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ASSET PRICING IN A SEGMENTED EMERGING MARKET

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This paper investigates the effect of market segmentation on stock prices and returns in emerging Chinese markets. Under the assumption of infinite investment horizon and representative consumer, I formulate an Intertemporal Capital Asset Pricing Model (ICAPM) with restrictions on share ownership. The model posits that cross-section variations in the average excess returns between domestic A -and foreign B- shares depend on systematic risks as measured by shares' own market betas and betas with respect to the international equity markets. After correcting for errors-in-variable problem, I obtain econometric results consistent with the empirical predictions of ICAPM.

JEL classification codes: G12, G15, O16
Key words: asset pricing, ICAPM, market segmentation, ownership restriction, China

I. Introduction

As China began moving toward a market economy and privatizing state enterprises, it introduced domestic share market in December 1990 and foreign share market in February 1992. Foreign shares are issued to international investors and domestic shares to local Chinese, respectively, and they trade on separate markets. Foreign and domestic shares of the same company have identical voting rights and cash-flow rights, but foreign shares (denominated

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in foreign currencies) are sold and traded at various discounts relative to the corresponding domestic shares (denominated in domestic currency). Because of ownership restriction, market segmentation, and inconvertibility of domestic currency to foreign currencies, investors cannot arbitrage across domestic and foreign shares.

Bailey (1994) first documents the distinction between A- and B-share markets in China. Ma (1996) argues that price differences between A- and B-shares can be attributed to investors' attitude towards risk. Poon et al. (1998) posits that an increase in the size of a firm's domestic investor base relative to its foreign counterpart will lower investors' expected returns and increase the market value of A-shares. Su (1999) suggests that illiquidity of foreign-owned shares is likely to be one of the causes of B-share price discount. This paper analyzes the price differential for A- and B-shares (identical except ownership restrictions) using an Intertemporal Capital Asset Pricing Model (ICAPM). The solution to the ICAPM clearly shows that cross-section variations in the expected return between two classes of shares-those purchased and traded by domestic and foreign investors, respectively, are determined by the shares' own market betas and betas with respect to the international financial markets. Then I test the model after correcting for errors-in-variables (EIV) problem. My empirical findings are:

- Cross-section excess of domestic over foreign shares' average returns are positively related to domestic shares' market betas and negatively related to both foreign shares' market betas and betas with the Hong Kong Hang Seng index.

- The variance of shares' returns and the firm size do not appear to influence cross-section return differences.

These results strongly support the ICAPM formulation.

The rest of the paper proceeds as follows: In Section 2, I describe the effects ownership restrictions have on stock prices in China. In Section 3, I analyze the ICAPM under ownership restrictions and derive some testable implications. In Section 4, I describe the methodology in empirical tests and present the empirical results. I conclude the paper in Section 5 with a summary of findings.

II. Ownership Restrictions in Chinese Stock Markets

There are two official stock exchanges in China: the Shanghai Securities Exchange (established in December 1990) and the Shenzhen Securities Exchange (established in April 1991). Dual listing is not allowed across the two exchanges. An automatic order matching and execution system similar to that of the New York Stock Exchange is used in trading securities. The regulatory body for the securities market is the Chinese Securities Regulatory Committee (CSRC), which supervises stock issues and trading activities. A company must first apply for permission to issue shares from the CSRC, and then apply for listing at a later date.

There are four types of domestic shares, namely, (1) government shares, held by the State Assets Management Bureau (SAMB); (2) legal entity shares, or C shares, held by other state-owned enterprises; (3) employee shares, held by managers and employees; and (4) ordinary domestic shares, or A shares, designated only for private Chinese citizens and traded on the two official exchanges. Government shares, legal entity shares, and employee shares are sold at share's face value, which is the book value of a firm's total assets divided by the total number of shares declared in the prospectus, and are not tradable in any of the official exchanges, although employee shares are allowed to be listed three years after being issued. A shares are typically sold through firm-commitment underwriting mechanism with a lottery to allocate shares or through auction mechanism (Su and Fleisher, 1999). All types of domestic shares are entitled to the same voting rights and cash flow rights.

China's stock markets opened to international investors on February 21, 1992, when Shanghai Vacuum Electronics began issuing B shares on the

Shanghai Securities Exchange. This was quickly followed by the listing of China Southern Glass B shares in Shenzhen on February 28, 1992. B shares can only be purchased and traded by foreign investors, and cannot be cross-listed. By the end of September 1996, 58 companies have listed B shares in the two official exchanges. B shares are sold using firm-commitment underwriting mechanism with pro-rata allocation of over-subscribed shares. For each company, A and B share are entitled to the same voting rights and cash flow rights.

In 1993, China created additional classes of stock to facilitate the direct listings of Chinese companies on foreign stock exchanges. They are H shares (for Hong Kong Stock Exchange) and N shares (for New York Stock Exchange). H shares and N shares carry the same rights and obligations as A and B shares, but they cannot be traded on stock exchanges in China.

Not all firms permitted to go public can issue foreign shares. Companies that have issued foreign shares are usually large enterprises with heavy export orientation so that they have sufficient foreign currencies to fulfill dividend payments. To limit foreign ownership, a company cannot issue more than 25% of its total tradable shares in foreign shares. Unlike Indonesia and Thailand, where individuals are permitted to purchase local shares and have them registered as foreign shares through a foreign sponsor, Chinese investors are allowed to purchase and trade only A shares while foreign investors can purchase and trade only B shares in Chinese exchanges. A- and B-share markets are segmented because no one has the legal right to trade on both markets and it is not directly possible to offset an unlimited purchase of B shares with a corresponding sale of A shares.

