Barriers to Portfolio Flows, Short Sales Constraints and International Asset Pricing: Theory and Evidence

Vihang Errunza and Hai T Ta*
Faculty of Magnagement, McGill University

30 Octocber, 2010

Abstract

We propose an international asset pricing model in a two-country framework where trading in the foreign market encounters barriers to portfolio flows and short-sale constraints. Under ownership restrictions, free assets are priced with a global risk premium whereas the restricted assets command a global risk premium, a conditional risk premium and a conditional discount. With binding ownership and short-sale constraints, some foreign assets become non-tradable, however, pricing rules are not altered. We estimate our model using maximum likelihood approach for 18 major emerging markets over the period 1989-2007 and find strong support for our model.

JEL Classification Codes: F39, G12, G15.
Keywords: International Asset Pricing, Barriers to Investment, Foreign Ownership Restrictions, Short Sales Constraints.

1 Introduction

International asset pricing models (IAPMs) invoke assumptions regarding capital flow controls and short sales that are not realistic in the present environment. For example, IAPMs of Solnik (1974), Stulz (1981a) and Adler and Dumas (1983) assume no barriers to capital flows whereas Stulz (1981b), Errunza and Losq (1985), Eun and Janakiramanan (1986) and Chaieb and Errunza (2007) are

*Vihang Errunza and Hai T Ta are from Faculty of Management, McGill University, 1001 Sherbrooke St. West, Montreal, Qc, H3A 1G5, Canada. Errunza may be reached at vihang.errunza@mcgill.ca, Hai Ta may be reached at hai.ta@mail.mcgill.ca. We would like to thank Francesca Carrieri, Ines Chaieb, Benjamin Croitoru, Morty Yalovsky and participants of McGill Finance Workshop, 2009. Errunza acknowledges financial support from the Bank of Montreal Chair at McGill University, IFM2 and SSHRC. Hai Ta thanks IFM2 for financial support.

based on unrealistic assumptions regarding barriers to capital flows. All above IAPMs assume unimpeded short selling. A model that incorporates both these deviations from a perfect market set-up is currently not available. Hence, we develop a formal IAPM based on more realistic assumptions regarding explicit barriers in place and short-sale restrictions.

Barriers to international investments are pervasive and may take various forms such as expropriations of foreign holdings, restrictions on the fraction of a local firm that foreign investors can own, or discriminatory taxation. Stulz (1981b) models barriers in the form of a proportional tax on equity holdings and makes a novel prediction regarding possible existence of non-traded assets. Errunza and Losq (1985, henceforth EL) study a mild segmentation structure in which domestic investors (for example, the U.S.) are prohibited access to foreign assets rendering all foreign assets non-tradeable. In Eun and Janakiramanan (1986, henceforth EJ) domestic investors are restricted to hold only a fraction of the outstanding foreign shares leading to a dual price system with an underlying assumption that the domestic and foreign investors can not trade with each other.[1] Although the potential existence of non-tradable assets in the foreign market and its implications for international investments were first discussed by Stulz (1981b), the assumptions in EL of the entire foreign market being non-tradable and in EJ that none of the foreign securities are non tradable seem unrealistic given the empirical evidence that domestic investors trade only in large and liquid foreign stocks.[2]

EJ briefly discuss the short-sale constraint in their model. However, they assume that the ownership constraint is binding for all foreign stocks, i.e. they implicitly assume that the domestic investor would hold long all foreign stocks. Thus, in their paper, the short-sale constraint has no effect on prices and asset demand. In view of the empirical evidence of Charoenrook and Daouk (2005), and Bris, Goetzmann, and Zhu (2007) that short sales in a majority of national markets are either not allowed legally or are too costly to be practiced, it is important to consider the joint impact of short-sale constraint and the ownership constraint for stock prices and portfolio holdings in international portfolio investment. Indeed, a more realistic model should take into account the explicit barriers in place including the existence of the non-tradable segment of the foreign market and short-sale restrictions. Our paper fills this gap and develops a model that provides new insights when markets are not freely accessible and short sales are restricted which seems to be the case for the majority of national markets.

