THE JOURNAL OF FINANCE • VOL. LXIII, NO. 1 • FEBRUARY 2008

Information Asymmetry and Asset Prices: Evidence from the China Foreign Share Discount

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ABSTRACT

We examine the effect of information asymmetry on equity prices in the local A- and foreign B-share market in China. We construct measures of information asymmetry based on market microstructure models, and find that they explain a significant portion of cross-sectional variation in B-share discounts, even after controlling for other factors. On a univariate basis, the price impact measure and the adverse selection component of the bid-ask spread in the A- and B-share markets explains 44% and 46% of the variation in B-share discounts. On a multivariate basis, both measures are far more statistically significant than any of the control variables.

THE EXTENT OF INFORMATION ASYMMETRY in the international equity market has become a very important topic. The question of whether domestic investors have better information than foreign investors has also become increasingly controversial. For instance, a few papers argue that domestic investors have a linguistic and cultural advantage (Brennan and Cao (1997), Choe, Kho, and Stulz (2001), and Hau (2001)), others argue that foreign investors have an informational advantage because they possess a significant amount of investment experience and expertise (Seasholes (2000), Grinblatt and Keloharju (2000),

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and Froot and Ramadorai (2007)). Despite this debate, however, it is more commonly accepted that the informational disadvantage of foreign investors is responsible for their reluctance to invest in foreign securities (Kang and Stulz (1997), Brennan and Cao (1997), and Grinblatt and Keloharju (2001)).

While there is much evidence on informational asymmetry in international equity markets, very few studies examine whether informational asymmetry affects equity prices. The only exceptions are Bailey and Jagtiani (1994) and Domowitz, Glen, and Madhavan (1997), who find that foreign investors in Thailand and Mexico seem to prefer to invest in larger companies that display greater financial disclosure and less information asymmetry, and that, therefore, the price premiums of foreign shares over domestic shares are higher for larger market capitalization firms. However, market capitalization might capture some other firm attributes. For example, firm size might measure share liquidity, as larger firms might have a more liquid foreign market, which would result in larger foreign share premiums. Furthermore, foreign institutional investors might have a mandate to invest only in larger companies, in which case they would be willing to pay higher prices.

In this paper, we borrow from the literature on market microstructure to construct measures of information asymmetry, and we examine whether these measures can explain asset prices in the Chinese A- and B-share markets. Before 2001, the Chinese stock market was a perfect example of market segmentation: Domestic investors could only trade (local) A-shares, and foreign investors could only trade (foreign) B-shares.[1] Although the two share classes are identical with respect to shareholder rights, such as voting and profit-sharing rights, B-shares are traded at a discount relative to A-shares. As with other emerging markets, foreign investors find it difficult to acquire and access information on Chinese firms compared with domestic investors. In fact, information asymmetry may be more severe in China, as share manipulation and insider trading is widespread and investor protection rights are not legally codified (Chakravarty, Sarkar, and Wu (1998)).

We first develop a simple model of information asymmetry for the Chinese A- and B-share markets. In this model, private information is possessed by some domestic investors but not by foreign investors. An increase in the proportion of informed domestic investors has an impact on market depth through two effects. The first is the adverse information effect, whereby uninformed investors adjust their demand in response to unexpected changes in the supply of shares (the reciprocal of order flows). The second is the risk-bearing capacity effect, whereby informed investors require a smaller risk premium if they have less information uncertainty. We show that an increase in the proportion of informed domestic investors has different effects on share price and market depth across the A- and B-share markets. In particular, the B-share discount is a function of the proportion of domestic informed investors, although in a nonmonotonic fashion, and the proportion of domestic informed investors in the A-share market, which measures the information asymmetry between the

[1] In March 2001, the Chinese government opened the B-share market to domestic investors.

two markets, influences the market depth or the price impact parameter in both markets. Thus, the model illustrates that even absent trading activity considerations, there could exist a relationship between the B-share discount and relative market depth across the two markets.

Based on the transactions data set for firms in mainland China from 2000 to 2001, we estimate several information asymmetry measures, including the price impact coefficient, the adverse selection component of the bid-ask spread, and the probability of informed trading (PIN) measure, and examine whether they can explain B-share discounts in China. As there exist other explanations for foreign share discounts, such as trading activity (Chen and Xiong (2001)), market momentum (Karolyi and Li (2003)), and speculative behavior (Mei, Scheinkman, and Xiong (2003)), we also control for the influence of these factors when analyzing the impact of informational asymmetry measures.

Our results indicate that the information asymmetry measures explain a significant portion of the variation in B-share discounts. On a univariate basis, the difference between the price impact parameters and the difference between the adverse selection components in the A- and B-share markets explain 44% and 46% of the variation in B-share discounts. On a multivariate basis, these two components are far more statistically significant than any of the control variables in explaining B-share discounts. We also examine the behavior of B-share discounts after the B-share market was partially opened to domestic investors in March 2001. Not only do we observe that B-share discounts have declined from an average of 72% to 43%, but we also find that the difference in the adverse selection component between the two markets has decreased. Therefore, by allowing domestic investors to trade in the B-share market, there is less of an information disadvantage and the B-share discount becomes smaller.

By showing that our information asymmetry measures can explain variation in the B-share discount, our paper contributes to the literature in demonstrating that information asymmetry is priced in international equity markets. It should be mentioned that the information asymmetry explanation in China is distinct from the illiquidity driven by inactive trading, which has been shown to explain the B-share discounts as well (see, e.g., Chen and Xiong (2001)). In general, information asymmetry and trading activity are interrelated, as a greater degree of informed trading increases the adverse selection cost, which, in turn, deters trading activity. But in China, A-shares, which exhibit more informed trading, are also much more actively traded than B-shares. Furthermore, our regression results that the information asymmetry measures are much more important than other control variables, including trading activity measures, indicate that information asymmetry is far more important than insufficient trading volume in explaining the B-share discount. That said, we want to emphasize that the explanatory power of information asymmetry is on the cross-sectional variation of the B-share discount rather than on the absolute level.

The rest of the paper is organized as follows. Section I contains a brief overview of the Chinese equity markets and the related literature. Section II presents a simple framework of information asymmetry for the A- and B-share markets. Section III discusses our information asymmetry measures and the control variables. Section IV introduces the data, provides preliminary statistics, and presents the empirical results. Section V summarizes the main findings of the paper.

I. Overview of the Chinese Equity Markets and the Related Literature

China's two securities markets, the Shanghai Securities Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE), were established in December 1990 and July 1991, respectively. The shares that were initially listed on the SHSE and the SZSE were referred to as A-shares. A-shares could be traded only by Chinese citizens. In early 1992, another category of shares, B-shares, was introduced exclusively for foreign investors. A-shares are domestic ordinary shares that are denominated and traded in yuan by Chinese citizens. The majority of A-shares are issued by state-owned enterprises and can be classified as: (i) state shares, which are held by the government through a designated government agency; (ii) legal shares, which are held by "legal persons," that is, enterprises or other economic entities, but not individuals; and (iii) public shares, which are owned by ordinary Chinese citizens. B-shares are ordinary shares offered to foreign investors, and are legally identical to A-shares, enjoying the same voting rights and dividends. The main difference is that all transactions, dividend payments, trades, and quotes are conducted in foreign currency—U.S. dollars for the Shanghai B-shares and Hong Kong dollars for the Shenzhen B-shares.

Before 2001, the Chinese stock market was a segmented market, with A-shares restricted to domestic residents and B-shares restricted to foreigners. Since March 2001, however, domestic residents have also been permitted to purchase (and sell) B-shares with foreign currency.

The fact that B-shares trade at a discount in China is a puzzle. According to Bailey, Chung, and Kang (1999), except for China, foreign shares exhibit price premiums in all other segmented markets.[2] In theory, foreign investors can diversify part of the risk that is inherent in B-shares through non-Chinese stocks, whereas domestic investors cannot. The required rate of return should therefore be lower for B-shares, which would result in a B-share premium instead of a discount. Fernald and Rogers (2002) attribute the fact that Chinese investors accept lower rates of return primarily to the lack of alternative investment opportunities. Because of the underdevelopment of financial markets and capital controls, it is difficult for Chinese investors to invest overseas, and the main investment alternative is bank deposits. However, bank deposits tend to pay interest rates that are below international levels, and thus Chinese investors face a lower opportunity cost of capital and in turn they may demand lower expected rates of return. Although the lack of alternative investments can explain

[2] These markets include Indonesia, South Korea, Malaysia, Mexico, Norway, the Philippines, Singapore, Switzerland, Taiwan, and Thailand.

why A-shares are sold at a premium relative to B-shares, it cannot explain the cross-sectional variation in A-share premiums. A few other explanations have been offered.

One common explanation for the B-share discount is that foreign investors find it more difficult to acquire information on local Chinese firms relative to domestic investors. A large international finance literature documents such information asymmetry between foreign and domestic investors (Kang and Stulz (1997) and Portes and Rey (2005)) and attributes it to differences in accounting standards, disclosure requirements, and regulatory environments across countries. Information asymmetry is also a common explanation for home bias. Information asymmetry is particularly severe in China. For example, many Chinese firms do not fully disclose material changes in their business conditions, and published statements are not always prepared according to international accounting standards. Furthermore, share manipulation and insider trading are widespread, and there is a lack of codes to protect investors. Because of information costs, foreign investors avoid holding stocks that they do not know (Merton (1987)), which results in discounts for foreign B-shares in China.[3]

An alternative explanation for the B-share discount is the trading activity hypothesis, which states that, because the A-share market has a much higher trading volume than the B-share market, the discounts arise to compensate foreign investors for higher trading costs. According to Amihud and Mendelson (1986), the less actively traded B-shares should have a higher expected return and be priced lower to compensate investors for these costs. Supporting evidence is provided by Chen, Lee, and Rui (2001), who find that the relative trading volume of B-shares to A-shares is strongly negatively related to the discount. Chen and Xiong (2001) find additional support for the trading activity hypothesis in the Chinese market by showing that restricted institutional shares have an average discount of 78% to 86% compared with their unrestricted counterparts.

A second alternative hypothesis is that A-share premiums are a reflection of the speculative bubbles that are created by domestic investors (Mei et al. (2003)). This hypothesis is based on the theoretical model of Scheinkman and Xiong (2003), who show that there could be a speculative component in asset prices, and predict that there is a positive relationship among the volume of speculative trading, the size of the speculative component, and the volatility in stock prices. In their empirical test, Mei et al. (2003) assume that the A-share price, but not the B-share price, contains a speculative component. Consistent with their explanation, they find that the A-share turnover rate, which proxies

[3] A couple of papers provide evidence on information asymmetry between foreign and domestic investors. Based on transaction data, Chan, Menkveld, and Yang (2007) show that A-shares lead B-shares rather than the opposite, which provides indirect evidence that foreign investors in the B-share market are less informed than domestic investors in the A-share market. Using the number of company citations in the *Wall Street Journal* index as a proxy for information asymmetry, Chakravarty et al. (1998) demonstrate empirically that this proxy explains a significant portion of the cross-sectional variation in B-share discounts.

for the amount of speculative trading, explains 20% of the cross-sectional variation in A-share premiums.

A third alternative hypothesis is the differential risk hypothesis, which asserts that domestic and foreign investors face different investment opportunity sets. Owing to capital controls, Chinese investors cannot diversify overseas. Thus, there is a divergence in risk exposure between domestic and foreign investors, as the risk of A- and B-shares is evaluated based on different investment benchmarks (Chinese market and world market returns). However, there is little or weak empirical evidence to support this hypothesis. Eun, Janakiramanan, and Lee (2001) find that the B-share discount is positively related to the covariance risk of B-shares with the Morgan Stanley world market index, but find no evidence of a negative relationship with the covariance risk of A-shares with the Chinese market index. Fernald and Rogers (2002) also find no evidence that the B-share discount is related to either B-share or A-share covariance risks.

II. Model of Information Asymmetry for the A- and B-Share Markets

In this section, we develop a model of information asymmetry for the Chinese A- and B-share markets. While the model is simple, it serves to illustrate the effect of information asymmetry on the B-share discount and derives some implications on the relationship between the two. The model is based on Grossman and Stiglitz (1980), who introduce informational asymmetries into a noisy rational expectations model of asset pricing. We extend the model to two separate markets, whereby domestic investors trade in the A-share and foreign investors trade in the B-market, although uninformed investors in both markets could infer, although imperfectly, private information of informed domestic investors based on the A-share price.