Although A and B shares represent claims to the same cash flow rights, B shares are generally sold and traded at substantially lower prices than A shares. Define A-share premium as $(P_A - P_B)/P_B$, where P_A is the price for A share and P_B is the price for the corresponding B share. Tables 1 and 2 present the time-series average weekly A-share premium for 27 Shanghai firms and 20 Shenzhen firms that issued both A- and B-shares before April 1994. The sample period is between April 1994 and October 1998. Define

Table 1. Sample Statistics for A-Share Premiums for Shanghai Companies that Issued A- and B-Shares before April 1994

(Sample Period: April 1, 1994 - October 31, 1998)

Company	Mean	Std. Dev.	Minimum	Maximum
Shanghai Vacuum Electronics	0.95	0.51	0.13	1.64
Shanghai Erfangji	0.56	0.31	-0.11	1.25
Dazhong Taxi	1.26	0.53	0.15	1.93
Yongsheng Stationery	0.61	0.39	-0.26	1.16
China First Pencil	0.75	0.23	0.33	1.30
China Textile Machinery	0.87	0.47	-0.35	1.66
Shanghai Rubber Belt	1.31	0.61	0.25	2.38
Shanghai Chlor Alkai	0.63	0.37	0.20	1.26
Shanghai Tire & Rubber	0.56	0.34	0.11	1.09
Shanghai Refrigerator	0.98	0.43	0.17	1.76
Jinqiao Export & Import	0.56	0.34	-0.09	1.23
Outer Gaoqiao	0.62	0.38	-0.19	1.46
Lianhua Fiber	0.92	0.39	-0.05	1.83
Shanghai Jin Jiang Tower	0.79	0.38	0.24	1.62
Forever Bicycle	0.61	0.36	0.08	0.97
Phoenix Bicycle	0.68	0.29	0.30	1.14
Shanghai Haixian Group	1.51	0.63	0.42	2.75
Yaohua Pilkington Glass	0.88	0.34	0.21	1.92
Dajiang Group	0.61	0.38	-0.04	1.27
Shanghai Diesel Engine	0.55	0.28	0.09	0.96
Hero Pen	0.73	0.36	-0.13	1.37
Sanmao Textile	1.38	0.49	0.26	2.12
Shanghai Friendship Store	0.85	0.48	-0.25	1.63
Industrial Sewing Machine	1.49	0.54	0.16	2.24
Shang-Ling Refrigerators	0.62	0.36	0.12	1.27
Shanghai Steel Tube	1.25	0.46	0.28	2.10
Shanghai Merchandise Trading	0.75	0.32	-0.06	1.27

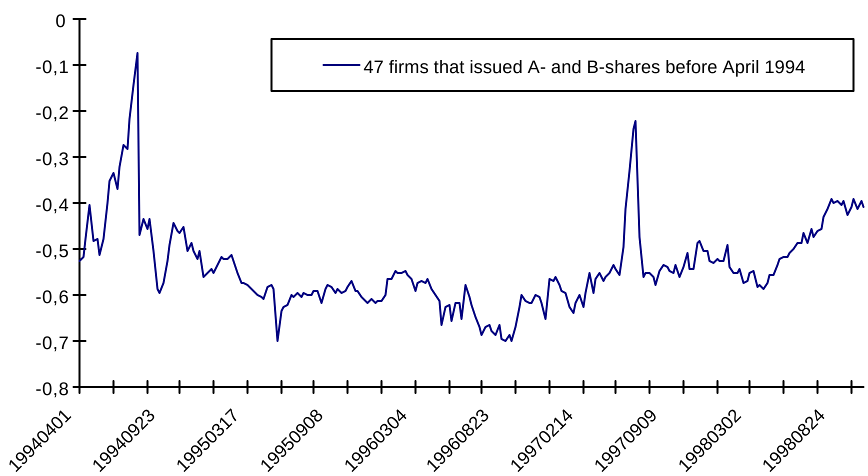
Table 2. Sample Statistics for A-Share Premiums for Shenzhen Companies that Issued A- and B-Shares before April 1994

(Sample Period: April 1, 1994 - October 31, 1998)

Company	Mean	Std. Dev.	Minimum	Maximum
Shenzhen Vanke Co.	0.43	0.21	0.08	0.87
Gintian Industry	0.62	0.27	0.09	1.08
Property & Resource Devel.	0.32	0.18	-0.05	0.68
China Southern Glass	0.36	0.20	0.04	0.83
Shenzhen Petroch. Co	0.58	0.34	0.11	1.07
Shenzhen Zhonghao Co.	0.49	0.31	-0.06	1.12
Konka Electronics	0.26	0.15	-0.18	0.62
Shenzhen China Bicycles	0.28	0.19	-0.23	0.75
Victor Onward Textile	0.69	0.37	0.09	1.41
Shenbao Industry	0.74	0.39	0.14	1.57
Shenzhen Huafa Electronics	0.24	0.16	-0.17	0.70
Chiwan Wharf Holdings	0.28	0.16	-0.14	0.69
China Merchants Shekou Co.	0.14	0.17	-0.58	1.06
Tellus Machinery	0.08	0.16	-0.24	0.46
Fiyta Holdings	0.04	0.32	-0.57	0.80
Yili Mineral Water	0.85	0.27	0.04	1.27
SEZ Real Estate	0.87	0.28	-0.09	1.56
Shenzhen Lionda Holdings	0.33	0.20	-0.14	0.93
Shenzhen Nanshan Power	0.45	0.24	-0.28	0.76
China Marine Containers	0.13	0.22	-0.24	0.53

B-share discount as $(P_B - P_A)/P_A$. Figure 1 plots the unweighted average weekly B-share discount for these firms during the sample period. As shown in the figure, the magnitude of the discount is persistently large but varies over time. The average B-share discount over the entire sample period is 59.18%, with the spreads in Shenzhen about half of those in Shanghai.

