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# The Information Transmission Effect and Asset Prices: Evidence from the China B-Share Discount

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*ABSTRACT:* We construct a model based on market microstructure and examine the information transmission effect of equity prices in A-share and B-share markets in China. The data on foreign share discounts raise a question: How are asset prices determined if uninformed foreign traders obtain signals by observing public information? Our investigation on the measure of the information transmission effect presents a substantial segment of the cross-sectional variation in B-share discounts and finds that the information transmission effect plays a critical role in explaining how foreign share discounts become more contractive.

*KEY WORDS:* information asymmetry, information transmission, asset pricing, market microstructure, stock market

## Introduction

According to traditional information asymmetry models, informed and uninformed trader behavior affects asset prices. We investigate the relationship between A-share and B-share stocks in China. The Chinese stock market was separated into two market segments; domestic traders could only trade A-share stocks, and foreign traders could only trade B-share stocks. Domestic and foreign shareholders are entitled to the same rights for the same stock. Many studies use information asymmetry to explain this phenomenon. Chakravarty et al. (1998) assert that information asymmetry plays a vital role between domestic traders and foreign traders for B-share discounts. Chan et al. (2008) propose that the proportion of informed domestic traders explains the B-share discount, and the effect of information asymmetry declines with an increased proportion of informed domestic traders. Other explanations for B-share discount also exist. Poon et al. (1998) propose that the B-share discount derives from B-share illiquidity and find less demand for B-shares when abnormal return on A-shares is more obvious. Chen and Xiong (2001) provide evidence on the considerable effect of illiquidity on the security market to explain this discount. Fernald and Rogers (2002) propose that the A-share and B-share price differences result from some discount factors for local traders and foreign traders possessing various risk exposures. Mei et al. (2009) explain the phenomenon using investor trading on speculative motives, in which a substantial fraction of the price difference exists between the A-share and the B-share.

We follow the literature on market microstructure and construct a model to measure the degree of information asymmetry under the information transmission situation. Our model provides an explicit framework for studying public information that can be used to analyze information transmission. To create information heterogeneity, we set up a model in which a fraction of the traders possess private and public information. The remaining traders (uninformed traders) only receive public information. Morris and Shin (2000) demonstrate that rational behavior is based on common knowledge of underlying fundamentals and on private belief. Price range is a measure of random variable volatility in statistics. Ozdenoren and Yuan (2008) propose an explanation for price multiplicity using an extreme volatility source and suggest that price movements are unrelated to fundamentals. A security market is efficient if security prices reflect all available public information. New information may cause a wider

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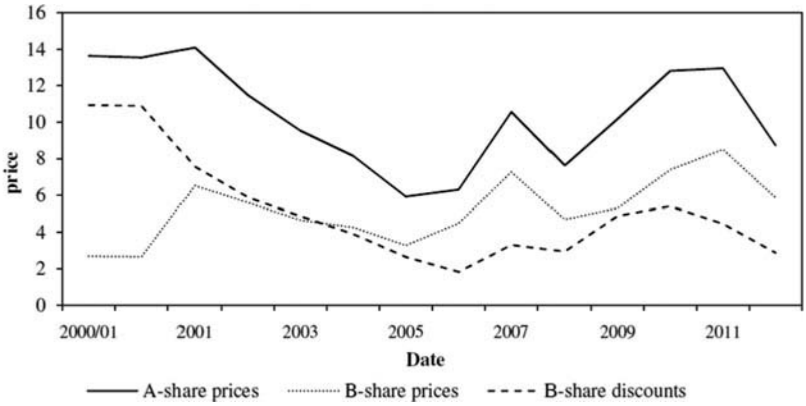


**Figure 1. Averages of A-share prices (solid line), B-share prices (dotted line), and B-share discounts (dashed line) of 59 firms in our sample data, from January 2000 to September 2012.**

price range because informed traders attempt to arbitrage quickly. Mandelbrot (1971) proposes that improved market anticipation could result from increasing price variance.

Although the B-share discount has existed in the A-share and B-share markets for a considerable time, it has become more contractive since 2001. Since the announcement of the Chinese Securities Regulatory Commission allowing Chinese residents to trade B-share stocks on the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE) beginning from June 2001, the A-share and B-share markets are not perfectly segmented markets in China. Figure 1 presents the averages of A-share prices, B-share prices, and B-share discounts from fifty-nine firms in our sample data from January 2000 through September 2012. The B-share discounts declined from an average of 53 percent to 33 percent according to these sample data from June 2001 through September 2012; however, the B-share discounts of certain stocks are no longer positive in the A-share and B-share markets. Some B-share prices are currently larger than A-share prices in China. We construct a model to allow uninformed foreign traders to deduce informed traders' private signals from public information. Grinblatt and Keloharju (2000) indicated that foreign investors possess better experience and knowledge in trading than domestic investors do. Zhu and Jiang (2012) also showed that foreign investors trade more aggressively than domestic investors do in China. Chou (2006) provided an efficient framework to analyze price movement by observing the upward and downward ranges of asset prices in the financial market. Therefore, we assume that when foreign traders observe a wide range in the B-share price on a given day, they suspect that informed traders might have received private stock information and coordinate their demand. For instance, a large upper shadow of the stock price on a given day conveys an expected decrease in future stock price. Similarly, a large lower shadow of the stock price on a given day conveys an expected increase in future stock price. On the contrary, if the highest price is close to the lowest price (i.e., the price range is small), it may reveal that the future asset return will not change drastically. Uninformed foreign traders also consider the B-share price when attempting to obtain information in the B-share market. Morris and Shin (2006) show that in a noisy rational equilibrium, one-dimensional price (public signal) reveals sufficient statistical information for uncertainty when noise decreases. Angeletos and Werning (2006) show that equilibrium price can be attained by uninformed investors by observing their counterparts' behavior including public information. This is why the B-share discount is becoming more contractive when we consider the B-share price and price range.