Specifically, we postulate an international capital market that is characterized by two countries and two sets of investors. Foreign investors are unrestricted i.e. they can hold their local securities and those available in the domestic market. Domestic investors are restricted in their foreign market trading, i.e. they can hold only up to a limited fraction of foreign stocks. This results in three

[1] Bergstrom, Rydqvist, and Sellin (1993) extend EJ to impose constraint on both the inflow and the outflow of capital. They find that the price effects are ambiguous since the two constraints operate in opposite directions.

[2] See, for example, Kang and Stulz (1997), and Edison and Warnock (2004).

sets of foreign stocks. The freely traded for which the ownership restriction is not binding, the set for which the ownership restriction is binding and the non-investable set that domestic investor would not hold due to concerns related to their size, liquidity, or free float. Note that the first two sets constitute the investable set. In the theoretical model, the non-investable set with a zero holding is considered as part of the set with binding ownership restrictions. However, we separately test the pricing of the non-investable set in the empirical analysis. Since many countries have eradicated the restriction of trade between local and foreign investors, we extend EJ by allowing foreign investors to trade with domestic investors to obtain unique equilibrium prices for restricted stocks. Further, all investors can short sale domestic stocks but not the foreign stocks.[3] Since short-selling of foreign assets is not allowed, the domestic investor would have zero holdings of foreign stocks he would want to short if allowed, thus giving rise to the fourth set, the non-tradable segment of the foreign market. In equilibrium, investable, non-investable, and non-tradable assets will coexist in the foreign stock market. To our knowledge, this is the first time that the pricing of different sets of securities in the foreign market have been explicitly characterized and put to empirical test. Next, starting from a micro-theory of individual portfolio choice we obtain, via aggregation and market clearing, equilibrium pricing relationships, risk-return trade-offs and portfolio holdings, taking into account the interaction between the constraints.

We first study the benchmark case with only the ownership constraint and then generalize the model by introducing the short-sale constraint. In equilibrium, the freely traded securities are always priced solely by the covariance risk with the global factor. The restricted stocks are priced with three factors: the risk premium with the global factor, a conditional local risk premium and a conditional local discount. The discount reflects the benefit of loosening equity ownership restrictions. The local premium and discount are conditional on the returns of freely traded assets. In the benchmark case, the premium factor is constituted of restricted foreign assets with binding ownership constraint, whereas it also includes non traded assets in the general case where both ownership and short-sale constraints are binding. In both cases, the discount factor is constituted of restricted assets whose ownership constraint is binding. Further the discount factor only includes the portion of the restricted assets that are available to the domestic investor and its price of risk is a linear, increasing function of legal limits on foreign holdings of all restricted securities in the foreign market.

Using maximum likelihood approach[4], we estimate a conditional version of our model for 18 major emerging markets (EMs) over the period 1989-2007. We use weekly US dollar denominated data for individual stocks that constitute the

[3] One can characterize the domestic market as a well developed market such as the U.S. that is open to all investors and has few legal or operational constraints on short selling and the foreign market as an emerging market most of which impose some limits on foreign participation and short selling is either legally not allowed or operationally not practiced. Otherwise, we assume perfect national capital markets.

[4] See, for example, Campbell, Lo and MacKinlay (1997).

S&P International Finance Corporation Global (IFCG) index in each market to construct test assets and local factors. To capture the explicit barriers, we use the investable weight factor (IWF) that indicates the fraction of the individual EM security that is accessible to foreigners, with zero for non-investable and one for fully investable stocks.[5] We find that both the world and the two local risk factors are significantly priced in all countries in our sample. We also find that the model favors time-varying factor risk premia and.the coefficient on investable weight factor has positive sign and is highly significant in most cases and thus supports our model prediction that the price of risk of the local discount factor is an increasing function of the IWF.

The rest of the paper proceeds as follows. Section 2 outlines the underlying assumptions and notations for our theory. In section 3, we derive the benchmark valuation model under the ownership restriction constraint. We introduce the short-sale constraint in section 4 and construct our general model where both the ownership and the short-sale constraints are present. Comparative statics with the benchmark case are also provided. Section 5 outlines the empirical method. Data and empirical results are provided in section 6. Section 7 concludes. All proofs are in the appendix.