We assume the domestic investors in the A-share market fall into one of two types, informed and uninformed, in the proportions λ and $1 - \lambda$, respectively. We further assume that all foreign investors in the B-share market are uninformed. This latter assumption is for convenience of analysis and could be relaxed without changing the key implications of the model as long as a smaller proportion of foreign investors is informed. All investors have CARA utility functions with a risk aversion coefficient of ρ or a risk tolerance parameter of η (i.e., $\eta = 1/\rho$). For the A- and B-share securities issued on the same company, the future payoff (v) is the same but uncertain, with $v \sim N(\bar{v}, \sigma_v^2)$. We assume that the domestic investors who are informed receive a noisy private signal (S) about the future payoff such that $S = v + \varepsilon_S$, with $\varepsilon_S \sim N(0, \sigma_\varepsilon^2)$. The uninformed domestic investors and the foreign investors do not observe the private signal, but attempt to extract information on the signal based on the A-share price (P_A). They are at an informational disadvantage, however, as noisy asset supply prevents the A-share price from being perfectly revealing. A-share asset supply is denoted by $y \sim N(\bar{y}, \sigma_y^2)$; B-share supply is denoted by $z \sim N(\bar{z}, \sigma_z^2)$. For convenience, we express all variance parameters in precision terms, that is, $\tau_v = 1/\sigma_v^2$, $\tau_\varepsilon = 1/\sigma_\varepsilon^2$, $\tau_y = 1/\sigma_y^2$, and $\tau_z = 1/\sigma_z^2$.

A. Equilibrium Price in the A-Share Market

We denote the demand of the informed domestic investors as $x_A^I(P_A, S)$ and the demand of the uninformed domestic investors as $x_A^U(P_A)$. The market clearing condition implies that $\lambda x_A^I(P_A, S) + (1-\lambda)x_A^U(P_A) = y$. To derive the equilibrium, we conjecture that the equilibrium price in the A-share market is linear in the private signal and the market supply. For ease of exposition, we specify the A-share price as a function of the surprise in the signal ($\Delta S = S - \bar{S}$) and the unexpected change in A-share supply ($\Delta y = y - \bar{y}$), as ΔS and Δy contain the same information as S and y. The functional form for the A-share equilibrium price is given by

$$P_A = \beta_0^A + \beta_S^A \Delta S + \beta_y^A \Delta y. \tag{1}$$

It can be shown that the parameters in equation (1) are

$$\beta_0^A = \frac{1}{(1+r)}\bar{v} - \frac{1}{(1+r)(\omega^I + \omega^U)}\bar{y}, \tag{2}$$

$$\beta_S^A = \frac{1}{(1+r)(\omega^I + \omega^U)}\left\{\omega^I \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon} + \omega^U \frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right\}, \tag{3}$$

$$\beta_y^A = \frac{1}{\Delta_A} = \frac{1}{(1+r)(\omega^I + \omega^U)}\left\{1 + \left(\omega^U \frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right) \Big/ \left(\omega^I \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\right)\right\}, \tag{4}$$

where $\phi = \frac{\lambda^2\eta^2\tau_y\tau_\varepsilon}{1+\lambda^2\eta^2\tau_y\tau_\varepsilon}$, $\omega^I = \lambda\eta(\tau_v + \tau_\varepsilon)$, and $\omega^U = (1-\lambda)\eta(\tau_v + \phi\tau_\varepsilon)$.

Proof: See Appendix A.

B. Equilibrium Price in the B-Share Market

The derivation of the equilibrium price in the B-share market is more straightforward. Since no foreign investor is informed, all demand comes from uninformed foreign investors. This demand, denoted by $x_B^U(P_A)$, is a function of the A-share price as foreign investors also infer the private information of informed domestic investors from the A-share price. As a result, the market clearing condition implies that $x_B^U(P_A) = z$. We also specify the B-share price as a function of the unexpected change in B-share supply ($\Delta z = z - \bar{z}$), and thus the functional form for the B-share equilibrium price is

$$P_B = \alpha_0 + \alpha_B P_A + \alpha_Z \Delta z. \tag{5}$$

Since $P_A = \beta_0^A + \beta_S^A \Delta S + \beta_y^A \Delta y$, equation (5) can be written as

$$P_B = \beta_0^B + \beta_S^B \Delta S + \beta_y^B \Delta y + \beta_Z^B \Delta z. \tag{6}$$

It can be shown that the parameters in equation (6) are

$$\beta_0^B = \frac{1}{(1+r)}\bar{v} - \frac{1}{(1+r)\omega^B}\bar{z}, \tag{7}$$

$$\beta_S^B = \frac{1}{(1+r)}\left(\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right), \tag{8}$$

$$\beta_y^B = \frac{1}{(1+r)}\left(\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right) \Big/ \left(\omega^I \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\right), \tag{9}$$

$$\beta_z^B = \frac{1}{\Delta_B} = \frac{1}{(1+r)\omega^B}, \tag{10}$$

where $\omega^B = \eta(\tau_v + \phi\tau_\varepsilon)$.

Proof: See Appendix B.

C. Analysis of the B-Share Discount and Market Depth

The theoretical analysis above shows that the A- and B-share prices are determined by a number of parameters. Our primary focus is how these prices are affected by the degree of information asymmetry, which is measured by the proportion of informed domestic investors in the A-share market (λ). We perform numerical analysis to examine the effect of λ on A-share and B-share prices. As a benchmark case, we assume there is no surprise in the signal ($\Delta S = 0$) and no unexpected change in supply in the A- and B-share markets ($\Delta y = \Delta z = 0$). A key parameter of the model is the quality of the information signal received by informed investors. We assume that $\tau_v = 5$ and $\tau_\varepsilon = 5$, implying a signal-to-noise ratio of one. The investor risk tolerance parameter (η) is assumed to be 0.5, and the interest rate (r) is fixed at 2%. For other parameters, we assume that $\tau_y = \tau_z = 5$, $\bar{v} = 3$, and $\bar{y} = \bar{z} = 6$. It should be noted that a change in the parameter values above does not have a qualitative effect on the relationship between λ and the share prices in the two markets.

Figure 1 plots the values of P_A and P_B against λ. The figure shows that both the A- and B-share prices are positively related to the proportion of informed domestic investors in the A-share market. It should be noted that an increase in the proportion of informed domestic investors in the A-share market has two effects. First, the informed investors will have a larger demand for A-shares because of the private signal they possess. Second, the uninformed investors in the A- and B-share markets will have less uncertainty about the payoffs because they can infer some of the private information based on the A-share price. As a result, an increase in the proportion of informed investors will reduce the risk premium for information uncertainty, resulting in higher share prices in both markets. This result is consistent with Easley and O'Hara (2004), who show that a higher fraction of informed traders makes the stock less risky for both

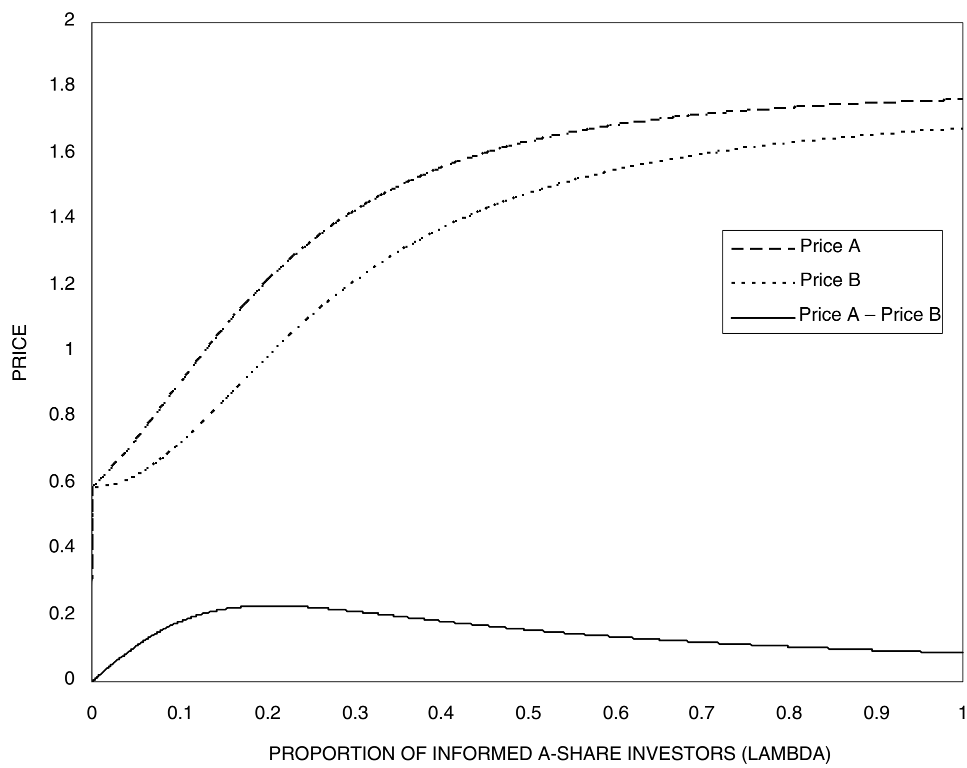

Figure 1. P_A, P_B, and $P_A - P_B$ ("foreign share discount") against the proportion of informed A-share investors (λ). This graph illustrates how in a noisy rational expectations model based on Grossman and Stigliz (1980), equilibrium prices depend on the proportion of (local) A-share investors that are informed. We define information as investors receiving the same noisy signal with respect to future payoff. (Foreign) B-share prices respond, as foreigners infer the signal from trading in the A-share market. The graph is based on the following parameter values ("precision" is "inverse variance"): $\eta = 0.5$ (risk tolerance); $\tau_v = \tau_\epsilon = 5$ (precision of random payoff and precision of noise in the noisy signal; the signal-to-noise ratio is therefore equal to 1); $\Delta S = \Delta y = \Delta z = 0$ (no surprise in signal and asset supply); $\tau_y = \tau_z = 5$ (precision of random asset supply); $\bar{v} = 3$ (mean payoff); and $\bar{y} = \bar{z} = 6$ (mean asset supply).

the informed and uninformed investors, decreasing the cost of capital.[4] Figure 1 also plots the difference between P_A and P_B, or effectively the B-share discount, against λ. The discount is nonnegative for all values of λ. Holding the supply of shares in the two markets the same, since the aggregate investor in the A-share market is more informed than in the B-share market, the demand for A-shares will be larger than the demand for B-shares, resulting in the A-share premium

[4] Easley and O'Hara also show that the risk premium is affected by the stock's information structure. For two stocks that are otherwise identical, the stock with more private and less public information will have a larger expected excess return. This occurs because when information is private, rather than public, uninformed investors cannot perfectly infer information from prices, and consequently they require a higher risk premium. The effect of the ratio of private to public information is beyond the scope of our discussion.

or B-share discount. Figure 1 shows that the B-share discount first increases with λ, reaching a peak around the value of 0.2 for λ, and then decreases with λ. The rationale is as follows. When λ initially increases, informed domestic investors who have less uncertainty about the stock's payoff will have greater demand than uninformed foreign investors so that the B-share discount will increase with the proportion of informed investors in the A-share market. But once the proportion of informed investors grows "sufficiently," the A-share price becomes very informative and the uninformed investors in the B-share market have less information disadvantage, in which case the price differential between the two markets declines.

We also examine the two parameters in equations (4) and (10), $\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$, which measure the impact of unexpected changes of share supply (Δy and Δz) on the prices in the A- and B-share markets, respectively. The unexpected changes in the supply of shares are reciprocal to the noise trading in Kyle (1985), although the former reflects supply shocks, while the latter reflects demand shocks. Similar to Kyle's model, $\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$ reflect the (inverse) market depth, as the deeper the market gets, the lower the two parameters are. These two parameters are also analogous to the price impact coefficients in the market microstructure literature that measure the price impact of unexpected order flows.