## Model of Information Asymmetry and Transmission

In this section, we construct a model of information asymmetry and transmission for the Chinese A-share and B-share markets. Our model is simple, showing the information asymmetry and transmission on the B-share discount. This model is based on Chan et al. (2008), who extend the Grossman and Stiglitz (1980) model to two separate markets, whereby domestic investors only trade in the A-share market and foreign investors only trade in the B-share market. We consider that domestic investors are allowed to trade B-share stocks in the B-share market and modify the model in which uninformed foreign investors in the B-share market infer private information by observing the B-share stock price and its range, resulting from the difference between the highest and lowest B-share prices. However, we do not consider domestic investors have information transmission effect in the A-share market.

We assume there are two types of domestic traders in the A-share market: One is informed traders with the proportion $\pi_A$, and the other is uninformed traders with the proportion $1-\pi_A$. Similarly, two types of traders exist in the B-share market. One is informed domestic traders with the proportion $\pi_B$, and the other is uninformed foreign traders with the proportion $1-\pi_B$. All traders have CARA utility functions with a risk aversion parameter $\eta$. We assume that $\tau$ is a risk tolerance parameter (i.e., $\tau = 1/\eta$). For the A-share and B-share securities issued by the same corporation, the future return ($\theta$), whether in the A-share market or in the B-share market, is equal but uncertain, with $\theta \sim N(\bar{\theta}, \sigma_\theta^2)$. We assume that the domestic informed traders obtain noisy private information ($S$) regarding the future return such that $S = \theta + \varepsilon_S$, with $\varepsilon_S \sim N(0, \sigma_\varepsilon^2)$. The foreign traders who are in the B-share market do not have private stock information, but they can infer private information from informed traders based on the B-share price ($P_B$). We further assume that uninformed foreign traders who are in the B-share market take advantage of the B-share price range to deduce informed traders' private information. The price range is defined as the difference between the highest and lowest B-share price in a given day. A natural range distribution is the lognormal distribution because any number under the distribution is nonnegative; nevertheless, after taking the natural logarithm, it becomes normally distributed. Hereafter, we will use $K$ as the logarithm of price range and call $K$ the price range, with $K \sim N(\bar{K}, \sigma_K^2)$. Denote $\rho$ as the correlation coefficient between the future return ($\theta$) and the price range ($K$). The total supply of A-shares is denoted as $a \sim N(\bar{a}, \sigma_a^2)$, and the total supply of B-shares is denoted as $b \sim N(\bar{b}, \sigma_b^2)$. We further assume that the future return ($\theta$) and the total asset supplies are independent.

### *Equilibrium Price in the A-Share Market*

We denote the demand of the informed domestic traders as $d_A^I(S, P_A)$ and the demand of the uninformed domestic traders as $d_A^U(P_A)$ to obtain the market clearing condition as $\pi_A d_A^I(S, P_A) + (1-\pi_A) d_A^U(P_A) = a$. To derive equilibrium price, we assume that the price in the A-share market is linear in private information and in the asset supply. Here we do not consider domestic investors have information transmission in the A-share market. Similar to Chan et al. (2008), the A-share price is affected by private information shock ($\Delta S = S - \overline{S}$) and the unanticipated supply change ($\Delta a = a - \overline{a}$) in the A-share market. Therefore, the price for the A-share market is given by

$$P_A = \alpha_0^A + \alpha_S^A \Delta S - \alpha_a^A \Delta a. \tag{1}$$

We obtain the parameters in Equation (1) as

$$\alpha_0^A = \frac{1}{(1+r)}\bar{\theta} - \frac{1}{(1+r)(\beta_1^I + \beta_1^U)}\bar{a}, \tag{2}$$

$$\alpha_S^A = \frac{1}{(1+r)(\beta_1^I + \beta_1^U)}[\beta_1^I \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2} + \beta_1^U \frac{\mu\sigma_\theta^2}{\sigma_\varepsilon^2 + \mu\sigma_\theta^2}], \tag{3}$$

$$\alpha_a^A = \frac{1}{(1+r)(\beta_1^I + \beta_1^U)}\left[1 + \left(\beta_1^U \frac{\mu\sigma_\theta^2}{\sigma_\varepsilon^2 + \mu\sigma_\theta^2}\right) \Big/ \left(\beta_1^I \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}\right)\right], \tag{4}$$

where $\mu = \frac{\pi_A^2\tau^2}{\pi_A^2\tau^2 + \sigma_a^2\sigma_\varepsilon^2}$, $\beta_1^I = \pi_A\tau(\frac{1}{\sigma_\theta^2} + \frac{1}{\sigma_\varepsilon^2})$, and $\beta_1^U = (1-\pi_A)\tau(\frac{1}{\sigma_\theta^2} + \frac{\mu}{\sigma_\varepsilon^2})$.