2 The Set-up

We consider a world with two countries, domestic (D) and foreign (F). The returns are measured in domestic currency, the reference currency. There are N risky securities of which n are from domestic country and m from foreign country. All investors can borrow and lend at the risk-free rate r, denominated in the reference currency.

Assume that the return of risky assets follows the Ito process:

$$\frac{dS_i}{S_i} = \mu_i dt + \sigma_i dz_i, \text{ } where \text{ } i = 1 \div N$$

where μ_i, σ_i are the instantaneous expected return and standard deviation of risky asset i; z_i is the standard Brownian motion; and $dz_j dz_k = \rho_{jk} dt$ where ρ_{jk} is the instantaneous correlation coefficient between the Wiener processes dz_j and dz_k.

2.1 Notations

Throughout the paper, we use the following notations. The tilde denotes randomness, the inferior bar a vector. The prime stands for the transposition operator.

Ω is the $N \times N$ matrix of instantaneous covariances of the rates of return on all risky securities (with elements being $\sigma_{jk} = \rho_{jk}\sigma_j\sigma_k$).

$\underline{0}_x$ ($\underline{\iota}_x$) is the $x \times 1$ vector of zeros (ones)

[5] It is similar to the measure of intensity of capital controls of Edison and Warnock (2003).

S_x is the set of risky securities x

W^l is the investable wealth of investor l at time 0, $l \in \{D, F\}$

$\widetilde{W}^l$ is the random end-of-period wealth of investor l

W^M is the total wealth of all investors, i.e. $W^M \equiv \sum_{l \in \{D,F\}} W^l$

C^l is the consumption flow of investor l

$\underline{\pi}^l_x$ is the $x \times 1$ vector of the dollar amount invested in the risky assets by investor l

$\underline{M}_x$ is the $x \times 1$ vector of market capitalizations of risky assets

M is the total market capitalization of all risky securities, $M \triangleq \sum_{i=1}^N M_i$

$\underline{\omega}_x$ is the $x \times 1$ vector of ownership limit fractions (values between 0 and 1) in the foreign market.

$\widetilde{R}_i$ is the random return of security $i, i \in N$

$\widetilde{R}_W$ is the random return of the world portfolio, $\widetilde{R}_W = \sum_{i=1}^N M_i \widetilde{R}_i / M$

2.2 Market Imperfections

The foreign capital market entails two types of constraints. First, the domestic investor is only allowed to hold up to a limit fraction of any foreign equity, and second, short sales of foreign securities are precluded. The ownership limits are assumed to be known a priori to all investors and are time invariant.[6] Obviously, if the ownership constraint is binding for all foreign securities, imposing the short-sale constraint for the foreign securities would be meaningless. Thus, to accommodate for more realistic and interesting cases, we assume additionally that the ownership constraint is only binding for a subset of foreign securities. The capital market is otherwise assumed to be perfect and frictionless.

We first deal with the ownership constraint in the next section, and subsequently study the joint effects of both types of constraints in section 4.

3 International Asset Pricing Model with Foreign Ownership Constraint

In this section, we derive an IAPM where the domestic investor faces only one constraint that is a legal limit on holdings of foreign equities. Short-selling foreign risky securities is allowed.

3.1 The Market Structure

We further assume that the ownership constraint is binding for only a subset $S_k (S_k \subset S_m)$ of the foreign securities. The remaining risky securities in foreign market belonging to the subset $S_{m \backslash k} = S_m \backslash S_k$[7] are effectively traded as restriction-free assets in the domestic market. Together with the domestic risky

[6] We leave the more dynamic case where the ownership limit is time varying for the future extension of the current paper.

[7] The slash \ denotes the set difference operation.

assets, the non-binding, foreign risky assets constitute the set of restriction-free assets, called the core set. We denote this core set as S_p which is the union of S_n and $S_{m\backslash k}$.

To facilitate our derivation in this section, whenever we stack N risky assets into a vector (be it expected returns or portfolio holdings) the following partition is understood: the first n assets are the domestic risky assets, the next $m-k$ assets are the foreign risky assets with non-binding ownership constraint, and finally the last k assets are the foreign risky assets with binding ownership constraint that also include non-investable assets that can not be held by domestic investors (ownership limit fraction of zero). Note that as binding constraints change over time, the set of $m-k$ and k assets will change as well. We rebalance our test portfolios in the empirical analysis to reflect this time variation.