Figure 2 plots the values of $\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$ against λ. The price impact parameter in the A-share market ($\frac{1}{\Delta_A}$) first increases with λ, reaching a peak around the value of 0.2 for λ, and then declines with λ. In contrast, the price impact parameter in the B-share market ($\frac{1}{\Delta_B}$) is monotonically declining in λ. The intuition is as follows. An increase in the proportion of informed domestic investors has two effects on market depth—the *risk-bearing capacity* and the *adverse selection* effect. When there are more informed investors, the risk-bearing capacity in the market increases as both informed and uninformed investors have less information uncertainty. This effect generates a negative relationship between the proportion of informed investors and the price impact (or inverse market depth). On the other hand, the uninformed investors will also take into account the presence of informed investors when determining their demand elasticity. When there are more informed investors, an unexpected price decrease (increase) is more likely to originate from unfavorable (favorable) price signals of informed investors, so uninformed investors will be more aggressive in adjusting their demand downward (upward). Therefore, when the proportion of informed investors is higher, an unexpected positive (negative) supply shock will cause a larger decrease (increase) in the stock price, thus lowering market depth. This effect, the adverse selection effect, generates a positive relationship between the proportion of informed investors and the price impact.

In the A-share market, the relationship between $\frac{1}{\Delta_A}$ and λ depends on which effect dominates. When λ is small, the adverse selection effect dominates and hence the price impact increases when the proportion of informed investors increases. When λ is large, A-share prices are more revealing and the risk-bearing capacity effect dominates; hence, the price impact decreases when the

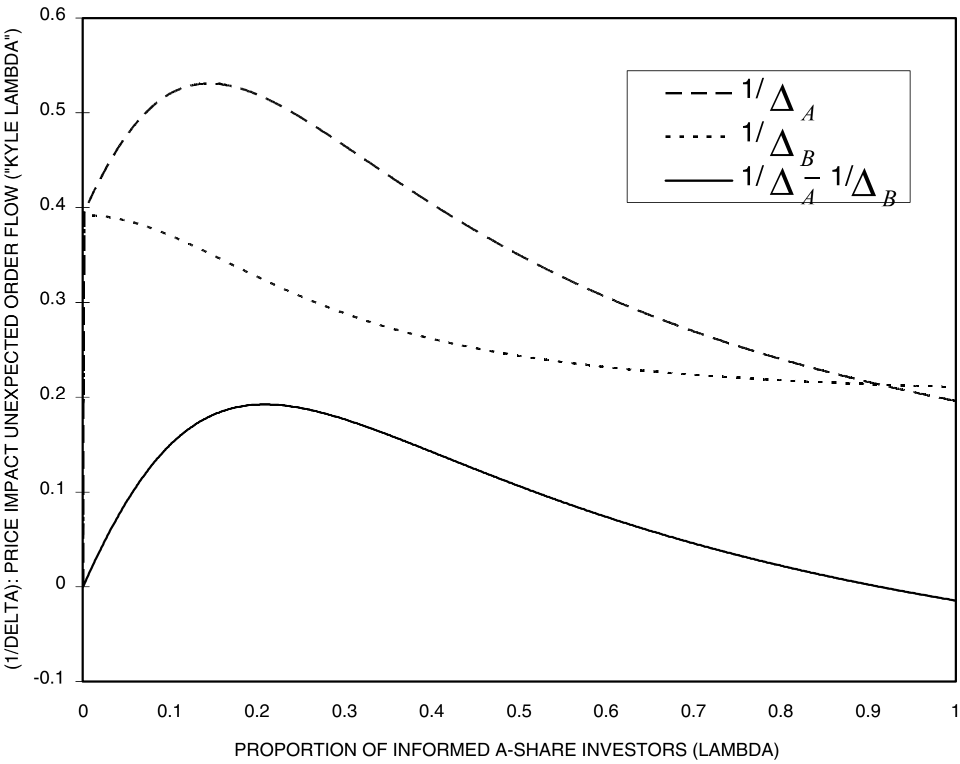

Figure 2. Price impact coefficients $1/\Delta_A$, $1/\Delta_B$, and $1/\Delta_A - 1/\Delta_B$ against the proportion of informed A-Share investors (λ). This graph illustrates how, in a noisy rational expectations model based on Grossman and Stigliz (1980), price impact coefficients (or inverse market depths) depend on the proportion of (local) A-share investors that are informed. We define information as investors receiving the same noisy signal with respect to future payoff. The graph is based on the following parameter values ("precision" is "inverse variance"): $\eta = 0.5$ (risk tolerance); $\tau_v = \tau_\varepsilon = 5$ (precision of random payoff and precision of noise in the noisy signal; the signal-to-noise ratio is therefore equal to 1); $\Delta S = \Delta y = \Delta z = 0$ (no surprise in signal and asset supply); $\tau_y = \tau_z = 5$ (precision of random asset supply); $\bar{v} = 3$ (mean payoff); $\bar{y} = \bar{z} = 6$ (mean asset supply).

proportion of informed investors increases. In the B-share market, since uninformed foreign investors are not trading directly with informed domestic investors, only the risk-bearing capacity effect prevails. Consequently, there is a negative relationship between $\frac{1}{\Delta_B}$ and λ.

Figure 2 also plots the difference between $\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$ against λ. When λ is small, the difference between $\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$ is positively related to λ. This is because the adverse selection effect increases $\frac{1}{\Delta_A}$, while the risk-bearing capacity effect decreases $\frac{1}{\Delta_B}$. When λ is large, the difference between $\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$ is negatively related to λ. In this instance, the risk-bearing capacity effect dominates, and it has a larger effect on the price impact in the A-share market than in the B-share market.

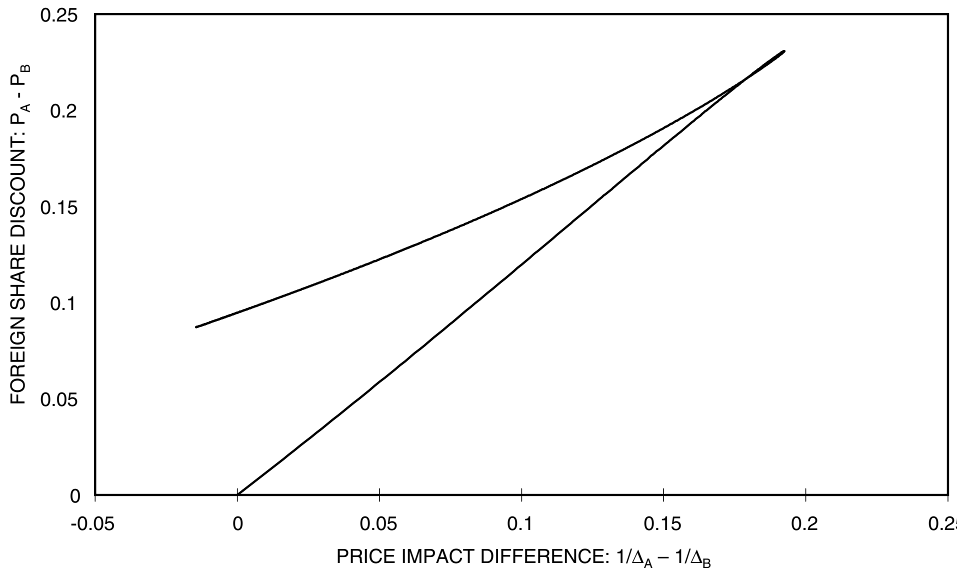

Figure 3. Foreign share discount ($P_A - P_B$) against price impact difference ($1/\Delta_A - 1/\Delta_B$). This graph illustrates how, in a noisy rational expectations model based on Grossman and Stigliz (1980), the foreign share discount ($P_A - P_B$) correlates with the price impact difference across markets ($1/\Delta_A - 1/\Delta_B$) as both are functions of the proportion of (local) A-share investors that are informed (see Figures 1 and 2). We define information as investors receiving the same noisy signal with respect to future payoff. The graph is based on the following parameter values ("precision" is "inverse variance"): $\eta = 0.5$ (risk tolerance); $\tau_v = \tau_\varepsilon = 5$ (precision of random payoff and precision of noise in the noisy signal; the signal-to-noise ratio is therefore equal to 1); $\Delta S = \Delta y = \Delta z = 0$ (no surprise in signal and asset supply); $\tau_y = \tau_z = 5$ (precision of random asset supply); $\bar{v} = 3$ (mean payoff); and $\bar{y} = \bar{z} = 6$ (mean asset supply).

It should be noted that the differential of price impact parameters ($\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$) in the two markets is not due to the exogenous trading activity factor, as trading volume does not play a role in our model. Instead, the reason for the relative market depth to vary is related to information asymmetry between the two markets. Given that the information asymmetry between the two markets also affects the B-share discount, as depicted in Figure 1, we also examine the relationship between the price impact differential and the B-share discount, which is plotted in Figure 3. For most values of λ, there is a positive relationship between the price impact differential and the B-share discount, except when we come to the neighborhood of the turning point, where the differential reaches the maximum value.

It should again be pointed out that the positive relationship between the price impact differential and the B-share discount cannot be explained by the trading activity explanation. According to the trading activity story, when the difference between $\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$ becomes smaller (or more negative), this indicates higher trading volume of the A-share market relative to the B-share market, which should be accompanied by higher B-share discounts in order to compensate foreign investors for the relatively inactive market. Therefore, it is only under the information asymmetry explanation, rather than the trading activity explanation, that we observe a positive relationship between the price impact differential and the B-share discount.

III. Information Asymmetry Measures and Control Variables

In this section, we discuss the methodology that we employ to construct the information asymmetry measures and the control variables used to explain the B-share discount in the next section. We first discuss three information asymmetry measures, namely, the price impact measure (PI), the adverse selection component (AS) of the spread decomposition, and the PIN.

A. Price Impact Measure (PI)

This approach is based on the theoretical models of Glosten (1987), Kyle (1985), and Easley and O'Hara (1987) and the empirical analysis of Glosten and Harris (1988), which suggest that the effects of asymmetric information are most likely to be captured by the price impact of a trade.

Let m_t denote the expected value of the security, conditional on the information set at time t, of a market maker who observes only the order flow ($V_t Q_t$, where V_t is trade size and Q_t is trade sign[5]) and a public information signal (e_t). According to Kyle (1985), m_t evolves as

$$m_t = m_{t-1} + \gamma Q_t V_t + e_t, \tag{11}$$

where γ is the price impact (or inverse market depth) parameter. Let φ denote the gross profit component associated with an order. Assuming competitive risk-neutral market makers, the transaction price (P_t) can be written as

$$P_t = m_t + \varphi Q_t. \tag{12}$$

Substituting out m_t using (11), we have

$$P_t = m_{t-1} + \gamma Q_t V_t + \varphi Q_t + e_t. \tag{13}$$

However, using $P_{t-1} = m_{t-1} + \varphi Q_{t-1}$, we find that the price change (ΔP_t) is given by

$$\Delta P_t = \gamma Q_t V_t + \varphi (Q_t - Q_{t-1}) + e_t. \tag{14}$$

It should be noted that the PI (γ) is directly related to the price impact parameters introduced in the theoretical model ($\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$). In the empirical analysis, we compare the PIs in the A- and B-share markets and investigate how they

[5] Trade sign is +1 for a buyer-initiated trade and –1 for a seller-initiated trade. Since not all trades occur at the bid or ask quotes, we follow the convention of Lee and Ready (1991) to classify trades as buyer- or seller-initiated. If a transaction occurs above the prevailing quote midpoint, it is regarded as a purchase and vice versa. If a transaction occurs exactly at the quote midpoint, it is signed using the previous transaction price according to the tick test (i.e., a purchase if the sign of the last nonzero price change is positive and vice versa).

affect the B-share discount. It should be pointed out, however, that in our theoretical model, the difference between $\frac{1}{\Delta_A}$ and $\frac{1}{\Delta_B}$ is due to the difference in informed trading in the two markets, whereas our empirical PI might also be driven by trading activity. Therefore, in the empirical analysis, we introduce additional variables to control for the trading activity differential across the two markets. We turn to this issue in the multivariate analysis in Section IV-C.