Figure 1. Average Weekly B-Share Discount from April 1994 to October 1998

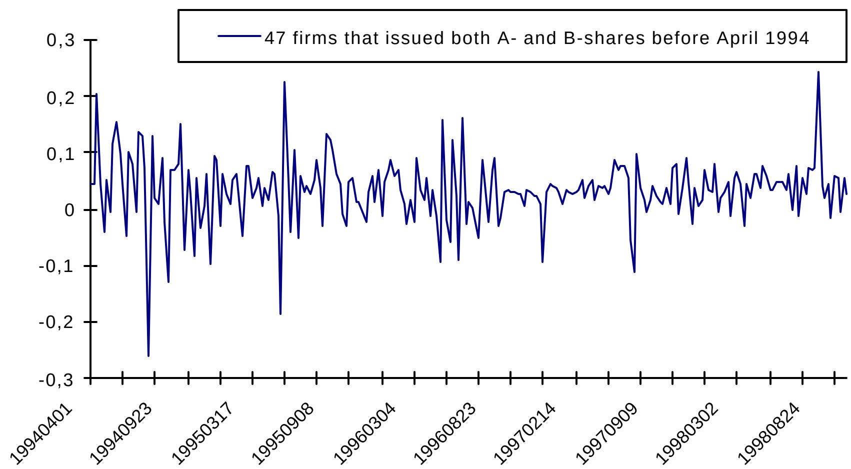


A complete analysis of this price difference would explain both why different investor groups pay different prices and why firms sell discounted B shares. Modeling firm's behavior in this regard encounters a number of difficult issues. Stulz and Wasserfallen (1995) use a one-period CAPM to analyze the price differentials between restricted and unrestricted shares in the Swiss case, in which firms choose ownership restrictions voluntarily. They argue that price differentials can arise when a representative domestic firm maximizes its value by discriminating between domestic and foreign investors. The application of their framework to the Chinese case, is problematic for three reasons. First, the aggregate amount of new shares to be issued each year is determined by a national quota set by the CSRC. It is unappealing to assume that the number of A- and B-shares is determined by firms' maximizing behavior. Second, even if firms choose the optimal amount of A and B shares issued to maximize their value under price discrimination, it is unclear whether they engage in Cournot competition or in cartel competition. Third, as Stulz and Wasserfallen (1995, p.1054) note, the price discrimination strategy they describe is likely to be time-inconsistent in a dynamic framework.

In light of these difficulties, I do not model the firms' behavior in this paper. Instead, I use asset pricing theory to explain why different investors pay different prices for exogenously determined quantity of shares. Since a stock's price equals the present value of expected future dividends discounted at investors' required rates of return, different shares with the same expected future cash flows should have the same prices unless different investors have different required rates of returns due to different valuation of risks. B-share investors are primarily foreign investors who are likely to have different risk exposure or attitude toward risks in Chinese financial markets than domestic investors do. For example, in a simple dividend growth model, $P_i = D_0(1+g)/(r_i - g)$ where P_i is the price for a specific type of share, g is the dividend growth rate (assumed as constant) and r_i is the investor's required rate of return for that type of share. From simple manipulation, $(P_B - P_A)/P_A = (r_A - r_B)/(r_B - g)$. If dividend growth rate is assumed to be zero, then $(P_B - P_A)/P_A = (r_A - r_B)/r_B$. The cum dividend average returns for A and B shares are 8.27% and 18.79% in the sample period, respectively. These return figures are consistent with an average B-share discount of 59.18%. Figure 2 plots the time-series differences in average weekly returns between B and A shares. As shown in the figure, B-share returns are on average 57.44% higher than their A-share counterparts.

In the next section, I show that the difference in the average return for domestic and foreign investors can be predicted from the equilibrium asset pricing theory. A general equilibrium model accounting for the supply side economy would certainly be an interesting extension to this paper.

Figure 2. Differences in Average Weekly Returns between B and A Shares from April 1994 to October 1998



III. An Intertemporal CAPM

In this section, I use the ICAPM to model the optimal portfolio selection for domestic and foreign investors under ownership restrictions and to explain the cross-section spread in average returns for A and B shares. I also draw several testable implications from the model.

A. Modeling Ownership Restrictions

I assume that there are two countries, the domestic country D and the foreign country F. Each domestic firm i ($i = 1, 2, \ldots, N$) issues a single stock, but in two types of shares: A and B shares. Each foreign firm j ($j = 1, 2, \ldots, M$)

issues a single type of stock: C share. A risk-free debt instrument exists in each country. Risk-free rates are assumed to be time-invariant. The following ownership restrictions exist in the world economy:

1. Domestic investors are prohibited from buying B and C shares;

2. Foreign investors are prohibited from buying A shares;

3. Investors in each country cannot hold the other country's safe asset.

Furthermore, I assume that there is no arbitrage across A and B shares that would undermine these restrictions.

B. Stock Price and Return Dynamics

Denote the cum dividend price of a type h stock i at time t as $P_{h,i}(t)$ $(h = A,B,C)$, and assume that $P_{h,i}(t)$ follows a diffusion process with constant proportional mean and variance (geometric Brownian motion).

$$dP_{h,i}(t) = m_{h,i}\, P_{h,i}(t)\, dt + s_{h,i} P_{h,i}(t)\, dz_{h,i}(t) \tag{1}$$

where $m_{h,i}$ and $s^2_{h,i}$ are the mean and variance of the return on type h stock i and $dz_{h,i}(t)$ is a standard diffusion (Wiener) process.

Therefore, the distribution of stock price is log-normal and the rate of return is

$$r_{h,i}(t) = \frac{dP_{h,i}(t)}{P_{h,i}(t)} = m_{h,i}\, dt + s_{h,i}\, dz_{h,i}(t) \tag{2}$$

The assumption of lognormal returns is a simplification of the actual process, which has some serial correlation as discussed by Su and Fleisher (1998).