3.2 The Equilibrium Expected Returns and Portfolio Holdings

We adopt the stochastic dynamic programming approach as in Merton (1969, 1971 and 1973), Solnik (1974), Stulz (1981a), Adler and Dumas (1983), and Chaieb and Errunza (2007). Each investor is assumed to maximize the expected value at each instant in time of a time-additive and state independent Von Neumann- Morgenstern utility function of consumption given his current wealth and portfolio constraints.

Agents maximize their lifetime expected utility by choosing optimal control variables, consumption flow and portfolio amount $\{C^l, \pi^l\}$ with $l \in \{D, F\}$. Hence, each investor has the following objective function:

$$J^l(W^l) = \max_{C^l,\pi^l} E_0 \int_0^\infty U^l(C^l(t))dt \quad (1)$$

where $U^l()$ is the utility function assumed to be strictly concave and $J^l()$ is the derived utility of wealth function of the investor $l = \{D, F\}$.

The foreign investor's wealth follows the standard dynamics as in Merton (1969, 1973):

$$dW^F = [\sum_{i=1}^N \pi_i^F(\mu_i - r) + rW^F - C^F]dt + \sum_{i=1}^N \pi_i^F \sigma_i dz_i \quad (2)$$

The wealth process for the domestic investor follows a similar dynamic:

$$dW^D = [\sum_{i=1}^N \pi_i^D(\mu_i - r) + rW^D - C^D]dt + \sum_{i=1}^N \pi_i^D \sigma_i dz_i \quad (3)$$

with the exception that his portfolio investments on the foreign risky assets face the restricted ownership constraint as follows:

$$\underline{\pi}_m^D \leq \underline{\omega}_m \circ \underline{M}_m \quad (4)$$

where the sign $\circ$ denotes the Hadamard product (element by element).

The optimization problem of the foreign investor is a standard stochastic control problem. Merton (1971 and 1973) has shown that the value function $J^F(W^F)$ for the foreign investor given his budget constraint (2) satisfies the Hamilton-Jacobi-Bellman (HJB) equation,

$$\begin{aligned} 0 \quad = \quad & \max_{\{C^F,\underline{\pi}^F\}} \{U^F(C^F) + J_W^F[\sum_{i=1}^{N} \pi_i^F(\mu_i - r) + rW^F - C^F] \\ & + \frac{1}{2} J_{WW}^F \sum_{i=1}^{N} \sum_{j=1}^{N} \pi_i^F \pi_j^F \sigma_{ij}\} \end{aligned} \tag{5}$$

where $\sigma_{ij} = \rho_{ij}\sigma_i\sigma_j$, $J_W^F = \partial J^F/\partial W^F$ and $J_{WW}^F = \partial^2 J^F/(\partial W^F)^2$.

The N first order conditions with respect to the portfolio holdings derived from the HJB equation (5) are,

$$J_W^F(\mu_i - r) + J_{WW}^F \sum_{j=1}^{N} \pi_i^F \sigma_{ij} = 0, \qquad (i = 1, 2, ..., N) \tag{6}$$

Let $A^F = -\frac{J_{WW}^F}{J_W^F}$ denote the absolute risk aversion of the foreign investor. We can rewrite the first order conditions (6) as follows

$$\underline{\mu}_N - r\underline{i}_N = A^F \; \Omega \; \underline{\pi}_N^F \tag{7}$$

Under the ownership constraint (4), the domestic investor's optimization problem is however a constrained stochastic control problem. It has been shown[8] that the value function of this constrained problem is the solution of the following HJB equations,

$$\begin{aligned} 0 \quad &= \quad \max_{\{C^D,\underline{\pi}_m^D \leq \underline{\omega}_m \circ \underline{M}_m\}} \phi(C^D, \underline{\pi}^D, W^D) \\ \phi(C^D, \underline{\pi}^D, W^D) \quad &= \quad \begin{pmatrix} U^D(C^D) + J_W^D[\sum_{i=1}^{N} \pi_i^D(\mu_i - r) + rW^D - C^D] \\ +\frac{1}{2} J_{WW}^D \sum_{i=1}^{N} \sum_{j=1}^{N} \pi_i^D \pi_j^D \sigma_{ij} \end{pmatrix} \end{aligned} \tag{8}$$