B. Adverse Selection Component of the Bid-Ask Spread (AS)

This approach extends the price impact parameter as estimated in equation (14). Basically, the price impact coefficient (γ) is a measure of the extent of private information that is available in the market, as it reflects the adverse selection cost of trading with informed investors. The gross profit cost (φ) has two components. The first is the order-processing cost, which is the cost of conveying an order to the market, monitoring the order, searching for a counterpart, and clearing and settlement procedures. The second is the inventory holding cost, which arises from the suboptimal inventory position that a risk-averse market maker must hold to supply immediacy (see, e.g., Stoll (1978) and Ho and Stoll (1981, 1983)).

A number of studies suggest that the adverse selection and gross profit costs consist of a fixed and a variable component. For the adverse selection cost, Easley and O'Hara (1987), Kyle (1985), and Glosten (1987) provide theoretical models that suggest that this component should increase with the quantity traded, as well-informed traders try to trade more to maximize the return on perishing information. Several empirical studies confirm this conjecture (see, e.g., Glosten and Harris (1988) and Lin, Sanger, and Booth (1995)). The gross profit component consists of the order-processing and inventory holding costs. The order-processing costs "represent the clerical costs of carrying out a transaction, the cost of a market maker's time, and the cost of the physical communications and office equipment necessary to carry out the transaction" (Copeland and Stoll (1990, p. 34)). To a considerable degree, the order-processing costs are fixed with respect to any particular transaction. However, we expect the inventory holding costs to increase with the quantity traded, as larger orders force liquidity providers to deviate further from their optimal inventory.

Based on the above, we assume that the adverse selection and the gross profit components vary over time and are linearly related to order size (V_t) as follows:

$$\begin{aligned} \gamma_t &= z_0 + z_1 V_t \quad \text{(adverse selection component)}, \qquad (15) \\ \varphi_t &= c_0 + c_1 V_t \quad \text{(gross profit component)}, \end{aligned}$$

where z_0, z_1, c_0, and c_1 are constants. Equation (15) can therefore be rewritten as

$$\Delta P_t = c_0(Q_t - Q_{t-1}) + c_1(Q_t V_t - Q_{t-1} V_{t-1}) + z_0 Q_t + z_1 Q_t V_t + e_t. \qquad (16)$$

The adverse selection cost is measured by $z_0 + z_1 V^*$, where V^* is the median order size. To incorporate the idea that market participants revise their beliefs according to the *innovation* in signed volume rather than signed volume itself (see, e.g., Madhavan, Richardsen, and Roomans (1997)), we use an ARMA (p, q) model to extract this innovation

$$Q_t V_t = \xi_1 Q_{t-1} V_{t-1} + \ldots. \xi_p Q_{t-p} V_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} \ldots\ldots\ldots - \theta_q \varepsilon_{t-q}. \tag{17}$$

After specifying and estimating this model with conventional ARIMA techniques, the residual, $\hat{\varepsilon}_t$, is interpreted as the innovation in signed volume. In addition, we introduce the rounding error due to price discreteness (η_t). The model then becomes

$$\begin{aligned} \Delta P_t &= c_0(Q_t - Q_{t-1}) + c_1(Q_t V_t - Q_{t-1} V_{t-1}) + z_0 Q_t + z_1 \hat{\varepsilon}_t + u_t, \\ u_t &= e_t + \eta_t - \eta_{t-1}. \end{aligned} \tag{18}$$

To estimate the model efficiently, we have to account for the dynamic structure in the (unobserved) error term u_t. This is achieved by estimating equation (18) with an MA (1) structure for the error term.

C. Probability of Informed Trading (PIN)

The probability of informed trading (PIN) measure is developed by Easley, Kiefer, and O'Hara (1996, 1997a, 1997b). Similar to the adverse selection component in the spread decomposition, the PIN is a measure of the amount of private information that is available in the market.

In the model of Easley, Kiefer, and O'Hara, it is assumed that with probability α, informed traders receive a private signal on the value of an asset at the start of a trading day. Conditional on the arrival of this signal, bad news arrives with probability δ and good news with probability $(1 - \delta)$. Furthermore, buy (sell) orders from liquidity traders arrive at rate ε_b (ε_s), and, conditional on the arrival of new information, orders from informed traders arrive at rate μ. Informed traders buy when they receive a positive signal and sell when they receive a negative signal.

The PIN model allows us to use observable trade and quote data on the number of buys and sells to make inferences about unobservable information events and the frequency of informed and uninformed trades. In the implementation, each day is considered as a trading period and the normal level of buys (sells) in a stock is used to identify ε_b (ε_s). Abnormal buys or sells indicate information-based transactions, which are used to identify μ. The number of days for which there are abnormal buys or sells is used to identify α and δ. Using a maximum likelihood estimation procedure and assuming a POISSION arrival process for the informed and uninformed traders, the likelihood function for a single day is

$$\begin{aligned} L(\vartheta \mid B, S) = {} & (1-\alpha) e^{-\varepsilon_b} \frac{\varepsilon_b^B}{B!} e^{-\varepsilon_s} \frac{\varepsilon_s^S}{S!} + \alpha\delta e^{-\varepsilon_b} \frac{\varepsilon_b^B}{B!} e^{-(\mu+\varepsilon_s)} \frac{(\mu+\varepsilon_s)^S}{S!} \\ & + \alpha(1-\delta) e^{-(\mu+\varepsilon_b)} \frac{(\mu+\varepsilon_b)^B}{B!} e^{-\varepsilon_s} \frac{\varepsilon_s^S}{S!}, \end{aligned} \tag{19}$$

where B and S indicate the total number of buys and sells, respectively, and $\vartheta = (\alpha, \delta, \mu, \varepsilon_b, \varepsilon_s)$ is the parameter vector. The likelihood is a mixture of distributions, for which the trade outcomes are weighted by the probability of a "good news day" ($\alpha(1-\delta)$), a "bad news day" ($\alpha\delta$), or a "no news day" ($1-\alpha$). Using the parameter estimates, the (unconditional) probability of an informed trade (PIN) is

$$\text{PIN} = \frac{\alpha\mu}{\alpha\mu + \varepsilon_b + \varepsilon_s}. \tag{20}$$

Based on the PIN measure, Easley, Hividjaer, and O'Hara (2002) find that the amount of private information affects asset returns. Using a sample of individual NYSE-listed stocks from 1983 to 1988, they find that a difference of 10 percentage points in the PIN measure between two stocks leads to a difference in their expected returns of 2.5% per year.

D. Control Variables

Given previous studies offer alternative explanations for B-share discounts, we construct a few control variables to examine the incremental explanatory power of our information asymmetry measures.[6]

The first set of control variables is the turnover ratios of A- and B-shares. Turnover is often used as a proxy for the level of trading activity and transaction costs. All things being equal, an investor requires a higher return or a lower price for holding a less actively traded stock. Therefore, the B-share discount should be higher if A-share trading volume increases and B-share trading volume decreases. An alternative interpretation of turnover is that it is a proxy for speculative trading. Mei et al. (2003)) view the A-share premium as a reflection of the speculative bubbles that are caused by overconfident domestic investors. The higher the turnover of the A-share market, the larger the speculative bubble. As speculative bubbles arise only in the A-share market, the B-share discount (or A-share premium) is positively related to the turnover of A-shares, but has no relationship with the turnover of B-shares. Besides turnover, we also measure the trading activity level based on the number of trades as the order sizes are different between the two markets.

The second set of control variables is the market capitalization of outstanding A- and B-shares. Market capitalization may be another measure of information asymmetry, as information costs are typically lower for large firms. To the extent this is the case, the B-share discount should be negatively related to the market capitalization of either A- or B-shares.

The last control variable is the cumulative A-share return or cumulative B-share return. Cumulative return proxies for stock momentum and, according to Karolyi and Li (2003), momentum itself may also be associated with

[6] It should be noted that we do not consider control variables that are related to the risk exposures of A- and B-shares, such as their betas and volatilities, as previous studies (e.g., Karolyi and Li (2003)) find little evidence to show that they can explain B-share discounts on a consistent basis.

risk. If stocks with high momentum are riskier stocks, and if Chinese investors are more risk tolerant than foreign investors, then we should observe that the discount is positively related to past returns. Another interpretation of the relationship between discounts and past returns is that domestic and foreign investors have different trading strategies. For example, Choe, Kho, and Stulz (1999) find strong evidence of positive feedback trading among foreign investors. If that is the case, then we should find that foreign investors purchase more B-shares when share prices increase, and thus the foreign share discount should be negatively related to past returns.

IV. Empirical Analysis

In this section, we discuss the data, present some summary statistics, and discuss the empirical results. We start with a brief description of the trading process and the available data.

A. Data and Preliminary Statistics

The trading processes for A- (local) and B- (foreign) shares on the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE) are similar. Both exchanges run order-driven, automated markets. Neither exchange has designated market makers. Traders can only submit limit orders, which arrive at an electronic consolidated open limit order book (COLOB). An incoming order is automatically matched against the best standing limit order in the COLOB, according to the price-time priority principle. If it cannot be matched, then it is added to the COLOB. There is no block trading system that allows liquidity traders to trade large volumes in an upstairs market. Off-exchange trading and insider trading are both forbidden, but this is not tightly monitored. The minimum trade size is 100 shares for local shares in both markets, but 1,000 shares for Shanghai foreign shares and 100 shares for Shenzhen foreign shares.

Our data consist of all time-stamped trades and quotes from January 2000 to November 2001 for all stocks traded on the SHSE and the SZSE.[7] We apply a number of filters to our data. First, we limit the sample to firms that traded A- and B-shares throughout the sample period, thereby reducing the number of firms from over 1,000 to 84. Second, we exclude eight firms, because only for a few days we find nonzero volume in the B-share market. Third, for the remaining 76 firms, we remove days for which, for exogenous reasons, there was no or very limited trading in either the A- or the B-share market.[8] Fourth, we remove stale quotes, which are easily recognized through zero depth. Fifth, the first and last 15 minutes of each trading session are removed from the sample.

[7] The data are collected by the Department of Economics of the School of Economics and Management of Tsinghua University.

[8] Examples include days when trading was halted because the price limit of a 10% change with respect to the previous day's close was reached.

Table I

Summary Statistics for A- and B-Share Trading

This table presents summary statistics of trading in Chinese A- (local) and B- (foreign) shares for January through December 2000, when both markets were fully separated. We provide cross-sectional statistics on trading variables for 76 firms whose shares were listed both as A- and B-shares. To facilitate comparisons across markets, for each share we only include those days for which there was uninterrupted trading in both the A- and B-share markets.

	A- (Local) Share				B- (Foreign) Share			
	Mean	σ	Min	Max	Mean	σ	Min	Max
Avg Transaction Price (Yuan)	14.29	4.17	6.15	26.05	3.10	1.14	1.21	7.96
St. Dev. of Price Change[a] (Yuan)	0.03	0.04	0.01	0.10	0.03	0.04	0.01	0.11
Avg Time between Trades (sec)	62	20	30	112	313	91	127	546
Avg Daily Volume (1,000 shares)	1,684	1,321	274	7,018	854	653	95	3,014
Avg Trade Size (shares)	5,769	3,011	1,957	18,536	16,769	8,842	4,081	40,773
Avg Quoted Spread[b] (Yuan)	0.027	0.016	0.011	0.124	0.035	0.014	0.013	0.085
Avg Relative Quoted Spread[b] (bps)	18	6	10	46	128	42	46	246
Avg Effective Spread[b] (Yuan)	0.035	0.019	0.013	0.135	0.035	0.012	0.013	0.077
Avg Relative Effective Spread[b] (bps)	24	6	14	50	126	40	52	272
Avg Depth at the Best Quote[bc] (shares)	4,679	2,976	1,275	18,061	26,720	20,194	5,868	95,360
Number of Stocks	76				76			

[a]Based on midquote changes in transaction time.
[b]Time-weighted averages.
[c]Average of the best bid depth and best ask depth.