C. Intertemporal Maximization by Domestic Investors

I assume that all domestic investors are identical (a representative consumer-investor) or differ in a restricted sense that wealth redistributions will not alter equilibrium asset prices so that consumer-investor aggregation is possible. I further assume that the composite domestic investor is infinitely lived and has state-independent isoelastic utility of consumption,[2]

$$U(C,t) = \frac{C(t)^{\blacksquare}}{1\text{-}g_D} \qquad (3)$$

where $C(t)$ is the composite domestic investor's consumption at time t and g_D is the measure of her constant relative risk aversion. This investor maximizes

$$V(W,t) = \max_{\{C(t),\, w_{a,i}(t)\}} E_0 \left[\int_{t=0}^{\infty} e^{-\rho t} U(C,t) dt \right] \qquad (4)$$

where r is the rate of pure time preference, $w_{a,i}(t) \equiv N_{a,i}(t)P_{a,i}(t)/W(t)$ is the fraction of wealth invested in the ith A-share stock at time t, $i = 1, 2, \ldots, N$. In particular, $w_{a,N+1}(t)$ is the fraction invested in safe asset. $N_{a,i}(t)$ is the number of ith A-share stock investor k owns, and $W(t)$ is his total wealth.

The investor's wealth accumulation equation is

$$dW(t) = \sum_{i=1}^{N+1} w_{a,i}(t)\, W(t)\, dr_{a,i}(t) - C(t)\, dt \qquad (5)$$

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[2]A composite investor's risk-aversion coefficient is the harmonic mean for all K individual investors' risk-aversion coefficients, $\frac{1}{\gamma_D} = \frac{\sum_{k=1}^{K} 1/\gamma_{k,D}}{K}$.

Equations (4) and (5) constitute a continuous-time portfolio optimization problem of the form solved by Merton (1971, 1973). The solution yields the following optimality condition for domestic investor's portfolio choice:

$$m_{a,i} - r_D = \gamma_D \sum_{j=1}^{N} w_{a,j}(t)\, s_{a,i,j} \tag{6}$$

where $s_{a,i,j}$ are the instantaneous covariance between the returns on the *i*th and *j*th A-share stock. The optimal portfolio is time-invariant because the investor's risk-aversion and the means, variances and covariance of asset returns are constant over time. Moreover, the optimal portfolio choice is independent of the domestic investor's wealth, consumption, and time preference. The greater the risk aversion, the lower the expected return, the higher the risk-free interest rate, or the higher the risk, the less will be held in A-share stocks.

The equilibrium ("domestic market") portfolio is mean-variance efficient. Therefore the equilibrium return for stock *i* satisfies the classical capital asset pricing model (CAPM). To show this, note that $\sum_{j=1}^{N} w_{a,j}(t) s_{a,i,j} = s_{a,i,M}$ and $\sum_{i=1}^{N} w_{a,i}(t) s_{a,i,M} = s^2_{a,M}$, where $s_{a,i,M}$ is the covariance of the *i*th A-share return with the return on A-share market portfolio and $s^2_{a,M}$ is the variance of A-share market portfolio return. Then (6) can be rewritten as $m_{a,i} - r_D = g_D s_{a,i,M}$, which implies $m_{a,M} - r_D = g_D s^2_{a,M}$. Therefore,

$$\begin{aligned} m_{a,i} - r_D &= \gamma_D \frac{\sigma_{a,i,M}}{\sigma^2_{a,M}} \sigma^2_{a,M} \\ &= \beta_{a,i,M}\, \gamma_D\, \sigma^2_{a,M} \end{aligned} \tag{7}$$

which is the familiar single-beta CAPM.

D. Intertemporal Maximization by Foreign Investors

I assume a composite foreign consumer-investor who is also infinitely lived and has state-independent isoelastic utility of consumption,

$$U(C,t)=\frac{C(t)^{1-\gamma_F}}{1-\gamma_F} \tag{8}$$

This foreign composite investor maximizes

$$V(W,t)=\max_{\{C(t),\, w_{b,i}(t),\, w_{c,j}(t)\}} E_0\left[\int_{t=0}^{\infty} e^{-\rho t}U(C,t)dt\right] \tag{9}$$

subject to

$$dW(t)=\sum_{i=1}^{N+1} w_{b,i}(t)\, W(t)\, dr_{b,i}(t)+\sum_{j=1}^{M} w_{c,j}(t)\, W(t)\, dr_{c,j}(t)-C(t)dt \tag{10}$$

where $w_{b,i}(t) \equiv N_{b,i}(t)P_{b,i}(t)/W(t)$ and $w_{c,j}(t) \equiv M_{c,j}(t)P_{c,j}(t)/W(t)$ are the fractions of wealth invested in the ith B-share stock and jth C-share stock at time t, respectively, $i = 1, 2, ..., N; j = 1, 2, ..., M; N_{b,i}(t)$ and $M_{c,j}(t)$ are the number of ith B-share stock and the number of jth C-share stock investor k owns.

There are N different B shares, M different C shares and one risk-free foreign debt instrument with interest rate r_F, which is assumed to be time-invariant. Without loss of generality, number the safe asset as $N+1$. Since $\sum_{i=1}^{N+1} w_{b,i}(t)+\sum_{j=1}^{M} w_{c,j}(t) = 1$, (10) can be rewritten as:

$$dW(t)=\left(\sum_{1}^{N} w_{b,i}(t)\,(\mu_{i=1}-r_F)+\sum_{1}^{M} w_{c,j}(t)\,(\mu_{c,j}-r_F)+r_F\right)W(t)\,dt \tag{11}$$

$$+\sum_{1}^{N} w_{b,i}(t)\, W(t)\, \sigma_{b,i}dz_{b,i}(t)+\sum_{1}^{M} w_{c,j}(t)\, W(t)\, \sigma_{c,j}dz_{c,j}(t)-C(t)\,dt$$

The solution for composite foreign investor's maximization problem (9) and (11) yields the following optimality condition:

$$\mu_{b,i} - r_F = \gamma_F \left(\sum_{j=1}^{N} w_{b,j}(t)\, \sigma_{b,i,j} + \sum_{j=1}^{M} w_{c,j}(t)\, \sigma_{b,c,i,j} \right) \tag{12}$$

where $\sigma_{b,i,j}$ $(\sigma_{c,i,j})$ are the instantaneous covariance between the returns on the ith and jth B-share (C-share) stock, and $\sigma_{b,c,i,j}$ are the instantaneous covariance between the returns on the ith B-share and the jth C-share.