Using the Kuhn-Tucker technique for optimization problem under constraint, we define the Lagarangian, $L = \phi + \sum_{i=1}^{m} \lambda_i(\omega_i M_i - \pi_i^D)$, where λ_i is the Lagrangian multiplier for the ownership constraint of risky asset i in the foreign market. Hence, the N first order conditions with respect to the portfolio hold-

[8] See, for instance, Zariphopoulou (1991) and Fleming and Zariphopoulou (1991).

ings for the domestic investor are as follows,

$$J_W^D(\mu_i - r) + J_{WW}^D \sum_{j=1}^{N} \pi_i^D \sigma_{ij} \quad = \quad 0, \qquad (i \in S_n) \tag{9}$$

$$J_W^D(\mu_i - r) + J_{WW}^D \sum_{j=1}^{N} \pi_i^D \sigma_{ij} - \lambda_i \quad = \quad 0, \qquad (i \in S_m) \tag{10}$$

$$\lambda_i(\omega_i M_i - \pi_i^D) \quad = \quad 0,\ \lambda_i \geq 0, \pi_i^D \leq \omega_i M_i, \quad (i \in S_m) \tag{11}$$

As remarked earlier, we assume that among the m ownership constraints only k constraints are indeed binding. Recall, we partition the set of foreign risky assets such that the first $m-k$ assets have non-binding ownership constraint while the last k assets have binding constraint. The Kuhn-Tucker condition (11) thus implies that

$$\begin{aligned} \lambda_i &= 0, & i \in S_{m\setminus k} \\ \lambda_i &> 0 \text{ and } \pi_i^D = \omega_i M_i, & i \in S_k \end{aligned} \tag{12}$$

Intuitively, this assumption means that the demand of the domestic investor for the first $m-k$ foreign risky assets is strictly less than legally allowed; the domestic investor might even want to short some of these risky assets.

Let $A^D = -\frac{J_{WW}^D}{J_W^D}$ denote the absolute risk aversion of the domestic investor. For brevity, we rewrite the demand equation (12) in vector notation as: $\underline{\pi}_k^D = \underline{\omega}_k \circ \underline{M}_k$. We can express the first order conditions (9,10,and 11) compactly as follows,

$$\underline{\mu}_N - r\underline{i}_N = A^D\ \Omega\ \underline{\pi}_N^D + \frac{1}{J_W^D}\begin{pmatrix} \underline{0}_p \\ \underline{\lambda}_k \end{pmatrix} \tag{13}$$

where, p indicates the core set of risky assets; $\underline{\lambda}_k$ is the $k \times 1$ vector of Lagrangian multipliers for the risky assets in the binding set S_k.

Proposition 1. In equilibrium, under the restricted foreign ownership constraint, the risk premium of a stock is given by:

$$E(\widetilde{R}_i - r) = AMcov(\widetilde{R}_i, \widetilde{R}_W),\ \forall i \in S_p \tag{14}$$

$$\begin{aligned} E(\widetilde{R}_i - r) = \quad & AMcov(\widetilde{R}_i, \widetilde{R}_W) + (A^F - A)M_{K_1}cov(\widetilde{R}_i, \widetilde{R}_{K_1}|\underline{\widetilde{R}}_p) \\ & -A^F M_{K_2}cov(\widetilde{R}_i, \widetilde{R}_{K_2}|\underline{\widetilde{R}}_p),\ \forall i \in S_k \end{aligned} \tag{15}$$

where the aggregate risk aversion A is defined such that $\frac{1}{A} = \frac{1}{A^D} + \frac{1}{A^F}$; and the local factors $\widetilde{R}_{K_1}, \widetilde{R}_{K_2}$ are defined below,

$$\begin{aligned}
\widetilde{R}_{K_1} &\triangleq \sum_{i\in S_k} \frac{M_i}{M_{K_1}}\widetilde{R_i} \qquad (16)\\
\widetilde{R}_{K_2} &\triangleq \sum_{i\in S_k} \frac{\omega_i M_i}{M_{K_2}}\widetilde{R_i}\\
M_{K_1} &\triangleq \sum_{i\in S_k} M_i\\
M_{K_2} &\triangleq \sum_{i\in S_k} M_i\omega_i
\end{aligned}$$