Table I provides trading statistics for the A- and B-shares from January to December 2000, a period during which both markets were fully segmented. The table presents the cross-sectional mean, standard deviation, minimum, and maximum based on the 76 sample stocks. For comparison, the trade and quote data for the B-shares (in Hong Kong dollars for SZSE and in U.S. dollars for the SHSE) are converted to yuan using the (fixed) official exchange rate for the sample period. The average trade price in this period is 14.29 yuan (\$1.73) for A-shares and 3.10 yuan (\$0.37) for B-shares. This corresponds to an average B-share discount of 72%, which is in line with previous evidence (see, e.g., Bailey et al. (1999)).

In terms of volume, the B-share market is about half the size of the A-share market—an average of 854,000 versus 1,684,000 shares per day. The A-share market is more actively traded, as expected. Furthermore, we find that while the trading frequency is higher in the A-share market, the transaction size is lower. This highlights the importance of controlling for trade size in our spread decomposition analysis. Although the average quoted spread is 0.027 yuan for A-shares and 0.035 yuan for B-shares, this difference is not significant at conventional confidence levels. The effective spreads in the two markets are both equal to 0.035 yuan.

B. Preliminary Analysis of Information Asymmetry Measures

In this subsection, we estimate the price impact coefficients (PI), adverse selection components (AS), and the probability of informed trading (PIN) measures, and we study whether these information asymmetry measures agree, cross-sectionally, as to which securities exhibit the highest information asymmetry. We then relate these measures to the foreign share discount.

In preparing the data for the estimation of PI and AS, we follow Glosten and Harris (1988) and truncate the trade size to 100,000 shares to avoid giving too much weight to large trades. The median truncation frequency is 0.28% and 1.55% for the A- and B-share market, respectively. This is most likely the result of more institutional investors who trade in larger sizes, in the B-share market. We also truncate the trade size to 200,000 and 400,000 shares and find that the results are generally similar.[9]

Panel A of Table II contains estimates of the price impact coefficients for the 76 A- and B-shares. The mean estimates of γ and ϕ are 9.66×10^{-7} yuan per share and 8.58×10^{-3} yuan for the A-share market, and 2.61×10^{-7} and 6.35×10^{-3} for the B-share market. Therefore, although A-share volume is higher than B-share volume (see Table I), A-share depth is actually lower than B-share depth. This result is interesting as it shows that one should not equate liquidity with trading volume. Thus, consistent with our model in Section II, even without trading volume consideration, the information asymmetry between A- and B-share markets could cause their market depths to be different. This motivates why in subsequent regression analyses we test the extent to which our information asymmetry measures explain the B-share discount after controlling for trading activity.

Panel B of Table II contains cross-sectional statistics on the fixed and variable adverse selection component (AS) of the spread and on gross profit for the 76 A- and B-shares. The AS component coefficients, z_0 and z_1, are significant, and carry the expected sign for all of the 76 securities in the A-share market and for almost all (66 and 61, respectively) of the securities in the B-share market. This evidence is consistent with previous literature in that the cost of adverse selection is a significant component of the spread that increases with the size of the transaction. The fixed gross profit coefficients, c_0, are significant, and carry the expected sign for all of the securities in the A-share market and for 67 of the securities in the B-share market. The variable gross profit coefficients, c_1, are significant for 55 of the securities in the A-share market and for only 4 of the securities in the B-share market. The last column in Panel B reports the AS component for a median-sized trade. Consistent with the PI estimate, we find that the average AS component is larger in the A-share market than in the B-share market, with values of 56.4×10^{-4} and 46.8×10^{-4} yuan, respectively.

A problem in estimating PI and the AS component for the two markets is that there is a lower trade frequency for B-shares as compared to A-shares. In addition to estimating the AS component based on trade-by-trade data, we also

[9] The median truncation frequency is 0.06% and 0.30% for the A- and B-share market using 200,000 shares, and 0.01% and 0.04% using 400,000 shares.

Table II

Information Asymmetry: PI, AS Component of the Spread, and PIN

This table presents cross-sectional statistics on the parameter estimates of three econometric models that provide us with measures on the level of information asymmetry in the market, namely, the price impact measure (PI), the adverse selection (AS) component of the spread, and the probability of informed trading (PIN). The three econometric models are estimated based on (local) A-share and (foreign) B-share transaction data for 76 stocks from January through December 2000. Panel A presents the estimates of the PI, which are based on Kyle (1985) and Glosten and Harris (1988)

$$P_t - P_{t-1} = \gamma Q_t V_t + \phi(Q_t - Q_{t-1}) + e_t,$$

where P_t is the price of transaction t, Q_t is an indicator that classifies the transaction as buyer-initiated (+1) or seller initiated (−1), V_t is the transaction size, e_t is the unobservable error term, ϕ is the gross profit component associated with an order, and λ is the (inverse) market depth parameter, which is directly related to the price impact parameters introduced in the theoretical model. Panel B presents the estimates of a spread decomposition model based on Glosten and Harris (1988), defined as

$$P_t - P_{t-1} = c_0(Q_t - Q_{t-1}) + c_1(Q_t V_t - Q_{t-1} V_{t-1}) + z_0 Q_t + z_1 \hat{\varepsilon}_t + u_t \text{ with } u_t = \eta_t - \gamma \eta_{t-1},$$

where ε_t is the innovation in signed order flow and η_t is an i.i.d. random variable. Panel C presents the estimates of the PIN model proposed in Easley et al. (1996, 1997a, 1997b). These estimates are established by maximizing the likelihood

$$L(\vartheta \mid \{B_t, S_t\}_{t=1\ldots T}) = \prod_{t=1}^{T} \left((1-\alpha) e^{-\varepsilon_b} \frac{\varepsilon_b^{B_t}}{B_t!} e^{-\varepsilon_s} \frac{\varepsilon_s^{S_t}}{S_t!} + \alpha\delta e^{-\varepsilon_b} \frac{\varepsilon_b^{B_t}}{B_t!} e^{-(\mu+\varepsilon_s)} \frac{(\mu+\varepsilon_s)^{S_t}}{S_t!} + \alpha(1-\delta) e^{-(\mu+\varepsilon_b)} \frac{(\mu+\varepsilon_b)^{B_t}}{B_t!} e^{-\varepsilon_s} \frac{\varepsilon_s^{S_t}}{S_t!} \right),$$

where B_t and S_t indicate the total number of buys and sells on day t, respectively, and $\vartheta = (\alpha, \delta, \mu, \varepsilon_b, \varepsilon_s)$ is the vector of parameters.

Panel A: PI (Price Impact) Estimates

		Parameter Estimates		Inf. Asym. Measure[c]
		γ Price Impact Measure[a]	ϕ Gross Profit Component[b]	γ PI[a]
A-share	Mean	9.66	85.5	9.66
	St.Dev.	8.31	39.4	8.31
	N sig @1%	76	76	
B-share	Mean	2.61	63.5	2.61
	St.Dev.	1.62	18.4	1.62
	N sig @1%	73	76	

(continued)

Table II—*Continued*

Panel B: AS (Adverse Selection) Estimates

		Parameter Estimates						Inf. Asym. Measure[c]
		z_0 Fixed AS Component[b]	z_1 Variable AS Component[a]	c_0 Fixed Gross-Profit Component[b]	c_1 Variable Gross-Profit Component[a]	γ Discreteness	σ_u St. Dev. Error Term	$z_0 + z_1V^*$ AS Component for Median-Size Trade[b]
A-share	Mean	42.2	9.2	66.9	−1.2	0.18	0.020	56.4
	St. Dev.	3.0	0.5	2.5	0.4	0.01	0.011	30.0
	N sig @1%	76	76	76	55	76		
B-share	Mean	33.5	2.1	42.5	−0.2	0.23	0.014	46.8
	St. Dev.	8.9	0.7	8.0	0.5	0.04	0.005	21.2
	N sig @1%	66	61	67	4	72		

Panel C: PIN Model Estimates

		Parameter Estimates					Inf. Asym. Measure[c]
		μ Arrival Rate of Informed Traders	ε_b Arrival Rate of Uninformed Buys	ε_s Arrival Rate of Uninformed Sells	α Probability of an Information Event	δ Probability That New Information Is Bad News	$\alpha\mu(\alpha\mu + \varepsilon_b + \varepsilon_s)^{-1}$ PIN
A-share	Mean	0.38	0.44	0.51	0.36	0.30	0.13
	St. Dev.	0.14	0.16	0.17	0.07	0.22	0.04
	N sig @1%	76	76	76	76	49	
B-share	Mean	0.11	0.06	0.07	0.31	0.28	0.20
	St. Dev.	0.04	0.03	0.03	0.08	0.23	0.04
	N sig @1%	73	73	73	71	42	

[a] In 1/10,000 yuan per 1,000 shares.
[b] In 1/10,000 yuan.
[c] V^* equals the median trade size.

estimate based on fixed-length intervals. For instance, in the case of 15 minutes, price change from $t - 1$ to t is measured as the price change over the 15-minute interval, $V(t)$ is defined as the absolute value of net order flow in the 15-minute interval t, and $Q(t)$ is defined as 1 or –1 depending on whether the net order flow is positive or negative in the 15-minute interval t. In general, we find that using alternative estimates of PI and the AS component in our subsequent regression analyses produces qualitatively similar results.

Panel C of Table II presents cross-sectional statistics on the parameter estimates of the PIN model. Again, we find considerable evidence for privately informed traders in the A-share market, as the average arrival rate of these types of traders, μ, is 0.38, which is of the same level of magnitude as the arrival rates of uninformed buyers (0.44) and sellers (0.51). The arrival rate of informed traders in the B-share market is lower at 0.11, and again is of the same level of magnitude as the arrival rates of uninformed buyers (0.06) and sellers (0.07) in this market. The probability of an information event on a specific day, α, is higher in the A-share market than in the B-share market, with rates of 0.36 versus 0.31, respectively. This is consistent with the existence of more information in the A-share market. However, the average level of the PIN measure is higher in the B-share market, as this market exhibits a relatively low number of uninformed trades. All parameters are significant for the majority of the securities except for the parameter δ, which is the probability of the news being bad news.

We compare our measures of information asymmetry by verifying whether they agree cross-sectionally as to which securities exhibit the most information asymmetry. Figure 4 presents scatterplots of the AS component of the spread (for a median-sized trade) against PI and the PIN for both the A- and B-share markets. These plots suggest a stronger relationship between the measures in the A-share market, with correlations of 89% and 59%, respectively. The relationship in the B-share market is much weaker.

Finally, scatterplot analysis reveals that the B-share discount appears to be explained by the proposed information asymmetry measures. Figure 5 plots foreign share discounts against the differentials of the information asymmetry measures in the A-share market relative to the B-share market, as measured by PI, the AS component, or the PIN. For all measures, we find that stocks with relatively higher information asymmetry appear to command higher B-share discounts. The correlations between the three information asymmetry measures and the discounts are 66% for PI, 67% for AS, and 28% for PIN, and are statistically significant at either the 1% or 5% level.

C. Regressions of Foreign Share Discount on Information Asymmetry and Controls

In this subsection, we examine whether the relatively greater quantity of private information in the A-share market will result in a higher A-share premium (or B-share discount), and we check the robustness of our results by controlling for alternative explanations.