Equation (12) implies that the optimal portfolio holding for a composite foreign investor is

$$w_{b,i}(t) = \frac{1}{\gamma_F} \left(\sum_{1}^{M} \sum_{1}^{N} \frac{(\mu_{b,j} - r_F)\, \sigma_{c,i,j}}{\sigma_{b,i,j}\, \sigma_{c,i,j} - \sigma^2_{b,c,i,j}} - \sum_{1}^{M} \sum_{1}^{N} \frac{(\mu_{c,j} - r_F)\, \sigma_{c,i,j}\, \sigma_{b,c,i,j}}{\sigma_{b,i,j}\, \sigma^2_{c,i,j} - \sigma^2_{b,c,i,j}} \right) \tag{13}$$

Therefore, the foreign composite investor's optimal portfolio choice is also time-invariant and is independent of his wealth, consumption and time preference. The greater the risk aversion, the lower the expected return on B shares, the higher the expected return on C shares, or the higher the risk on B shares, the less will be held in B share stocks. Moreover, less wealth will be allocated to B shares if the correlation between B- and C-share stocks is higher.

To show that the CAPM holds under continuous time portfolio optimization problem for the foreign investors, denote $\sigma_{b,i,M}$ as the covariance of returns between an ith B-share stock and the B-share market portfolio, $\sigma^2_{b,M}$ as the variance of returns on B-share market portfolio, $\sigma_{b,i,c,M}$ as the covariance of returns between an ith B-share stock with a C-share market portfolio and $\sigma^2_{c,M}$ as the variance of returns on C-share market portfolio, since

$$\sum_{j=1}^{N} w_{b,j}(t)\, \sigma_{b,i,j} = \sigma_{b,i,M}$$

$$\sum_{i=1}^{N} w_{b,i}(t)\, \sigma_{b,i,M} = \sigma^2_{b,M}$$

$$\sum_{j=1}^{M} w_{c,j}(t)\ \ s_{b,\,c,\,i,\,j} = s_{b,\,i,\,c,\,M}$$

and

$$\sum_{i=1}^{M} w_{c,i}(t)\ \ s_{b,\,i,\,c,\,M} = s_{c,M}$$

(12) becomes,

$$m_{b,\,i} - r_F = b_{b,\,i,\,M}\, g_F\ s^2_{b,\,M} + b_{b,\,i,\,c,\,M}\, g_F\ s^2_{c,M} \qquad (14)$$

E. Testable Implications from the Model

Combining (7) and (14), I obtain the following testable equation for the dispersion of expected excess returns between A and B shares:

$$(m_{a,i} - r_D) - (m_{b,\,i} - r_F) = b_{a,\,i,\,M}\, g_D\, s^{\,2}_{a,\,M} - b_{b,\,i,\,M}\, g_F\, s^{\,2}_{b,\,M} - b_{b,\,i,\,c,\,M}\, g_F\, s^{\,2}_{c,M} \qquad (15)$$

Equation (15) relates the difference in the expected return premium for the A and B shares of any given firm to three risk factors as measured by A-share market beta, B-share market beta and B-share beta with respect to international financial market. The lower the A-share market beta, the higher the B-share market beta, or the higher the beta of an individual B-share with respect to international financial market returns, the higher the foreign investor's required B-share premium. Therefore, (15) provides a basis for testing the linear relationship between the difference in the expected return Premiums for A and B shares and the market risk factors in the Chinese stock markets.

Note that no other variables, such as the variance of returns or firm size, appears in (15). Therefore, another testable implication of the model is that the betas are complete measure of the stock risks.

IV. Empirical Results

A. Data Description

The Chinese data consist of time-series of weekly A- and B-share market indexes and weekly stock prices for all 47 firms that issued both domestic A shares and foreign B shares before April 1994. 27 firms are listed in Shanghai and 20 firms are listed in Shenzhen. The sample period is from April 1994 to October 1998 with a total of 235 observations for each firm.

In calculating the rates of return on individual shares, the following adjustments are made to account for dividend payoffs, stock splits and rights issued:

- The amount of cash dividend per share is added to the stock price on the date it is paid.

- When there is a stock split at time t, P_t is divided by the split ratio so that $r_{t-1} = [(P_t /SR) - P_{t-1}]/P_{t-1}$, where SR is the stock split ratio. The rate of return between t and t+1 is calculated as usual.

- When shares begin trading ex-rights, the theoretical stock price falls by the intrinsic value of rights. To consider the effect of rights issued on the rate of return of a share, the following adjustment is made to the market price at the time trading ex-rights begins: Take the number of rights required to buy one new share, multiply by the market price per share before the ex-date, plus the subscription price and then divide the result by 1 plus the number of rights required to buy one new share.

Because A shares are listed in Chinese *renminbi yuan* while Shenzhen B shares are listed in Hong Kong dollar and Shanghai B shares in U.S. dollar, I use the weekly exchange rates between the Chinese yuan, U.S. dollar and Hong Kong dollar to convert all share prices to U.S. dollars. Returns are calculated using U.S. dollar prices. The rate of return for the six-month Chinese

Treasury Bond is used as the risk-free rate for domestic investors and the yield on the one-month U.S. T-bill is used as foreign risk-free rate. Stock indexes for Hong Kong Hang Seng market, MSCI world equity market, and NYSE are also obtained from April 1994 to October 1998.[3]

B. Testing B-Share Return Premiums

To test equation (15), I estimate betas for each company from the following time-series regressions,

$$r_{i,t} - r_{f,t} = \omega_i + \beta_{i,l}(r_{M,l,t} - r_{f,t}) + \nu_{i,t} \tag{16}$$

where $r_{i,t}$ is the rate of return for stock i in week t, $r_{f,t}$ is the corresponding risk-free interest rate, $r_{M,l,t}$ is the rate of return for lth market index at time t, $\beta_{i,l}$ is the market beta for stock i with respect to type l market, and $\nu_{i,t}$ is the error term. Six beta estimates, namely, $\hat{\beta}_{i,A}$, $\hat{\beta}_{i,B}$, $\hat{\beta}_{i,NYSE}$, $\hat{\beta}_{i,MSCI}$ and $\hat{\beta}_{i,HS}$, are obtained for all companies.