### *Equilibrium Price in the B-Share Market*

The demand in the B-share market derives from two types of traders: informed domestic traders and uninformed foreign traders. We assume that foreign traders receive private signals from informed traders by observing the B-share price and its range. We denote the demand of uninformed foreign traders as $d_B^U(P_B, K)$, which is a function of the B-share price and its range, whereas foreign traders deduce private information from the B-share price and its range. Similarly, we denote the demand of domestic informed traders by $d_B^I(S, P_B, K)$ and obtain the market clearing condition: $\pi_B d_B^I(S, P_B, K) + (1-\pi_B)d_B^U(P_B, K) = b$. The B-share price is affected by the shock of private information ($\Delta S = S - \overline{S}$), the shock of range ($\Delta K = K - \overline{K}$), and the unanticipated supply change ($\Delta b = b - \overline{b}$), in the B-share market. Therefore, the price for the B-share market is given by

$$P_B = \alpha_0^B + \alpha_S^B \Delta S + \alpha_K^B \Delta K - \alpha_b^B \Delta b. \tag{5}$$

We obtain the parameters in Equation (5) as

$$\alpha_0^B = \frac{1}{(1+r)}\bar{\theta} - \frac{1}{(1+r)(\beta_2^I + \beta_2^U B)}\overline{b}, \tag{6}$$

$$\alpha_S^B = \frac{1}{(1+r)(\beta_2^I + \beta_2^U B)}\left[\beta_2^I \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2} + \beta_2^U \sigma_\theta^2 \sigma_K^2 (1-\rho^2)\right], \tag{7}$$

$$\alpha_K^B = \frac{\beta_2^U(\rho\sigma_\theta\sigma_K\sigma_\varepsilon^2 + h_1^2\rho\sigma_\theta\sigma_K\sigma_a^2 - h_2\sigma_\theta^2\sigma_K^2(1+\rho^2))}{(1+r)(\beta_2^I + \beta_2^U B)}\left[1 + \frac{\beta_2^U(\sigma_\theta^2 + \sigma_\varepsilon^2)\sigma_K^2(1-\rho^2)}{\beta_2^I}\right], \tag{8}$$

$$\alpha_b^B = \frac{1}{(1+r)(\beta_2^I + \beta_2^U B)}\left[1 + \frac{\beta_2^U(\sigma_\theta^2 + \sigma_\varepsilon^2)\sigma_K^2(1-\rho^2)}{\beta_2^I}\right], \tag{9}$$

where $B = (\sigma_\theta^2\sigma_K^2(1-\rho^2) + \sigma_K^2\sigma_\varepsilon^2 + h_1^2\sigma_a^2\sigma_K^2 - 2h_2\rho\sigma_\theta\sigma_K^3)$, $\beta_2^I = \pi_B\tau\frac{\sigma_\theta^2 + \sigma_\varepsilon^2}{\sigma_\theta^2\sigma_\varepsilon^2}$,

$\beta_2^U = \frac{(1-\pi_B)\tau}{[\sigma_\theta^2\sigma_\varepsilon^2\sigma_K^2(1-\rho^2) + h_1^2\sigma_\theta^2\sigma_K^2\sigma_a^2(1-\rho^2) - 2h_2\rho\sigma_\theta^3\sigma_K^3(1-\rho^2)]}$, $h_1 = \frac{\sigma_\varepsilon^2}{\pi_B\tau}$, and $h_2 = \frac{h_1\beta_2^U\rho\sigma_\theta\sigma_K(\sigma_\varepsilon^2 + h_1^2\sigma_a^2)}{1 + h_1\beta_2^U\sigma_\theta^2\sigma_K^2(1+\rho^2)}$ (for the proof, see the appendix).

### *Analysis of the Information Transmission Effect on the B-Share Discount*

Before 2001, the price in the A-share market was higher than in the B-share market when the supply of shares in the two markets was the same because traders in the A-share market received more information than those in the B-share market. According to our model, certain parameters determine the A-share and B-share prices. We can find that the B-share price range affects not only the B-share discount, but also the changes in the B-share price. The B-share price range can be viewed as a volatility of the B-share price in a day. However, we propose that the B-share discount will shrink when the B-share price range increases. It is consistent with Ozdenoren and Yuan (2008), who show that uninformed investors accept informed investor beliefs and information transmission according to asset price coordination. This feedback effect, which derives from informed trader behavior upon receiving private information, creates high volatility. To measure the information transmission, we assume that informed traders who have private information regarding future returns change their position. As uninformed foreign traders observe a large price range, they have sufficient professional skills and experience to deduce private information. Eventually, they reduce uncertainty regarding future returns and have less risk for asymmetric information. In our model, the effect of information transmission is obvious with increasing price range when $\alpha_K^B$ is positive in the B-share market.

## Empirical Analysis

In this section, we present the data and main statistics. We first show a summary description of the trading structure and data in the A-share and B-share markets in China, followed by our empirical results.

