldkamp (2009) that the home market may have superior access to information.

Table 1 reports summary statistics of major variables of each pair of AH-share firms from January 1st, 2006 to December 31st, 2006. There are 17 pairs of firms that are listed on both the SSE/SZSE and the HKEx during 2006. "Daily Trades" corresponds to the average number of trades each day of 2006, which is equal to the total number of trades/number of trading days. "Trade Size (1)" corresponds to the trade size as measured by the number of shares and is equal to the average number of shares in each trade. "Trade Size (2)" corresponds to the trade size as measured by the turnover and is equal to the average turnover of each trade. "Daily Volume" equals the average number of shares that are traded in each day. "Daily Turnover" equals the average turnover that is traded in each day.

5.1. The Co-Integration of Price Series Pairs

Table 2 reports the result of the co-integration test of the two price series. We follow Chan et al. (2007) in testing co-integration by testing the stationarity of the price differential across the A-share and H-share prices. We use an augmented Dickey and Fuller (1981) unit root test and the Dickey et al. (1984) limiting distribution with seasonal unit roots to account for seasonality. **Table 2** reports the number of co-integrated pairs that are significant at the 5% level out of the 17 cross-listed pairs for the month in question. We find that the price series of 133 pairs out of 199 are cointegrated. The result suggests that the two price series are cointegrated.

5.2. Price Discovery Analysis

The cross-sectional averages of the daily coefficients of the efficient price for each firm month are reported in **Table 3**. The common factor is the implicit efficient price of the security, and it is defined as the random walk component of the price from the markets, which is a measure of the information intensity of the efficient price process. The comparative analysis results in **Table 3** show that in each month the A-share always exhibits a one-order-of-magnitude higher coefficient for the common factor.

Information share estimates in each month are reported in **Table 4**. Means, medians, and standard deviations (across the day) are reported by month. The A-share price possesses by far, the dominant information share (greater than 70% of the mean and 97% of the median for all months) of the price discovery. The H-share price displays approximately a single-digit percentage. This supports our hypothesis that local investors dominate the price discovery process of

Table 3. Coefficients of efficient price (common index price factor).

Month	A-Share Price	H-Share Price
Jan.	0.8976	0.0361
Feb.	0.9214	0.0144
Mar.	0.8733	0.0779
Apr.	0.8943	0.0264
May	0.9179	0.0434
Jun.	0.9157	0.0189
Jul.	0.8804	0.0357
Aug.	0.8855	0.0687
Sep.	0.8627	0.0289
Oct.	0.8452	0.0646
Nov.	0.7751	0.0747
Dec.	0.8706	0.0427

Note: This table reports the means of the daily coefficients of the efficient price for each company. These statistics are based on a vector error correction model of A-share and H-share prices. We estimate the model on a daily basis from January 1st, 2006 to December 31st, 2006. The figures are averaged across firms for each month.

Table 4. Price-discovery information shares in AH shares.

Month		A-share	H-share	A-share	H-share
		Information Share Maximum	Information Share Maximum	Information Share Minimum	Information Share Minimum
Jan.	Mean	0.73	0.09	0.70	0.04
	Median	0.99	0.04	0.92	0.01
Feb.	Mean	0.75	0.06	0.72	0.02
	Median	0.99	0.04	0.95	0.01
Mar.	Mean	0.75	0.06	0.73	0.02
	Median	0.99	0.04	0.94	0.01
Apr.	Mean	0.71	0.10	0.69	0.07
	Median	0.97	0.04	0.92	0.01
May	Mean	0.74	0.08	0.70	0.02
	Median	0.99	0.03	0.94	0.01
Jun.	Mean	0.72	0.11	0.68	0.04
	Median	0.98	0.05	0.89	0.01
Jul.	Mean	0.74	0.10	0.69	0.02
	Median	0.99	0.05	0.91	0.01

Continued

Aug.	Mean	0.74	0.11	0.68	0.02
	Median	0.98	0.06	0.90	0.01
Sep.	Mean	0.73	0.09	0.69	0.03
	Median	0.98	0.05	0.90	0.01
Oct.	Mean	0.74	0.06	0.71	0.02
	Median	0.99	0.04	0.95	0.01
Nov.	Mean	0.73	0.07	0.70	0.03
	Median	0.99	0.04	0.93	0.01
Dec.	Mean	0.74	0.06	0.71	0.02
	Median	0.98	0.03	0.94	0.01