To test hypothesis on B-share return premiums, I proceed in three steps. First, I test the validity of equation (7) by estimating the following cross-section regression:

$$\frac{\sum_{t=1}^{T}(r_{a,i,t} - r_{d,t})}{T} = \delta_0 + \delta_1 \hat{\beta}_{i,A}^{SW} + \delta_2 (\hat{\beta}_{i,A}^{SW})^2 + \delta_3 D_i + \delta_4 \hat{\sigma}_{a,i}^2 + \tag{17}$$

$$+ \delta_5 (\ln MV_i) + \xi_i$$

where $\sum_{t=1}^{T}(r_{a,i,t} - r_{D,t})/T$ is the average excess return for the i-th A-share,

[3] The data on Chinese stock prices are obtained from Shenyin International Securities, Xiamen Branch. The dividend, stock split and rights issued information is obtained from "Chinese Stocks and Futures Encyclopedia" on a compact disc produced by Shanghai Xian Zi Information Co., Ltd. and from China Securities Weekly magazine.

$\hat{\sigma}^2_{a,i}$ is the sample variances of A-share returns, ln MV_i is the logarithm of the sum of the average daily outstanding market capitalization of A and B shares for firm i, and D_i is a location dummy variable,

$$D_i = \begin{cases} 0: & \text{if firm } i \text{ is listed in Shanghai} \\ 1: & \text{if firm } i \text{ is listed in Shenzhen} \end{cases}$$

and $d_1 = g_D s^2_{a,M}$

In estimating regression (17), it is necessary to recognize that betas estimated from (16) are measured with error. To correct for the errors-in-variables (EIV) problem (specifically asynchronous trading) and obtain a consistent estimator for $\beta_{i,A}$, I follow Scholes and Williams (1977) and use the lag, current and lead market returns to construct $\hat{\beta}^{SW}_{i,A}$. In particular,

$$\hat{\beta}^{SW}_{i,A} = \frac{\hat{\beta}_{i,A,-1} + \hat{\beta}_{i,A} + \hat{\beta}_{i,A,+1}}{1 + 2\rho_A}$$

where r_A is the first-order autocorrelation coefficient of the A-share market return. The variable $(\hat{\beta}^{SW}_{i,A})^2$ is included in (17) to test for linearity. The exchange dummy is also included because Shanghai and Shenzhen exchanges use different currencies in trading foreign-owned B-shares. Most B-share investors in Shenzhen are Hong Kong investors while the majority of B-share investors in Shanghai are U.S. investors. Moreover, if the ICAPM is valid in explaining the cross-section differences in average returns, the variance of share returns should not have any explanatory power and $\hat{\delta}_4$ should not be statistically significant. The ICAPM also implies that firm size should not have any power in explaining the cross-section variation of asset returns, after controlling for risks (Chan, Chen and Hsieh, 1985). Therefore, $\hat{\delta}_5$ should not be statistically significant either.

Table 3 presents the parameter estimates using Generalized Least Squares (GLS). As shown in the Table, $\hat{\delta}_1$ is significantly positive at the 5% level, suggesting that A-share market beta is a good measure of risk for an individual firm's share.[4] $\hat{\delta}_2$ is statistically insignificant, indicating that the relationship between individual firm's excess return and its A-share market beta is linear. In addition, neither $\hat{\delta}_4$ and $\hat{\delta}_5$ is statistically significantly different from zero. Therefore, after the betas are controlled for, the variance of returns and firm size do not systematically affect the average A-share returns in Chinese stock markets. $\hat{\delta}_3$ is significantly positive at the 1% level while the slope coefficient, $\hat{\delta}_0$ is statistically insignificant, implying that non-beta risks, with the exception

Table 3. Cross-Premiums Regression for Average A-Share Excess Returns

$\hat{\delta}_0$	$\hat{\delta}_1$	$\hat{\delta}_2$	$\hat{\delta}_3$	$\hat{\delta}_4$	$\hat{\delta}_5$	$\bar{R}^2$	F
-0.161	0.094*	0.027	0.051*	0.448	-0.216	0.350	3.416
(-1.428)	(2.290)	(0.783)	(2.035)	(0.491)	(-1.071)		[0.035]
	{2.043}			{0.406}	{-0.962}		

Note: The dependent variable is the average excess return of A-share for firm i. The independent variables are the Scholes-Williams (1977) consistent estimator for A-share market beta for firm i ($\hat{\beta}^{SW}$), the sample variances of A-share returns ($\hat{\sigma}^2_{a,i}$), the logarithm of the average daily outstanding market capitalization for firm i ($\ln MV_i$), and a location dummy variable (D_i), where

$$D_i = \begin{cases} 0: & \text{if firm } i \text{ is listed in Shanghai} \\ 1: & \text{if firm } i \text{ is listed in Shenzhen} \end{cases}$$

Figures in parentheses are t-statistics for the GLS estimates. Figures in braces are EIV-adjusted t-statistics. Figures in brackets are p-values. * denotes statistically significant at the 5% level.

[4] Using principle component analysis (Campbell et al. 1997), I find only one common factor affecting A-share excess returns among firms.

of the location where a firm's shares are listed and traded, do not affect the average returns across firms. Furthermore, the representative domestic investor's absolute risk aversion coefficient, g_D, is $\hat{\delta}_1 / s^2_{a,M} = 0.094/0.033 = 2.85$.