### *Data and Statistics*

There are two securities markets in China. One is the Shanghai Stock Exchange (SHSE), established on November 26, 1990, and the other is the Shenzhen Stock Exchange (SZSE), established on April 11, 1991. Before June 2001, the A-share and B-share markets were two perfectly segmented markets in which domestic investors were restricted to A-shares and foreign investors were restricted to B-shares. The SHSE and the SZSE are both order-driven, and traders only submit limited orders to an electronic consolidated open limit order book. There is no market maker in China, and the price-time priority principle is a criterion when an incoming order is matched automatically on the SHSE and the SZSE. There is also no upstairs market that allows traders to trade large volumes. Neither exchange allows insider trading and off-exchange trading behavior. The trading currencies for B-shares on the SHSE and the SZSE are U.S. dollars and Hong Kong dollars, respectively. However, the minimal quote price for local shares is 0.01 yuan on the SHSE and the SZSE. The minimal quote price for foreign shares is 0.001 U.S. dollars on the SHSE, and the minimal quote price for foreign shares is 0.01 Hong Kong dollars on the SZSE. The minimal trade size for local shares is 100 shares on the SHSE and the SZSE. Similarly, the minimal trade size for both SHSE and SZSE foreign shares is 100 shares.

Our sampling period for the data on the SHSE and the SZSE is January 2000–September 2012. We consider the following adjustment to our daily data. First, we collect all firms whose stocks are listed both in the A-share and B-share markets and obtain eighty-six firms. Second, we consider the entire sample period starting from August 2001 and exclude certain firms, reducing the total to fifty-nine to construct a balanced panel data. Firms with more than 200 days without trading and days with more than two firms without trading in our sample period are excluded. Finally, our sample data include thirty firms on the SHSE and twenty-nine firms on the SZSE. We will use the closed price of A-shares and B-shares, the highest price of B-shares, the lowest price of B-shares, the trading volume of A-shares, and the trading volume of B-shares in our empirical study.

Table 1 shows the summary statistics for trading variables in the A-share and B-share markets from August 2001 through September 2012. We derive cross-sectional statistics from fifty-nine firms whose stocks contained both A-shares and B-shares in China. To construct a balanced panel data, we only include those days for which each stock was traded in the sample period. The table provides the cross-sectional mean, median, standard deviation, minimum, and maximum based on the fifty-nine sample stocks. We calculate the average values of the B-share discount, the A-share stock price, and the B-share stock price to be 4.43, 9.63, and 5.20 yuan, respectively. The average B-share discount was 46 percent, which means the difference between the A-share and B-share stock prices is equal to nearly half of the A-share stock price. By observing the B-share price and its range, we can find that the average change of the B-share price (i.e., the range of the B-share price over the B-share stock price) is approximately 3.12 percent. However, the maximum of the B-share discount is approximately equal to 24.4 yuan, which is considerably larger for domestic and foreign traders in the A-share and B-share markets.

**Table 1. Summary statistics, August 2001–September 2012**

| | Mean | Median | Maximum | Minimum |
|---|---|---|---|---|
| A-share stock price (yuan) | 9.627311 | 8.600000 | 60.50000 | 1.060000 |
| B-share stock price (yuan) | 5.199675 | 4.442340 | 40.57567 | 0.679230 |
| B-share discount (yuan) | 4.427635 | 3.925310 | 24.38822 | –4.454020 |
| range of A-share stock price (yuan) | 0.350012 | 0.260000 | 6.600000 | 0.000000 |
| range of B-share stock price (yuan) | 0.162210 | 0.112920 | 3.478360 | 0.000000 |
| A-share trading volume (per share) | 3,486,035 | 887,298 | 3.73E+08 | 2,700.000 |
| B-share trading volume (per share) | 864,222 | 397,130 | 42,411,670 | 100.0000 |

*Notes:* Based on daily data. We derive cross-sectional statistics from 59 firms whose stocks are contained in both A-share and B-share markets. In order to construct a balanced panel data, we only include those days for which each stock was traded in the sample period.

### *Empirical Result of Panel Data*

Before empirical investigation, all variables are transformed and the variable stationarity must be examined.[1] We have conducted the unit root test based on the augmented Dickey Fuller-Fisher test (Levina et al. 2002). The ADF test result shows that the original data rejects the unit root hypothesis at the 1 percent level (Table 2). According to Table 2, our sample data are significant at the 1 percent level of significance.

According to the above statistical test, we set the following specification for the B-share discount.

$$\begin{aligned} \text{B-share discount} = \beta_0 & \\ & + \beta_1(\text{Range of B-share price}) \\ & + \beta_2(\text{A-share trading volume}) \\ & + \beta_3(\text{B-share trading volume}) \end{aligned} \tag{10}$$

Furthermore, we present the difference between the fixed effect and random effect in our panel data using the Hausman test. The estimated fixed effect (Hsiao et al. 2002) and the random effect (Bhargava and Sargan 1983) are shown in Table 3. The null hypothesis is that intercepts have fixed effects and are not affected by cross-sectional variables. However, because each $p$-value is not sufficiently small to reject the null hypothesis, we conclude that the intercept of our panel data with fixed effect is correlated with the explanatory variables and captures the effect of all the time-variant variables. Thus, each firm has a common fixed intercept without its own random intercept.