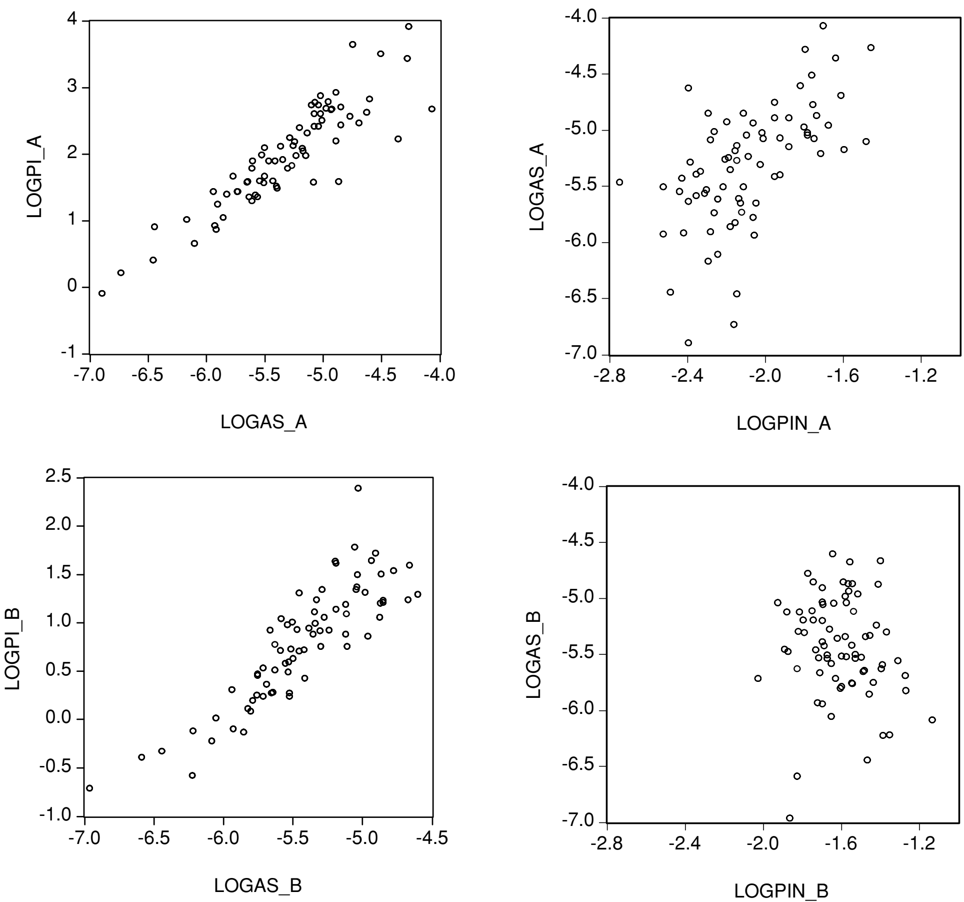

Figure 4. Scatterplots of (i) the price impact coefficient PI versus the AS component of the spread and (ii) the AS component versus PIN. PI is a price impact measure based on a regression of transaction price change on signed order flow; AS is the adverse selection component of the bid-ask spread based on a spread decomposition model; PIN is the probability of informed trading measure proposed by Easley, Kiefer, and O'Hara. These scatterplots for the (local) A-share and (foreign) B-share markets show to what extent the proposed information asymmetry measures (PI, AS component, and PIN) agree on which stocks exhibit the greatest information asymmetry. The estimates are based on January through December 2000, a period when both markets were fully segmented.

We start with a correlation analysis of information asymmetry and competing explanatory variables to check whether our explanation can be discriminated from these alternatives. The results in Table III show that stocks that exhibit higher information asymmetry between A- and B-share markets (higher differentials of PI, AS, and PIN) also enjoy higher turnover in both the A- and B-share markets, have a smaller A-share market capitalization,[10] and exhibit

[10] A-share market capitalization can be interpreted as total market capitalization, as B-share market capitalization is relatively small because both the B-share price is lower and the number of outstanding shares is lower.

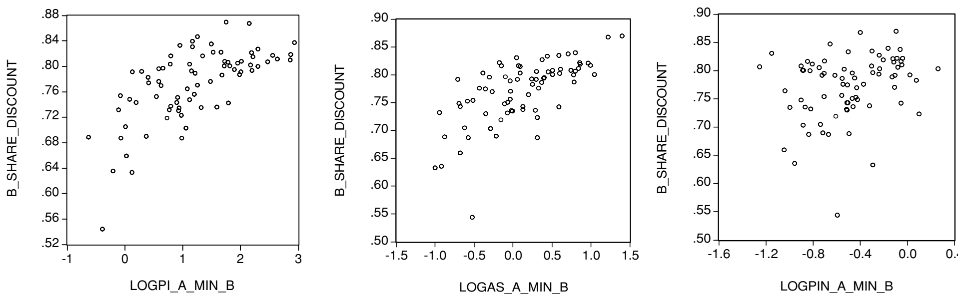

Figure 5. Scatterplots of foreign share discount versus information asymmetry measures. These scatterplots show to what extent our information asymmetry measures (PI, AS component, and PIN) can explain the foreign share discount. The estimates are based on January through December 2000, a period when both markets were fully segmented.

higher momentum. It is therefore imperative to control for these competing explanatory variables when relating our information asymmetry measures to the B-share discount.

Regression analysis of the foreign share discount on the candidate explanatory variables generates further support for the information asymmetry hypothesis, even after controlling for alternative explanations. Table IV summarizes the results of the univariate regressions with one of the information asymmetry variables and multivariate regressions using a subset of explanatory variables. The first three univariate regressions show that all three information asymmetry measures are significant. The PI and AS measures are the strongest, explaining 44% and 46% of the cross-sectional variation in the discounts, as compared to only 8% for the PIN measure. The slight increase in the explanatory power of the AS measure over the PI measure indicates that order size information, which is used in computing the AS measure, is marginally important in capturing the information asymmetry. The fourth regression finds that the A-share market's turnover is significantly positive, which is consistent with the explanation of Mei et al. (2003) that a premium is paid for shares that carry opportunities for speculative trading. The turnover of B-shares is also significant, albeit to a lesser extent, but its positive sign is not consistent with the trading activity explanation for the B-share discount. The fifth regression finds that the number of trades in the A-share market is statistically significant though bearing the wrong sign, while it is insignificant in the B-share market. The sixth regression shows that A-share market capitalization is significantly negative, which indicates that larger firms exhibit smaller discounts. This can be interpreted as support for our information asymmetry explanation, as the information cost is typically lower for larger firms. The seventh regression finds that momentum is significantly positive, which is consistent with the findings of Karolyi and Li (2003), who attribute this effect to high momentum stocks being riskier and Chinese investors being more risk tolerant.[11]

[11] We also try the cumulative B-share return and obtain qualitatively similar results.

Table III

Correlation Explanatory Variables

This table presents the correlations among all candidate explanatory variables for the cross-sectional variation in foreign share discounts. These explanatory variables include the three measures of information asymmetry differences across markets (PI, AS component of the spread, and PIN), turnover, number of trades, market capitalization in both markets, and momentum. All variables are calculated based on the period from January 2000 through December 2000.

	Diff. AS Component	Diff PIN[a]	Turnover A-share	Turnover B-share	Number of Trades A-share	Number of Trades B-share	Market Cap. A-share	Market Cap. B-share	Momentum[b]
Diff. PI	0.84**	0.16	0.32**	0.60**	−0.79**	0.26**	−0.69**	−0.03	0.36**
Diff. AS component		0.18	0.29**	0.51**	−0.67**	0.35**	−0.45**	0.07	0.20*
Diff. PIN			0.08	−0.05	−0.24**	−0.11	−0.20*	−0.18	0.13
Turnover A-share				0.35**	−0.25**	−0.32**	−0.70**	−0.52**	0.34**
Turnover B-share					−0.52**	0.26**	−0.44**	−0.27**	0.24**
Number of trades A-share						0.05	0.70**	0.11	−0.15
Number of trades B-share							0.26**	0.71**	0.07
Market cap. A-share								0.50**	−0.18
Market cap. B-share									−0.17

[a](local) A-share minus (foreign) B-share.
[b]A-share return.
*/**Signficant at the 90%/ 95% level.

Table IV

Foreign Share Discount: Information Asymmetry and Competing Explanations

This table presents regressions that relate the foreign share discount (FSD) to various explanatory variables. First, based on our information asymmetry hypothesis, we relate the FSD to our measures of information asymmetry, namely, the difference in PI (price impact), the AS component of the spread, and PIN. Second, we study the explanatory power of share turnover that, for the A- (local) share market, proxies for the amount of "speculative trading." According to Mei et al. (2003), this potentially leads to an A-share premium. For the B- (foreign) share market, it proxies for inactive trading which might explain B-share discounts. Third, we replace share turnover by the number of trades. Fourth, we study market capitalization as an explanatory variable. Mei et al. (2003) use it as an alternative proxy for speculative trading. Alternatively, market capitalization in the A-share market could be interpreted as a proxy for information asymmetry. Fifth, we relate the FSD to momentum, a variable that Karolyi and Li (2003) find to be important in explaining the FSD. Finally, we relate the FSD to our measures of information asymmetry, controlling for all competing explanations by adding the explanatory variables proposed by others. Turnover is defined as log(1+(Average Volume/Outstanding Shares)); market capitalization is the number of shares outstanding times the average daily closing price; momentum is the A-share return. The variables are based on January through December 2000, a period during which both markets were fully segmented. t values are in parentheses.

Model	Diff. PI[a]	Diff. AS Comp.[b]	Diff. PIN[c]	Turnover A-share	Turnover B-share	Number of Trades A-share	Number of Trades B-share	Market Cap. A-share	Market Cap. B-share	Momentum	Intercept	R^2
1 (PI diff)	0.045**										0.72**	0.44
	(7.64)										(83.47)	
2 (AS diff)		0.069**									0.76**	0.46
		(7.84)									(153.36)	
3 (PIN diff)			0.049**								0.80**	0.08
			(2.58)								(71.04)	
4 (Share turnover)				0.052**	0.020*						1.07**	0.17
				(2.61)	(1.77)						(13.75)	
5 (Number of trades)						−0.0735**	0.0078				1.13**	0.16
						(−3.78)	(0.44)				(9.73)	
6 (Market cap.)								−0.037**	−0.007		1.68**	0.32
								(−4.54)	(−0.86)		(10.00)	
7 (Momentum)										0.042**	0.75**	0.13
										(3.33)	(86.16)	
8 (PI diff + controls)	0.065**			0.033	−0.07**	−0.033	0.128**	0.030**	−0.089**	0.010	1.258**	0.77
	(7.25)			(1.62)	(−5.81)	(−1.08)	(4.53)	(2.34)	(−6.60)	(1.19)	(6.47)	
9 (AS diff + controls)		0.079**		−0.029	−0.043**	0.029	0.079**	−0.027*	−0.059**	0.003	1.69**	0.74
		(6.25)		(−1.17)	(−2.83)	(0.74)	(2.24)	(−1.85)	(−3.81)	(0.28)	(9.98)	
10 (PIN diff + controls)			−0.006	0.0375	−0.079**	−0.13**	0.20**	0.006	−0.098**	0.01	2.28**	0.59
			(−0.39)	(1.33)	(−3.85)	(−3.13)	(5.10)	(0.34)	(−4.79)	(1.01)	(11.1)	
11 (AS diff + PIN diff + controls)		0.080**	0.009	−0.034	−0.037**	0.043	0.068*	−0.030*	−0.053**	0.003	1.64**	0.75
		(6.25)	(0.67)	(−1.31)	(−2.07)	(0.97)	(1.70)	(−1.96)	(−2.96)	(0.33)	(8.60)	

[a]A-share PI minus B-share PI.

[b]A-share AS component minus B-share AS component.

[c]A-share PIN minus B-share PIN.

*/**Significant at the 90%/ 95% level.

In regressions 8, 9, and 10, we find that the PI and AS measures remain significant even after all control variables are included, while the PIN measure becomes insignificant. The explanatory power of PI and AS appears to be pervasive, as their coefficients are more statistically significant than all other control variables, including the B-share trading volume (turnover and number of trades). This also indicates that the effect of information asymmetry on illiquidity, as captured by PI and AS, is not captured by trading activity. In the final regression, regression 11, we include both AS and PIN and all control variables to establish the robustness of the result that AS (or PI for that matter[12]) is the most significant explanatory variable and that PIN is insignificant.

D. Changes After the B-Share Market Was Opened Up to Local Investors

In March 2001, regulators opened the B-share market to domestic investors. We use this regulatory change event to further test our information asymmetry hypothesis in two ways. First, we expect B-share discounts to shrink or vanish and, more important, our information asymmetry measures to increase for the B-share market after this event, because better-informed domestic investors are now allowed to participate in this market. Second, we repeat our cross-sectional regressions for the new sample period as a robustness test. We analyze the same 76 stocks for the sample period of April to November 2001.