However, the EIV problem treated by Scholes and Williams remains in the cross-section regression standard errors, i.e., $\hat{\delta}_1$ is not N-consistent.[5] To adjust for the small sample bias in the cross-section regression estimates due to measurement errors in the betas, I follow Shanken (1992) and compute an EIV adjustment term from the sample covariance matrix of market risk factors, $\hat{c}$, which is positively related to the price of market risk factor and inversely related to the variance of market risk factor.[6] In cross-section regression (17), $\hat{c} = 0.26$. Then I compute the EIV-adjusted standard error for $\hat{\delta}_1$ as:

$$\sqrt{1.21\left[\left(\frac{0.094}{2.29}\right)^2 - \frac{0.033}{235}\right] + \frac{0.033}{235}} = 0.046$$

where 0.094 is $\hat{\delta}_1$, 2.29 is the unadjusted t-statistic for $\hat{\delta}_1$, 0.033 is the variance of A-share market excess return, $s^2_{a,M}$, and $T = 235$ is the number of weekly observations. The EIV-adjusted t-statistic is 0.094/0.046 = 2.043 with p-value of 0.041, as reported in the braces in Table 3. Therefore, $\hat{\delta}_1$ is still statistically significant at the 1% level after adjusting for the EIV problem.[7]

Second, I test the validity of equation (14) by estimating the following cross-section regression:

[5] It is not consistent when the time-series length is fixed and the number of assets, N, is allowed to vary (Shanken, 1992).

[6] Given a single market risk factor, $\hat{c}$ is just the squared value of the famous Sharpe ratio (Shanken, 1992).

[7] Note that the EIV-adjusted t-statistics for $\hat{\delta}_1$, $\hat{\delta}_4$ and $\hat{\delta}_5$ are smaller than the conventional t-statistics, which weaken evidence for the CAPM formulation. Nevertheless, smaller t-statistics for $\hat{\delta}_5$ and $\hat{\delta}_6$ after adjusting for the EIV problem indicate that there are no idiosyncratic variance effect and firm size effect, thus render further support to the ICAPM formulation.

$$\sum_{t=1}^{T}\frac{(r_{b,i,t}-r_{F,t})}{T} = \theta_0 + \theta_1\hat{\beta}^{SW}_{i,B} + \theta_2\hat{\beta}^{SW}_{i,c} + \theta_3(\hat{\beta}^{SW}_{i,B})^2 + \theta_4(\hat{\beta}^{SW}_{i,c})^2 + \theta_5 D_i + \theta_6\hat{\sigma}^2_{b,i} + \theta_7(\ln MV_i) + \xi_i \qquad (18)$$

where $\sum_{t=1}^{T}(r_{b,i,t} - r_{F,t})/T$ is the average excess return for the i-th B-share, $\hat{\sigma}^2_{b,i}$ is the sample variances of B-share returns, ln MV_i is the logarithm of the sum of the average daily outstanding market capitalization of A and B shares for firm i, $\hat{\beta}^{SW}_{i,B}$ and $\hat{\beta}^{SW}_{i,C}$ are the Scholes-Williams consistent estimators for B-share market beta and B-share beta with respect to the c-th foreign market ($c \in$ {NYSE, MSCI, HS}), respectively. According to equation (14), $\theta_1 = \gamma_F\sigma^2_{b,M}$ and $\theta_2 = \gamma_F\sigma^2_{c,M}$.

Table 4 presents the GLS parameter estimates. Using the usual t-statistics, $\hat{\theta}_1$ is significantly positive at the 5% level in all four regressions. Using the EIV-adjusted t-statistics, it is still significant at the 5% level (with p-value of 0.031, 0.018, 0.057, and 0.039, respectively), suggesting that B-share own market beta is a good measure of risk for B shares. In addition, none of the foreign-market betas chosen in this study is statistically significant except the B-share beta with respect to the Hong Kong Hang Seng index, which is significant at the 5% level even under the EIV-adjusted t-statistic. This result may be explained by the geographical proximity of Hong Kong to mainland China (and hence more rapid transmission of news) and the high proportion of B-share investors residing in Hong Kong.

The estimated parameters $\hat{\theta}_3$ and $\hat{\theta}_{4,\text{HS}}$ are both statistically insignificant, indicating that the relationships between B-share excess returns and B-share market beta and B-share beta with respect to the Hong Kong market is linear. In addition, neither $\hat{\theta}_6$ nor $\hat{\theta}_7$ is statistically significantly different from zero. Therefore, after the betas are controlled for, the variance of returns and firm size do not systematically affect the average B-share returns in Chinese stock markets. Both $\hat{\theta}_0$ nor $\hat{\theta}_5$ are statistically insignificant, implying that non-beta risk does not affect the average returns across firms.

Table 4. Cross-Premiums Regression for Average B-Share Excess Returns

$\hat{\theta}_0$	$\hat{\theta}_1$	$\hat{\theta}_{2,NYSE}$	$\hat{\theta}_3$	$\hat{\theta}_{4,NYSE}$	$\hat{\theta}_5$	$\hat{\theta}_6$	$\hat{\theta}_7$	$\bar{R}^2$	F
-0.149	0.063*	0.031	0.046	0.017	-0.003	0.696	-1.025	0.204	2.883
(-1.483)	(2.147)	(1.290)	(1.183)	(0.506)	(-0.244)	(0.830)	(-1.225)		[0.074]
	{ 1.962}	{ 0.974}				{0.709}	{-1.053}		
$\hat{\theta}_0$	$\hat{\theta}_1$	$\hat{\theta}_{2,MSCI}$	$\hat{\theta}_3$	$\hat{\theta}_{4,MSCI}$	$\hat{\theta}_5$	$\hat{\theta}_6$	$\hat{\theta}_7$	$\bar{R}^2$	F
-0.126	0.071*	0.029	0.058	0.052	0.002	0.472	-0.851	0.175	2.603
(-1.218)	(2.305)	(1.074)	(1.160)	(0.804)	(0.755)	(0.682)	(-1.044)		[0.081]
	{ 2.114}	{ 0.816}				{0.529}	{-0.823}		
$\hat{\theta}_0$	$\hat{\theta}_1$	$\hat{\theta}_{2,HS}$	$\hat{\theta}_3$	$\hat{\theta}_{4,HS}$	$\hat{\theta}_5$	$\hat{\theta}_6$	$\hat{\theta}_7$	$\bar{R}^2$	F
-0.073	0.084 *	0.167*	0.073	0.061	0.005	0.733	-1.169	0.384	4.092
(-0.938)	(2.475)	(2.580)	(1.268)	(1.173)	(0.924)	(1.065)	(-1.340)		[0.009]
	{ 2.226}	{ 2.319}				{0.814}	{-1.185}		