**Table 2. Results of Unit Root Test**

| | Level data |
|---|---|
| B-share discount | 15,482.3*** |
| Range of B-share price | 15,371.8*** |
| A-share trading volume | 15,305.4*** |
| B-share trading volume | 15,115.9*** |

*Notes:* This table shows the results of the augmented Dickey-Fuller (Dickey and Fuller 1981) unit root test. ADF = augmented Dickey-Fuller test. The critical values of the augmented Dickey-Fuller are −3.8304, −3.0294, and −2.6552 at the 1 percent, 5 percent, and 10 percent level, respectively. The numbers in the table are the ADF. ***Significant at the 1 percent level.

**Table 3. Hausman test: SHSE and SZSE**

| | Chi-Square Statistic | Chi-Square degrees of freedom | Probability |
|---|---|---|---|
| SHSE | | | |
| Cross-section random | 1.148758 | 3 | 0.7653 |
| SZSE | | | |
| Cross-section random | 4.179278 | 3 | 0.2427 |

*Notes:* We estimate fixed effect (Mundlak 1961) and random effect (Maddala 1971). The null hypothesis is that the intercepts have fixed effect and are not affected by cross-sectional variables.

**Table 4. Analysis of coefficients and *t*-statistic: SHSE**

| | Coefficient | *t*-Statistic |
|---|---|---|
| Panel A: Full period (August 2001~September 2012) | | |
| Constant | –0.001078*** | –5.109954 |
| | (0.000211) | |
| Range of B-share price | –0.000419** | –2.090155 |
| | (0.000200) | |
| A-share trading volume | 0.003902*** | 27.97012 |
| | (0.000100) | |
| B-share trading volume | –0.000134** | –2.229302 |
| | (6.01E-05) | |
| Adjusted $R$-squared | 0.026455 | |
| Panel B: During financial crisis (August 2007~December 2009) | | |
| Constant | 0.002406*** | 2.948920 |
| | (0.000816) | |
| Range of B-share price | –0.002047** | –2.021807 |
| | (0.001013) | |
| A-share trading volume | 0.015089*** | 19.84889 |
| | (0.000760) | |
| B-share trading volume | –0.003115*** | –3.497529 |
| | (0.000891) | |
| Adjusted $R$-squared | 0.161350 | |
| Panel C: After financial crisis (January 2010~September 2012) | | |
| Constant | –0.001259** | –2.534502 |
| | (0.000497) | |
| Range of B-share price | –0.001836*** | –2.914091 |
| | (0.000630) | |
| A-share trading volume | 0.009604*** | 16.73760 |
| | (0.000574) | |
| B-share trading volume | –0.001004** | –2.195615 |
| | (0.000457) | |
| Adjusted $R$-squared | 0.059227 | |

*Notes:* The numbers in parentheses are the standard errors of the estimated coefficients. **Significance at the 5 percent level; ***significance at the 1 percent level.

Using the Hausman and Taylor (1981) methodology, we can estimate the coefficients in Equation (10), and the results from the SHSE and the SZSE are summarized in Table 4 and Table 5, respectively. The B-share discount is decomposed into several components that affect the discount

**Table 5. Analysis of coefficients and *t*-statistic: SZSE**

| | Coefficient | *t*-Statistic |
|---|---|---|
| Panel A: Full period (August 2001~September 2012) | | |
| Constant | –0.000714*** | –2.771709 |
| | (0.000257) | |
| Range of B-share price | –7.33E-05 | –0.271054 |
| | (0.000271) | |
| A-share trading volume | 0.001914*** | 12. 26215 |
| | (0.000156) | |
| B-share trading volume | –1.31E-05 | –0.127830 |
| | (0.000102) | |
| Adjusted *R*-squared | 0.005268 | |
| Panel B: During financial crisis (August 2007~December 2009) | | |
| Constant | –0.001173 | –1.382731 |
| | (0.000849) | |
| Range of B-share price | –0.002463** | –2.404313 |
| | (0.001025) | |
| A-share trading volume | 0.011197*** | 17.42032 |
| | (0.000643) | |
| B-share trading volume | 0.001342*** | 3.114274 |
| | (0.000431) | |
| Adjusted *R*-squared | 0.134318 | |
| Panel C: After financial crisis (January 2010~September 2012) | | |
| Constant | 0.000756 | 0.719073 |
| | (0.001052) | |
| Range of B-share price | –0.000749 | –0.583970 |
| | (0.001283) | |
| A-share trading volume | 0.001711 | 1.636094 |
| | (0.001046) | |
| B-share trading volume | –0.000801 | –1.242312 |
| | (0.000645) | |
| Adjusted *R*-squared | –0.002395 | |

*Notes:* The numbers in parentheses are the standard errors of the estimated coefficients. **Significance at the 5 percent level; ***significance at the 1 percent level.

(i.e., range of B-share price, A-share trading volume, and B-share trading volume). In order to have a robustness analysis, we consider the influence of financial crisis and separate the sample period into three periods. According to Table 4, the evidence from panel A indicates that in the full period, the coefficients of the range of B-share price, A-share trading volume, and B-share trading volume terms are –0.000419, 0.003902, and –0.000134, respectively. In addition to the constant term, each variable coefficient in Equation (10) is more crucial. The coefficients of the range of B-share price and B-share trading volume are significant at the 5 percent level. The coefficient of A-share trading volume is significant at the 1 percent level. Similarly, the evidences from panel B and panel C are consistent with panel A. A-share trading volume is positively correlated with the B-share discount. In contrast, the range of B-share price and B-share trading volume are negatively correlated with the B-share discount. This means that a larger range of B-share price will reduce the B-share discount on the SHSE from 2001 to 2012.