We find that, consistent with our hypothesis, the discount levels decrease from an average of 72% to 43%, and the level of informed trading in the B-share market increases compared with the model estimates for the preevent period. The main reason for this gradual, rather than sudden, decline in discounts is the lack of foreign currency among domestic investors. Panel A in Table V presents pre- and postentry estimates of PI, and shows that PI almost doubles (+81%) for the B-share market from 2.6 preentry to 4.7 postentry. This increase is larger than the 21% increase in the A-share market and is therefore consistent with the arrival of better-informed domestic investors in the B-share market. Panel B confirms these results based on the AS component of the spread. For both the fixed (z_0) and the variable (z_1) AS component, we find considerable increases in the B-share market of 52% and 101%, respectively, after domestic investors were allowed to enter into this market. We find that the AS component for median-sized trades increases by 44% from 46.8 cents to 67.4 cents. This increase is again larger than the increase in the A-share market and thus consistent with the PI findings. Panel C of Table V reveals that the arrival rate of informed investors in the B-share market increases by 164%. This rate actually decreases by 29% in the A-share market. Further evidence of increased information in the B-share market is that the probability of an information event increases from 0.31 to 0.42, whereas in the A-share market, the probability increases only from 0.36 to 0.38. Nevertheless, the level of the PIN measure does not change much in either market, because the changes

[12] We do not include both PI and AS, as these proxies are highly collinear (correlation is 0.84, see Table III). If, instead of AS, we include PI, we find similar results.

Table V

PI, AS Component, and PIN: before and after Domestic Investors Are Allowed to Trade Foreign Shares

This table presents cross-sectional statistics on the parameter estimates of the econometric models we use to measure the level of information asymmetry. We present these statistics for 76 stocks for a period when the A- (local) and B- (foreign) share markets were fully segmented, as in Table II, and for a period after the B-share market was opened to domestic investors, that is, April through November 2001. Panel A presents the estimates of the price impact measure (PI), which is based on Kyle (1985) and Glosten and Harris (1988)

$$P_t - P_{t-1} = \gamma Q_t V_t + \phi(Q_t - Q_{t-1}) + e_t,$$

where P_t is the price of transaction t, Q_t is an indicator that classifies the transaction as buyer-initiated (+1) or seller initiated (−1), V_t is the transaction size, e_t is the unobservable error term, ϕ is the gross profit component associated with an order, and λ is the (inverse) market depth parameter, which is directly related to the price impact parameters introduced in the theoretical model. Panel B presents the estimates of a spread decomposition model based on Glosten and Harris (1988), defined as

$$P_t - P_{t-1} = c_0(Q_t - Q_{t-1}) + c_1(Q_t V_t - Q_{t-1} V_{t-1}) + z_0 Q_t + z_1 \hat{\varepsilon}_t + u_t \text{ with } u_t = \eta_t - \gamma \eta_{t-1},$$

where ε_t is the innovation in signed order flow and η_t is an i.i.d. random variable. Panel C presents the estimates of the PIN model proposed in Easley et al. (1996, 1997a, 1997b). These estimates are established by maximizing the likelihood

$$L(\vartheta \mid \{B_t, S_t\}_{t=1\ldots T}) = \prod_{t=1}^{T} \left((1-\alpha) e^{-\varepsilon_b} \frac{\varepsilon_b^{B_t}}{B_t!} e^{-\varepsilon_s} \frac{\varepsilon_s^{S_t}}{S_t!} + \alpha \delta e^{-\varepsilon_b} \frac{\varepsilon_b^{B_t}}{B_t!} e^{-(\mu+\varepsilon_s)} \frac{(\mu+\varepsilon_s)^{S_t}}{S_t!} + \alpha(1-\delta) e^{-(\mu+\varepsilon_b)} \frac{(\mu+\varepsilon_b)^{B_t}}{B_t!} e^{-\varepsilon_s} \frac{\varepsilon_s^{S_t}}{S_t!} \right),$$

where B_t and S_t indicate the total number of buys and sells on day t, respectively, and $\vartheta = (\alpha, \delta, \mu, \varepsilon_b, \varepsilon_s)$ is the vector of parameters.

Panel A: PI (Price Impact) Estimates

		Parameter Estimates		Inf. Asym. Measure
		γ Price Impact Measure[a]	ϕ Gross Profit Component[b]	γ PI[a]
A-share	Preevent	9.7	85.8	9.7
	Postevent	11.7	87.1	11.7
B-share	Preevent	2.6	63.5	2.6
	Postevent	4.7	57.0	4.7

(continued)

Table V—*Continued*

Panel B: AS (Adverse Selection) Estimates

		Parameter Estimates						Inf. Asym. Measure[c]
		z_0 Fixed AS Component[b]	z_1 Variable AS Component[a]	c_0 Fixed-Gross-Profit Component[b]	c_1 Variable-Gross-Profit Component[a]	γ Discreteness	σ_u St. Dev. Error Term	$z_0 + z_1V^*$ AS Component for Median-Size Trade[b]
A-share	Preevent	42.2	9.2	66.9	−1.2	0.18	0.020	56.4
	Postevent	52.7	11.1	59.6	−1.7	0.15	0.020	67.4
B-share	Preevent	33.5	2.1	42.5	−0.2	0.23	0.014	46.8
	Postevent	50.9	4.2	36.3	−0.8	0.11	0.017	67.4

Panel C: PIN Model Estimates

		Parameter Estimates					Inf. Asym. Measure[c]
		μ Arrival Rate of Informed Traders	ε_b Arrival Rate of Uninformed Buys	ε_s Arrival Rate of Uninformed Sells	α Probability of an Information Event	δ Probability That New Information Is Bad News	$\alpha\mu(\alpha\mu + \varepsilon_b + \varepsilon_s)^{-1}$ PIN
A-share	Preevent	0.38	0.44	0.51	0.36	0.30	0.13
	Postevent	0.27	0.26	0.35	0.38	0.23	0.15
B-share	Preevent	0.11	0.06	0.07	0.31	0.28	0.20
	Postevent	0.29	0.21	0.31	0.42	0.33	0.19

[a] In 1/10,000 yuan per 1,000 shares.
[b] In 1/10,000 yuan.
[c] V^* equals the median trade size.

in the arrival rate of uninformed traders roughly match those of informed traders.

The regressions of the foreign share discount on the information asymmetry measures and controls in the postevent period are consistent with earlier findings. Table VI presents the results for PI, AS, and PIN including and excluding the control variables. In all of the regressions, the information asymmetry measures are significantly positive, with the PI and AS component measures explaining 61% and 71% of the variation in foreign share discounts, respectively.

E. Discussion and Interpretation of the Results

Overall, our results provide strong evidence that the information asymmetry measures, especially the adverse selection component of the bid-ask spread, are far more important than any of the control variables in explaining the cross-sectional variation in B-share discounts. Our interpretation is that the information asymmetry measures reflect the extent of private information available to domestic investors. When there is a higher degree of information asymmetry, as measured by a higher price impact coefficient or adverse selection component in the A-share market than in the B-share market, domestic investors are more willing to pay a higher price than foreign investors, resulting in B-share discounts. However, several issues are worthy of discussion.

The first issue concerns the type of private information to which we refer. It is widely believed that Chinese investors trade on rumors rather than fundamentals. Furthermore, share manipulation is widespread, pushing prices away from the intrinsic value for a relatively long time period. Mei et al. (2003) argue that A-share prices are a reflection of speculative bubbles. Thus, it is not clear whether our information asymmetry measures reflect fundamental news. Although we agree with this view of the speculative behavior of investors, we do not think that it should disqualify our price impact coefficient or adverse selection component from being effective measures of information asymmetry. The difference between the adverse selection component and the gross profit component of the bid-ask spread is that the adverse selection component reflects a permanent price change, rather a temporary price change. Therefore, even for long-term investors, the adverse selection component is always important, regardless of whether it reflects fundamental news or rumors. Furthermore, Chan, Menkveld, and Yang (2007) show that A-share quote revision has predictive ability for B-share quote revision, but not vice versa. Therefore, even though A-share prices may not necessarily reflect fundamentals, it appears that foreign investors also react to the A-share price movement.

Second, if the A-share market is dominated by speculation, in which case stock prices do not reflect fundamentals, then we must ask why the differentials between A- and B-share prices are explained by some fundamental variables, such as our information asymmetry measures. Obviously, due to speculation, A-share prices might be more random, and hence less reflective of fundamentals. However, if B-shares are priced according to fundamentals by rational foreign investors, then the discounts should still correlate with information asymmetry measures. Our evidence demonstrates that foreign share discounts

Table VI

Foreign Share Discount: Information Asymmetry and Competing Explanations, Postevent

This table relates the foreign share discount to our measures of information asymmetry and various control variables in the same spirit as Table IV. The main difference is that all estimations are based on a period after the foreign share market was opened to domestic investors, April 2001 through October 2001.

Model	Diff. PI[a]	Diff. AS Comp.[b]	Diff. PIN[c]	Turnover A-share	Turnover B-share	Number of Trades A-share	Number of Trades B-share	Market Cap. A-share	Market Cap. B-share	Momentum	Intercept	R^2
1 (PI diff)	0.101**										0.31**	0.61
	(9.51)										(23.88)	
2 (AS diff)		0.213**									0.43**	0.71
		(13.51)									(59.95)	
3 (PIN diff)			0.082*								0.43**	0.05
			(1.94)								(25.32)	
4 (Share turnover)				0.068**	−0.050						0.51**	0.13
				(3.25)	(−1.44)						(3.39)	
5 (Number of trades)						−0.208**	0.099*				0.98**	0.24
						(−4.78)	(1.82)				(3.49)	
6 (Market cap.)								−0.105**	0.089**		0.74*	0.41
								(−6.77)	(4.67)		(1.90)	
7 (Momentum)										0.25**	0.46**	0.09
										(2.64)	(20.47)	
8 (PI diff + controls)	0.140**			0.184**	−0.214**	−0.253**	0.258**	0.156**	−0.163**	0.128**	0.41	0.82
	(9.17)			(7.58)	(−7.91)	(−4.97)	(4.17)	(6.16)	(−6.29)	(2.23)	(1.63)	
9 (AS diff + controls)		0.266**		−0.029	−0.148**	0.047	0.181**	−0.03	−0.09**	0.133**	1.11**	0.85
		(10.87)		(−1.10)	(−6.13)	(0.80)	(3.15)	(−1.49)	(−4.40)	(2.58)	(5.01)	
10 (PIN diff + controls)			0.018	0.141**	−0.162**	−0.359**	0.350**	0.032	−0.052	0.133	0.89**	0.59
			(0.54)	(3.78)	(−3.87)	(−4.37)	(3.67)	(0.94)	(−1.46)	(1.54)	(2.45)	
11 (AS diff + PIN diff + controls)		0.269**	0.034	−0.041	−0.135**	0.088	0.152**	−0.04*	−0.09**	0.141**	1.12**	0.86
		(11.09)	(1.65)	(−1.49)	(−5.42)	(1.39)	(2.55)	(−1.96)	(−3.95)	(2.74)	(5.15)	

[a] A-share PI minus B-share PI.
[b] A-share AS component minus B-share AS component.
[c] A-share PIN minus B-share PIN.
*/**Signficant at the 90%/ 95% level.

can be explained by fundamental components even if they become noisy due to randomness in A-share prices.

Third, a major reason for the PI or the AS component to be larger in the A-share market than in the B-share market might be that trades are more frequent in the former, making it easier for informed investors to camouflage themselves in the A-share market. In other words, the larger AS component for the A-share market may not necessarily be due to the A-share investors possessing "more information" than the B-share investors, but to being easier for the A-share informed investors to take advantage of their information. We do not rule out this possibility because we cannot trace the reason for observing a greater degree of informed trading in the A-share market than in the B-share market, that is, we cannot determine whether it is due to the ability of domestic investors to acquire private information or to their ability to hide their trades. Nevertheless, since the empirical evidence shows that information asymmetry measures are much more important than the number of trades in explaining the B-share discount, we think that this explanation, while plausible, is unlikely.

V. Conclusion

To conclude, the foreign share discount in China is a puzzle that many researchers have tried to solve. One common explanation for this puzzle is that foreign investors, who trade B-shares, have an informational disadvantage relative to domestic investors, who trade A-shares. In this paper, we construct several measures of information asymmetry based on market microstructure models—the price impact coefficient, the adverse selection component (AS) of the spread, and the probability of informed trading (PIN)—and investigate whether they can explain the cross-sectional variation in foreign share discounts after controlling for the influence of other variables that proxy for trading activity, speculative behavior, and stock momentum.