Note: This table reports the daily information share estimates in each month. These statistics are based on a firm's daily information share from Hasbrouck's (1995) vector error correction model with A-share and H-share prices. We estimated the model using intraday data from each trading day from January 1st, 2006 to December 31st, 2006. The means and medians are averaged over the month in question and then across all firms during the month.

domestic stocks. The monthly results are quite consistent, with only small changes over time, and all of the results demonstrate that A-shares dominate H-shares in the price discovery process. This is consistent with our hypothesis that non-local investors may deliberately choose not to obtain information about local Chinese companies and instead take a free ride on costly information acquisition by local investors. As such we observe the pattern of overinvestment in domestic stocks by local Chinese investors. Our results are also consistent with those of Qiao et al. (2008), who document that A-shares lead B-shares and that, in turn, B-shares lead H-shares.

5.3. Liquidity Implications

We next address the fundamental question: how is our price discovery result important to market liquidity? O'Hara (2003) mentions that liquidity and price discovery are related but are not the same. We are among the first to investigate the relation between a firm's information share and its market liquidity by comparing market liquidity in high and low information share subsamples. Following the literature on market liquidity (Hasbrouck, 2009; Goyenko et al., 2009), we employ three measures of market liquidity in **Table 5**: 1) the Amihud illiquidity ratio (Amihud, 2002), which is defined as the monthly average of the daily price change per dollar of the trading volume (all figures are multiplied by 106 for normalization (Amihud, 2002)); 2) the percentage of zero-return trading days (Lesmond et al., 1999); 3) the percentage of zero-return trading days with a positive volume (Lesmond et al., 1999). Information shares are computed following Hasbrouck (1995). **Table 5** reports the means of stock market liquidity

Table 5. Market liquidity and information share.

		Low Information Share Firms	High Information Share Firms	t-statistics
Amihud	Obs.	187	191	3.0766***
	Mean	0.0152	0.0086	
Zero-return days	Obs.	168	169	−7.8664***
	Mean	0.1759	0.3495	
Zero-return days with positive volume	Obs.	168	151	−5.5841***
	Mean	0.1759	0.2719	

Note: Significance at the 1% level is indicated by ***.

for firms in high and low information share subsamples from January to December 2006. For each month, a firm belongs to the high (low) information share group if its information share is higher (lower) than the cross-sectional median for the month in question.

Satterthwaite t-statistics with unequal variances are estimated and reported in the last column. We find strong evidence that firms with high information share are more liquid. The average Amihud ratio is significantly smaller for firms with higher information share (e.g., the corresponding t-statistic equals 3.077) , implying that, the price impact per dollar traded is lower. We find the average percent of zero-return days is significantly higher for firms with high information share. The result using the percentage of zero-return days with positive volume is also significant at 1%. Overall our results suggest that firms with higher information share have more liquid stocks.

6. Conclusion

This paper provides evidence that the local market (i.e., China's A-share market) dominates the non-local market (i.e., the Hong Kong H-share market) in price discovery processes of dual-listed firms in Mainland China. The results support the theory of Nieuwerburgh and Veldkamp (2009) that home bias can be explained by their learning choice model when there is a comparative advantage in the local investors' information collection. Our results also support the finding by Veldkamp (2006) about the existence of markets of information and suggest that it may be more cost-efficient for local investors to collect information for local firms. This creates a comparative advantage for Mainland Chinese investors in obtaining information about dual-listed firms and trading their A-shares, which later creates an even larger information asymmetry. The dominance of the information shared in the local market suggests that local investors may choose to learn more than non-local investors for dual-listed stocks, thus amplifying local investors' information advantage. Our results further reconcile the mixed findings in the literature by providing a more direct test—we examine different contributions of local and non-local investors to the price discovery process, after considering the differences in their portfolio returns. Our findings shed light on how markets aggregate information and may have important implications on portfolio diversification among A- and H-shares. Nevertheless, this paper may suffer from two drawbacks. For one thing, while this paper shows that home bias can be explained by the learning choice model, the information learning speed and proposition might be exaggerated. For another, we suggest that it may be more cost-efficient for local investors to collect local information in 2006 during China's stock market boom period. Such findings might be subject to sample limitations and specific institutional background. Hence, we recommend either introducing stock price overshooting or extending sample dimensions to facilitate future studies on similar topics.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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