According to Table 5, the evidence from panel B indicates that during financial crisis, the coefficients of the range of B-share price, A-share trading volume, and B-share trading volume terms are –0.002463, 0.011197, and 0.001342, respectively. The coefficient of the range of B-share price is significant at the 5 percent level. The coefficients of A-share trading volume and B-share trading volume are significant at the 1 percent level. This also means that a large range of B-share price reduces the B-share discount on the SZSE during financial crisis. This is consistent with our hypothesis that uninformed foreign traders obtain information by observing the range of B-share prices, and the information transmission effect is obvious with increasing price range in the B-share market. However, the evidence from panel A and panel C shows that the range of B-share price is negatively correlated with the B-share discount and not significant because the supply of securities came primarily from small market capitalization stocks on the SZSE after 2004. Uninformed domestic traders' speculative trading behavior may cause foreign traders to stop receiving private information from the range of B-share price. This is consistent with Bailey and Jagtiani (1994) Palomino (1996) who proposes that rational investors are reluctant to trade small firms' stocks. However, uninformed investors can earn abnormal returns by trading small market capitalization stocks in an imperfectly competitive market.

## Conclusion

Although the foreign share discount is now well established in China and numerous studies have attempted to explain this phenomenon using information asymmetry, trading activity, and speculative behavior, research investigating why the difference between A-share and B-share prices has become more contractive is rare. We propose a framework to analyze asset price in the presence of the information transmission effect and present equilibrium prices in a setting in which informed trader coordination executes information transmission. Nevertheless, uninformed foreign traders receive private signals from informed traders by observing public information, but this transmission is limited.

Our sample of fifty-nine Chinese firms from August 2001 through September 2012 measures the information transmission effect and presents a substantial segment of the cross-sectional variation in B-share discounts. Further, we show that the B-share discount shrank when the B-share price range increased on the SHSE from June 2001 through September 2012. Similarly, the B-share discount shrank when the B-share price range increased on the SZSE during financial crisis. This article contributes to the existing literature by identifying information transmission from the range of the difference between the highest and lowest prices, and that range thereby plays an important role in determining the size of foreign share discount. Uninformed foreign traders in B-share markets deduce private information and reduce uncertainty by observing large price range. The change of B-share discount results from informed trader coordination and uninformed foreign traders receiving private signals. Van Nieuwerburgh and Veldkamp (2006) observe information transmission during the boom and bust over the business cycle to be relatively significant. However, the primary reason for the existence of the information transmission effect is for informed traders to obtain sufficiently precise information, enabling them to coordinate their position according to their private information. Finally, we demonstrate that the information transmission effect offers an explanation for the cross-sectional variation in B-share discounts that have become more contractive in China.

## Note

1. All variables are transformed by $X'_{it} = \frac{X_{it} - X_{it-1}}{X_{it-1}}$, where $i$ can be the range of B-share price, A-share trading volume, and B-share trading volume.

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## Appendix

We construct a model of information asymmetry and transmission effect for the Chinese A-share and B-share markets. Our developed model is simple, showing the information asymmetry and the information transmission effect on the B-share discount. This model is based on Chan et al. (2008), who extend the Grossman and Stiglitz (1980) model to two separate markets, whereby domestic investors only trade in the A-share market and foreign investors only trade in the B-share market. We consider that domestic investors are allowed to trade B-share stocks in the B-share market and modify the model by which uninformed foreign investors in the B-share market infer private information by observing the B-share stock price and its range, resulting from the difference between the highest and lowest B-share prices. However, we do not consider that domestic investors have information transmission effect in the A-share market.

We assume two types of domestic traders in the A-share market. One is informed traders with the proportion $\pi_A$, and the other is uninformed traders with the proportion $1-\pi_A$. Similarly, two types of traders exist in the B-share market. One is informed domestic traders with the proportion $\pi_B$, and the other is uninformed foreign traders with the proportion $1-\pi_B$. All traders have CARA utility functions with a risk aversion parameter $\eta$. We assume that $\tau$ is a risk tolerance parameter (i.e., $\tau = 1/\eta$). For the A-share and B-share securities issued by the same corporation, the future return ($\theta$), whether in the A-share market or in the B-share market, is equal but uncertain, with $\theta \sim N(\bar{\theta}, \sigma_\theta^2)$. We assume that the domestic, informed traders obtain noisy private information ($S$) regarding the future return such that $S = \theta + \varepsilon_S$, with

$\varepsilon_S \sim N(0, \sigma_\varepsilon^2)$. The foreign traders who are in the B-share market do not have private information, but undertake to infer private information from informed traders based on the B-share price ($P_B$). In the market microstructure, we further assume that uninformed foreign traders who are in the B-share market take advantage of the B-share price range to deduce informed traders' private information. The price range is defined as the difference between the highest and lowest B-share price in a given day. A natural range distribution is the lognormal distribution because any number under the distribution is nonnegative; nevertheless, after taking the natural logarithm, it becomes normally distributed. Hereafter, we will use $K$ as the logarithm of price range and call $K$ the price range, with $K \sim N(\bar{K}, \sigma_K^2)$. Denote $\rho$ as the correlation coefficient between the future return ($\theta$) and the price range ($K$). We assume that the total supply of A-shares is denoted by $a \sim N(\bar{a}, \sigma_a^2)$, and the total supply of B-shares is denoted by $b \sim N(\bar{b}, \sigma_b^2)$. We further assume that the future return ($\theta$) and the total asset supplies are independent.