Based on a sample of 76 Chinese firms from 2000 to 2001, we find that all our measures of information asymmetry explain a significant portion of the cross-sectional variation in foreign share discounts. On a univariate basis, the PI and the AS component are particularly strong, explaining 44% and 46% of the variation in B-share discounts, while the PIN explains 8%. On a multivariate basis, the PI and the AS component are statistically more significant than any of the control variables in explaining B-share discounts. We do not claim that the information asymmetry measure is the only variable for explaining the B-share discount. In fact, we suspect that some other explanations, such as trading activity consideration and lack of investment opportunities, might be more important in explaining the *level* of the B-share discount. Our paper does demonstrate, however, that the information asymmetry measures are very important in explaining the *cross-sectional variation* of the discount.

We also investigate the effect of the B-share market being opened to domestic investors in March 2001. The advent of supposedly better-informed domestic investors in the B-share market should lead to a higher PI and AS component of the spread, as market makers in the B-share market now also face order flow from the better-informed domestic investors. This is confirmed by the data. Not only do we observe that B-share discounts decline from an average of 72% to 43% but we also find that the PI and the AS component increase by 81% and 44%, respectively. We also see increases in the A-share market, which indicates that postevent trading is more informative, but the B-share increases far exceed those observed in the A-share market. Hence, by allowing domestic investors to trade in the B-share market, there is less of an information disadvantage in this market, and thus the B-share discounts become smaller.

An extensive literature documents information asymmetry in international equity markets, but very few studies investigate whether information asymmetry is priced in the market. Our work is one of the few studies to demonstrate the effect of information asymmetry on asset prices. In particular, we find that our two information asymmetry measures explain the cross-sectional variation in foreign share discounts, which indicates that information asymmetry is priced in international equity markets.

Appendix

The model is based on Grossman and Stiglitz (1980), who introduce informational asymmetries into a noisy rational expectations model of asset pricing. We extend the model to two separate markets, whereby domestic investors trade in the A-share market and foreign investors trade in the B-market, although uninformed investors in both markets could infer, although imperfectly, private information of informed domestic investors based on the A-share price.

We assume the domestic investors in the A-share market fall into two types, informed and uninformed, in the proportions λ and $1-\lambda$, respectively. We further assume that all foreign investors in the B-share market are uninformed. This latter assumption is for convenience of analysis and could be relaxed without changing the key implications of the model as long as a smaller proportion of foreign investors is informed. All investors have CARA utility functions with a risk aversion coefficient of ρ or a risk tolerance parameter of η (i.e., $\eta = 1/\rho$). For the A- and B-share securities issued on the same company, the future payoff (v) is the same but uncertain, with $v \sim N(\bar{v}, \sigma_v^2)$. We assume that the domestic investors who are informed receive a noisy private signal (S) about the future payoff such that $S = v + \varepsilon_S$, with $\varepsilon_S \sim N(0, \sigma_\varepsilon^2)$. The uninformed domestic investors and the foreign investors do not observe the private signal, but attempt to extract information on the signal based on the A-share price (P_A). They are at an informational disadvantage, however, as noisy asset supply prevents the A-share price from being perfectly revealing. A-share asset supply is denoted by $y \sim N(\bar{y}, \sigma_y^2)$; B-share supply is denoted by $z \sim N(\bar{z}, \sigma_z^2)$. For convenience, we express all variance parameters in precision terms, that is, $\tau_v = 1/\sigma_v^2$, $\tau_\varepsilon = 1/\sigma_\varepsilon^2$, $\tau_y = 1/\sigma_y^2$, and$\tau_z = 1/\sigma_z^2$.

A. Equilibrium Price in the A-Share Market

We conjecture that the equilibrium A-Share price is

$$P_A = \beta_0^A + \beta_S^A \Delta S - \beta_y^A \Delta y. \tag{A1}$$

The posterior mean ($E[v \mid S, P_A]$) and posterior precision ($\tau[v \mid S]$) of the future payoff conditional on the private signal and the resulting demand of informed domestic investors ($x_A^I(P_A, S)$) in the A-share market are calculated as follows

$$E[v \mid S, P_A] = E[v \mid S] = \bar{v} + \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\Delta S, \tag{A2}$$

$$\tau[v \mid S] = \frac{1}{\mathrm{Var}[v \mid S]} = \tau_v + \tau_\varepsilon, \tag{A3}$$

$$\begin{aligned} x_A^I(P_A, S) &= \frac{E[v \mid S, P_A] - P_A(1+r)}{\rho \mathrm{Var}[v \mid S]} \\ &= \eta(\tau_v + \tau_\varepsilon)\left\{\bar{v} + \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\Delta S - P_A(1+r)\right\}. \end{aligned} \tag{A4}$$

The uninformed investors in the A-share market do not observe the private signal and hence they form their expectation of the future payoff based only on the price change. The posterior mean ($E[v \mid P_A]$), the posterior precision ($\tau[v \mid P_A]$), and the demand function of the uninformed traders ($x_A^U(P_A)$) in the A-share market are given by

$$E[v \mid P_A] = \bar{v} + \frac{\beta_S^A \sigma_v^2}{\left(\beta_S^A\right)^2\left(\sigma_v^2 + \sigma_\varepsilon^2\right) + \left(\beta_y^A\right)^2 \sigma_y^2}\Delta P_A = \bar{v} + \frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\Delta P_A, \tag{A5}$$

$$\mathrm{Var}[v \mid P_A] = \sigma_v^2\left(1 - \frac{\left(\beta_S^A\right)^2 \sigma_v^2}{\left(\beta_S^A\right)^2\left(\sigma_v^2 + \sigma_\varepsilon^2\right) + \left(\beta_y^A\right)^2 \sigma_y^2}\right),$$

$$\text{or } \tau[v \mid P_A] = \frac{1}{\mathrm{Var}[v \mid P_A]} = \tau_v + \frac{\tau_y}{\tau_y + h^2\tau_\varepsilon}\tau_\varepsilon, \tag{A6}$$

$$x_A^U(P_A) = \frac{E[v \mid P_A] - P_A(1+r)}{\rho \mathrm{Var}[v \mid P_A]} = \eta(\tau_v + \phi\tau_\varepsilon)\left\{\bar{v} + \frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\Delta P_A - P_A(1+r)\right\},$$

$$\text{where } \phi = \frac{\tau_y}{\tau_y + h^2\tau_\varepsilon} \text{ and } h = \frac{\beta_y^A}{\beta_S^A}. \tag{A7}$$

Based on the market clearing condition, we obtain

$$\begin{aligned} &\lambda x_A^I(P_A, S) + (1-\lambda)x_A^U(P_A) = y, \quad \text{or} \\ &\lambda\eta(\tau_v + \tau_\varepsilon)\left\{\bar{v} + \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\Delta S - P_A(1+r)\right\} \\ &\quad + (1-\lambda)\eta(\tau_v + \phi\tau_\varepsilon)\left\{\bar{v} + \frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\Delta P_A - P_A(1+r)\right\} = y. \end{aligned} \tag{A8}$$

Since $\Delta P_A = P_A - E(P_A) = P_A - \beta_0^A$, we can express the A-share price

$$P_A(S, y) = \frac{1}{\Delta_A}\left\{(\omega^I + \omega^U)\bar{v} - \frac{1}{\beta_S^A}\omega^U \frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\beta_0^A - \bar{y} + \omega^I \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\Delta S - \Delta y\right\}, \tag{A9}$$

where

$$\frac{1}{\Delta_A} = \frac{1}{(1+r)(\omega^I + \omega^U) - \dfrac{1}{\beta_S^A}\left(\dfrac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right)\omega^U},$$

$$\omega^I = \lambda\eta(\tau_v + \tau_\varepsilon),\ \omega^U = (1-\lambda)\eta(\tau_v + \phi\tau_\varepsilon).$$

By imposing the rationality condition, comparing equation (A1) with (A9), we have

$$\beta_0^A = \frac{1}{\Delta_A}\left\{(\omega^I + \omega^U)\,\bar{v} - \frac{1}{\beta_S^A}\omega^U \frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\beta_0^A - \bar{y}\right\}, \tag{A10}$$

$$\beta_S^A = \frac{1}{\Delta_A}\left\{\omega^I \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\right\}, \tag{A11}$$

$$\beta_y^A = \frac{1}{\Delta_A}. \tag{A12}$$

Based on equations (A10), (A11), and (A12), we solve for β_0^A, β_S^A, and β_y^A as explicit functions of the exogenous parameters

$$\beta_0^A = \frac{1}{(1+r)}\bar{v} - \frac{1}{(1+r)(\omega^I + \omega^U)}\bar{y}, \tag{A13}$$

$$\beta_S^A = \frac{1}{(1+r)(\omega^I + \omega^U)}\left\{\omega^I \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon} + \omega^U \frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right\}, \tag{A14}$$

$$\beta_y^A = \frac{1}{\Delta_A} = \frac{1}{(1+r)(\omega^I + \omega^U)}\left\{1 + \left(\omega^U \frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right)\Big/\left(\omega^I \frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\right)\right\}. \tag{A15}$$

The solution to h in equation (A7) can be also found by dividing equation (A15) by equation (A14).

B. Equilibrium Price in the B-Share Market

The derivation of the equilibrium price in the B-share market is more straightforward. Since there is no informed foreign investor, all the demand comes from uninformed foreign investors. The demand of foreign investors in the B-share market, denoted by $x_B^U(P_A)$, is a function of the A-share price as foreign investors also infer the private information of informed domestic investors from the A-share market, that is,

$$x_B^U(P_A) = \frac{E[v \mid P_A] - P_B(1+r)}{\rho \mathrm{Var}[v \mid P_A]} = \eta(\tau_v + \phi\tau_\varepsilon)\left\{\bar{v} + \frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\Delta P_A - P_B(1+r)\right\}. \tag{A16}$$

By imposing the market clearing condition, we obtain

$$\eta(\tau_v + \phi\tau_\varepsilon)\left\{\bar{v} + \frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\Delta P_A - P_B(1+r)\right\} = z. \tag{A17}$$

Since $\Delta P_A = P_A - E(P_A) = P_A - \beta_0^A$ and $z = \bar{z} + \Delta z$, equation (A17) could be rewritten as

$$\omega^B\left(\bar{v} - \frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\beta_0^A\right) + \omega^B\frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}P_A - \omega^B P_B(1+r) = \bar{z} + \Delta z, \tag{A18}$$

where $\omega^B = \eta(\tau_v + \phi\tau_\varepsilon)$.

Therefore, the equilibrium B-share price is

$$P_B(P_A, z) = \frac{1}{\Delta_B}\left\{\omega^B\left(\bar{v} - \frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\beta_0^A\right) - \bar{z} + \omega^B\frac{1}{\beta_S^A}\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}P_A - \Delta z\right\}, \tag{A19}$$

where $\frac{1}{\Delta_B} = \frac{1}{(1+r)\omega^B}$.

The B-share equilibrium price now takes the following functional form

$$\begin{aligned} P_B &= \alpha_0 + \alpha_B P_A + \alpha_Z \Delta z, \\ P_B &= \beta_0^B + \beta_S^B \Delta S - \beta_y^B \Delta y - \beta_Z^B \Delta z. \end{aligned} \tag{A20}$$

By substituting for P_A in equation (A19), and substituting for the expressions in equations (A13) to (A15), and comparing the final expression with equation (A20), we obtain

$$\beta_0^B = \frac{1}{(1+r)}\bar{v} - \frac{1}{(1+r)\omega^B}\bar{z}, \tag{A21}$$

$$\beta_S^B = \frac{1}{(1+r)}\left(\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right), \tag{A22}$$

$$\beta_y^B = \frac{1}{(1+r)}\left(\frac{\phi\tau_\varepsilon}{\tau_v + \phi\tau_\varepsilon}\right)\Big/\left(\omega^I\frac{\tau_\varepsilon}{\tau_v + \tau_\varepsilon}\right), \tag{A23}$$

$$\beta_z^B = \frac{1}{\Delta_B} = \frac{1}{(1+r)\omega^B}. \tag{A24}$$

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