Note: The dependent variable is the average excess return of B-share for firm i. The independent variables are the Scholes-Williams consistent estimators for B-share market beta for firm i ($\hat{b}^{SW}_{i,B}$), B-share beta with respect to c-th foreign market for firm i ($\hat{b}^{SW}_{i,C}$, c ∈ {NYSE, MSCI, HS}), the sample variances of B-share returns ($\hat{\sigma}^2_{b,i}$), the logarithm of the average daily outstanding market capitalization for firm i ($lnMV_i$), and a location dummy variable (D_i). Figures in parentheses are t-statistics for the GLS estimates. Figures in braces are EIV-adjusted t-statistics. Figures in brackets are p-values. * denotes statistically significant at the 5% level.

Furthermore, the representative foreign investor's absolute risk aversion coefficient, γ_F, can be computed in two ways: $\hat{q}_1/\sigma^2_{b,M}$ = 0.084/0.013 = 6.46 or $\hat{q}_1/\sigma^2_{HS,M}$ = 0.167/0.027 = 6.19, implying that international investors are at least twice more risk-averse towards Chinese shares than domestic Chinese investors.

Finally, I estimate the following cross-section regression:

$$\left(\frac{\sum_{t=1}^{T}(r_{a,i,t}-r_{D,t})}{T}\right)-\left(\frac{\sum_{t=1}^{T}(r_{b,i,t}-r_{F,t})}{T}\right)=a_0+a_1\hat{\beta}_{i,A}^{SW}+a_2\hat{\beta}_{i,B}^{SW}+a_3\hat{\beta}_{i,HS}^{SW}+\alpha_4 D_i+\xi_i \quad (19)$$

Regression (19) decomposes the differences in average returns for A- and B-share into two components: The first component, $\alpha_1\hat{\beta}_{i,A}^{SW}+\alpha_2\hat{\beta}_{i,B}^{SW}+\alpha_3\hat{\beta}_{i,HS}^{SW}$ represents the part of the average return difference between A and B shares that is related to the cross-section structure of risks, as measured by consistent estimates of A-share market beta, B-share market beta, and B-share beta with respect to the Hong Kong Hang Seng index. The second component, $\alpha_0+\varepsilon_i$, is the sum of residuals and an intercept which is uncorrelated with measures of risk.

Table 5 reports the GLS parameter estimates of equation (19). The coefficient estimates for the three market-risk factors are not only of right sign but also statistically significant using the conventional *t*-statistics. In addition, the constant terms are not significantly different from zero, suggesting that the smaller the A-share market beta, the higher the B-share market beta, or the higher the B-share beta with respect to the Hong Kong Hang Seng market, the smaller the difference in average returns between A and B shares. Using the EIV-adjusted *t*-statistics, A-share market beta becomes marginally significant (with a *p*-value of 0.15), B-share market beta becomes significant only at the 10% level, but the B-share beta against the Hong Kong Hang Seng market is still statistically significant at the 5% level. Therefore, the cross-section results support the ICAPM formulation, although the evidence is not as strong after adjusting for the EIV problem.

Table 5: Cross-Premiums Test for B-Share Return Premiums

$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$	$\bar{R}^2$	F
0.084	0.124†	-0.173*	-0.210*	0.112	0.366	4.287
(1.251)	(1.804)	(-2.311)	(-2.967)	(0.793)		[0.005]
	{1.517}	{1.945}	{-2.558}			

Note: The dependent variable is the difference between the average excess return of A- and B-share for firm i. The independent variables are the Scholes-Williams consistent estimators for A-share market beta for firm i ($\hat{\beta}^{sw}_{i,A}$), B-share market beta for firm i ($\hat{\beta}^{sw}_{i,B}$), B-share beta with respect to Hong Kong Hang Seng market for firm i ($\hat{\beta}^{sw}_{i,HS}$), and a location dummy variable (D_i) where

$$D_i = \begin{cases} 0: & \text{if firm } i \text{ is listed in Shanghai} \\ 1: & \text{if firm } i \text{ is listed in Shenzhen} \end{cases}$$

Figures in parentheses are t-statistics for the GLS estimates. Figures in braces are EIV-adjusted t-statistics. Figures in brackets are p-values. * and † denote statistically significant at the 5% and 10% level, respectively.

V. Conclusion

In this paper, I combine the ICAPM with circumstances peculiar to China to explain the discounts on foreign-owned Chinese B shares relative to the prices of domestic A shares. Under the assumption of infinite investment horizon and representative consumer-investor, I formulate an ICAPM with restrictions on share ownership. Under the one-instant ICAPM, the differences in prices for A and B shares for the same firm can be expressed in terms of the differences in their average excess returns. The model posits that cross-section variations in the average excess returns between A and B shares depend on shares' own market betas and betas with respect to the international equity markets.

Empirical tests of the model using the conventional GLS *t*-statistics indicate that cross-section excess A-share over B-share average return is positively related to A-share market betas and is negatively correlated to B-share own market betas and betas with respect to Hong Kong Hang Seng market. After correcting for the EIV problem using Shanken's method, I find that these relationships are somewhat weak. Nevertheless, non-beta risk variables, such as the variance of returns and firm size do not systematically affect returns. Therefore, the empirical results by and large support the ICAPM formulation in explaining the price differentials and return spread between domestic A shares and foreign B shares.

I only investigate the investors' side of the problem in this paper. A natural extension would be to account for the supply side as well as the demand side in a general equilibrium multi-period asset pricing framework. Future research in this area is needed.

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