The equilibrium price in the B-share market is

$$P_B = \alpha_0^B + \alpha_S^B \Delta S + \alpha_K^B \Delta K - \alpha_b^B \Delta b. \tag{A1}$$

The mean ($E[\theta|S, K, P_B]$) and variance ($Var[\theta|S, K, P_B]$) of the future return conditional on the private information in the B-share market are

$$E[\theta|S, K, P_B] = E[\theta|S] = \overline{\theta} + \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2} \Delta S, \tag{A2}$$

$$Var[\theta|S, K, P_B] = Var[\theta|S] = \frac{\sigma_\theta^2 \sigma_\varepsilon^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}, \tag{A3}$$

respectively.

Therefore, we can obtain the demand of informed traders in the B-share market:

$$\begin{aligned} d_B^I(S, K, P_B) &= \frac{E[\theta|S, K, P_B] - P_B(1+r)}{\eta Var[\theta|S, K, P_B]} \\ &= \tau \frac{\sigma_\theta^2 + \sigma_\varepsilon^2}{\sigma_\theta^2 \sigma_\varepsilon^2} \left[ \overline{\theta} + \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2} \Delta S - P_B(1+r) \right]. \end{aligned} \tag{A4}$$

However, the uninformed foreign traders in the B-share market observe public information whereby the uninformed foreign traders can infer the informed traders' private signal but do not have private information. The mean ($E[\theta|K, P_B]$) and variance ($Var[\theta|K, P_B]$) of the future return based only on public information for the uninformed foreign traders in the B-share market are

$$\begin{aligned} E[\theta|K, P_B] = E[\theta] &+ \frac{[\alpha_S^B(\sigma_\theta^2 \sigma_K^2 - \rho^2 \sigma_\theta^2 \sigma_K^2)] \Delta P_B}{(\alpha_S^B)^2 \sigma_\theta^2 \sigma_K^2 + (\alpha_S^B)^2 \sigma_\varepsilon^2 \sigma_K^2 + (\alpha_b^B)^2 \sigma_b^2 \sigma_K^2 - (\alpha_S^B)^2 \rho^2 \sigma_\theta^2 \sigma_K^2 - 2\rho \alpha_S^B \alpha_K^B \sigma_\theta \sigma_K^3} \\ &+ \frac{[(\alpha_S^B)^2 \rho \sigma_\theta \sigma_K \sigma_\varepsilon^2 + (\alpha_b^B)^2 \rho \sigma_\theta \sigma_K \sigma_b^2 - \alpha_S^B \alpha_K^B \sigma_\theta^2 \sigma_K^2 (1+\rho^2)] \Delta K}{(\alpha_S^B)^2 \sigma_\theta^2 \sigma_K^2 + (\alpha_S^B)^2 \sigma_\varepsilon^2 \sigma_K^2 + (\alpha_b^B)^2 \sigma_b^2 \sigma_K^2 - (\alpha_S^B)^2 \rho^2 \sigma_\theta^2 \sigma_K^2 - 2\rho \alpha_S^B \alpha_K^B \sigma_\theta \sigma_K^3}, \end{aligned} \tag{A5}$$

$$Var[\theta|K, P_B] = \frac{(1-\rho^2)(\sigma_\theta^2 \sigma_\varepsilon^2 \sigma_K^2 + h_1^2 \sigma_\theta^2 \sigma_b^2 \sigma_K^2 - 2h_2 \rho \sigma_\theta^3 \sigma_K^3)}{\sigma_\theta^2 \sigma_K^2 (1-\rho^2) + \sigma_\varepsilon^2 \sigma_K^2 + h_1^2 \sigma_b^2 \sigma_K^2 - 2h_2 \rho \sigma_\theta \sigma_K^3}, \tag{A6}$$

respectively,

where $h_1 = \frac{\alpha_b^B}{\alpha_S^B}$, and $h_2 = \frac{\alpha_K^B}{\alpha_S^B}$. Therefore, we can obtain the demand of uninformed foreign traders in the B-share market:

$$\begin{aligned} d_B^U(K, P_B) &= \frac{E[\theta|K, P_B] - P_B(1+r)}{\eta Var[\theta|K, P_B]} \\ &= \frac{\tau B}{A}[\bar{\theta} + \frac{1/\alpha_S^B \sigma_\theta^2 \sigma_K^2 (1-\rho^2)}{B} \Delta P_B] \\ &+ \frac{\tau B}{A}\left[\frac{\rho\sigma_\theta\sigma_K\sigma_\varepsilon^2 + h_1^2\rho\sigma_\theta\sigma_K\sigma_b^2 - h_2\sigma_\theta^2\sigma_K^2(1+\rho^2)}{B}\Delta K - P_B(1+r)\right], \end{aligned} \tag{A7}$$

where $A = (1-\rho^2)(\sigma_\theta^2\sigma_\varepsilon^2\sigma_K^2 + h_1^2\sigma_\theta^2\sigma_b^2\sigma_K^2 - 2h_2\rho\sigma_\theta^3\sigma_K^3)$, and
$B = \sigma_\theta^2\sigma_K^2(1-\rho^2) + \sigma_\varepsilon^2\sigma_K^2 + h_1^2\sigma_b^2\sigma_K^2 - 2h_2\rho\sigma_\theta\sigma_K^3$.

The market clearing condition is

$$\pi_B d_B^I(S, K, P_B) + (1-\pi_B) d_B^U(K, P_B) = b. \tag{A8}$$

We then substitute (A4) and (A7) into (A8),

$$\begin{aligned} &\beta^I(\bar{\theta} + \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}\Delta S - P_B(1+r)) \\ &+ \beta^U B(\bar{\theta} + \frac{1/\alpha_S^B \sigma_\theta^2\sigma_K^2(1-\rho^2)}{B}\Delta P_B) \\ &+ \beta^U B(\frac{\rho\sigma_\theta\sigma_K\sigma_\varepsilon^2 + h_1^2\rho\sigma_\theta\sigma_K\sigma_b^2 - h_2\sigma_\theta^2\sigma_K^2(1+\rho^2)}{B}\Delta K - P_B(1+r)) = b. \end{aligned} \tag{A9}$$

where $\beta^I = \pi_B\tau\frac{\sigma_\theta^2 + \sigma_\varepsilon^2}{\sigma_\theta^2\sigma_\varepsilon^2}, \beta^U = \frac{(1-\pi_B)\tau}{A}$.

We replace $\Delta P_B$ by $P_B - E(P_B) = P_B - \alpha_0^B$. Therefore, we can obtain the equilibrium B-share price:

$$\begin{aligned} P_B = &\frac{1}{C}\{(\beta^I + \beta^U B)\bar{\theta} - \frac{\beta^U}{\alpha_S^B}\sigma_\theta^2\sigma_K^2(1-\rho^2)\alpha_0^B - \bar{b}\} \\ &+ \frac{1}{C}\{\beta^I\frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}\Delta S\} \\ &+ \frac{1}{C}\{\beta^U[\rho\sigma_\theta\sigma_K\sigma_\varepsilon^2 + h_1^2\rho\sigma_\theta\sigma_K\sigma_b^2 - h_2\sigma_\theta^2\sigma_K^2(1+\rho^2)]\Delta K - \Delta b\}, \end{aligned} \tag{A10}$$

where $C = (1+r)(\beta^I + \beta^U B) - \frac{\beta^U}{\alpha_S^B}\sigma_\theta^2\sigma_K^2(1-\rho^2)$.

Furthermore, comparing Equation (A1) with (A10),

$$\alpha_0^B = \frac{1}{(1+r)}\bar{\theta} - \frac{1}{(1+r)(\beta_2^I + \beta_2^U B)}\bar{b}, \tag{A11}$$

$$\alpha_S^B = \frac{1}{(1+r)(\beta_2^I + \beta_2^U B)}[\beta_2^I \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2} + \beta_2^U \sigma_\theta^2 \sigma_K^2 (1-\rho^2)], \tag{A12}$$

$$\alpha_K^B = \frac{\beta_2^U(\rho\sigma_\theta\sigma_K\sigma_\varepsilon^2 + h_1^2\rho\sigma_\theta\sigma_K\sigma_a^2 - h_2\sigma_\theta^2\sigma_K^2(1+\rho^2))}{(1+r)(\beta_2^I + \beta_2^U B)}[1 + \frac{\beta_2^U(\sigma_\theta^2 + \sigma_\varepsilon^2)\sigma_K^2(1-\rho^2)}{\beta_2^I}], \tag{A13}$$

$$\alpha_b^B = \frac{1}{(1+r)(\beta_2^I + \beta_2^U B)}[1 + \frac{\beta_2^U(\sigma_\theta^2 + \sigma_\varepsilon^2)\sigma_K^2(1-\rho^2)}{\beta_2^I}]. \tag{A14}$$

where

$$B = (\sigma_\theta^2\sigma_K^2(1-\rho^2) + \sigma_K^2\sigma_\varepsilon^2 + h_1^2\sigma_a^2\sigma_K^2 - 2h_2\rho\sigma_\theta\sigma_K^3),$$

$$\beta_2^I = \pi_B\tau\frac{\sigma_\theta^2 + \sigma_\varepsilon^2}{\sigma_\theta^2\sigma_\varepsilon^2},$$

$$\beta_2^U = \frac{(1-\pi_B)\tau}{[\sigma_\theta^2\sigma_\varepsilon^2\sigma_K^2(1-\rho^2) + h_1^2\sigma_\theta^2\sigma_K^2\sigma_a^2(1-\rho^2) - 2h_2\rho\sigma_\theta^3\sigma_K^3(1-\rho^2)]},$$

$$h_1 = \frac{\sigma_\varepsilon^2}{\pi_B\tau}, \text{and } h_2 = \frac{h_1\beta_2^U\rho\sigma_\theta\sigma_K(\sigma_\varepsilon^2 + h_1^2\sigma_a^2)}{1 + h_1\beta_2^U\sigma_\theta^2\sigma_K^2(1+\rho^2)}.$$