As expected the free assets in the core S_p (including domestic securities and foreign securities whose ownership constraint is not binding) are priced solely with one factor, the covariance risk with the global factor - the world market return $\widetilde{R}_W$. However, the restricted assets' expected returns are priced with three factors: the risk premium with the global factor, a conditional risk premium with the local factor $\widetilde{R}_{K_1}$, and a conditional discount with the local factor $\widetilde{R}_{K_2}$. The local premium and discount are conditional on the returns of all assets in the core $\underline{\widetilde{R}}_p$. The first local factor $\widetilde{R}_{K_1}$ represents the aggregate return of all restricted securities in S_k, whereas the second local factor $\widetilde{R}_{K_2}$ measures the aggregate return of the portions of these securities that are available to the domestic investor.[9]

The conditional risk premium is similar to the conditional market risk or the super risk premium in EL, though the latter is defined for the entire foreign market whereas in our model it is applied only to subset S_k consisting of restricted assets in the foreign market. The price of risk of the conditional discount, the last term on the RHS of (15), is a linear, increasing function of the ownership limits of all restricted assets in S_k. The negative sign, hence the name discount, reflects the benefit of loosening the equity ownership restriction. Giving the domestic investor limited access to the foreign equity market results in the conditional discount. Clearly, the discount will vanish when all restricted assets become non-tradable in the sense of Stulz (1981b) or when all the legal limits are reduced to zero; in that case our model collapses to EL.

A special, noteworthy case is when the ownership limits of restricted stocks are all equal, i.e. $\omega_i = \omega$. In this case, $M_{K_2} = \omega M_{K_1}$ and we can simplify the expected return for restricted assets as follows,

$$E(\widetilde{R}_i - r) = AMcov(\widetilde{R}_i, \widetilde{R}_W) + [1 - \frac{\omega}{A^F/(A^D + A^F)}](A^F - A)M_{K_1}cov(\widetilde{R}_i, \widetilde{R}_{K_1}|\underline{\widetilde{R}}_p) \qquad (17)$$

The conditional risk premium in (17) is an inverse, linear function of ω. Since the limit ω is non-negative, the super risk premium of EL[10] is the maximal value

[9] The concept of the local factors $\widetilde{R}_{K_1}, \widetilde{R}_{K_2}$ is similar to that of the S&P's IFCG and IFCI, discussed in section 6.

[10] Recall that the super risk premium in EL(1985) is $(A^F - A)M_{K_1}cov(\widetilde{R}_i, \widetilde{R}_{K_1}|\underline{\widetilde{R}}_p)$

of the local, conditional risk premium in our model. Note that the price of the conditional risk in (17) is non-negative as the legal limit ω can not exceed the ratio $\frac{A^F}{A^D+A^F}$ as noted in EJ. This is because the ratio of the foreign risk aversion over the total risk aversion is the maximal foreign equity weight that the domestic investor would hold were there no constraints in the foreign market. Hence, it necessitates that the limit be less than this ratio. Last but not least, the positivivity of the price of risk of the conditional local factor in (17) implies that the conditional premium dominates the conditional discount in (15), resulting in a net local premium of restricted assets. This result also holds in the general case where the ownership limits differ across restricted securities[11].

Proposition 2. In equilibrium the portfolio choices of the domestic and foreign investor are as follows[12]*.*

For the domestic investor

$$\begin{aligned} \underline{\pi}_p^D &= \frac{A^F}{A^D+A^F}\underline{M}_p + \Omega_{pp}^{-1}\Omega_{pk}\underline{T}_k \\ \underline{\pi}_k^D &= \underline{\omega}_k \circ \underline{M}_k \end{aligned}$$

For the foreign investor

$$\begin{aligned} \underline{\pi}_p^F &= \frac{A^D}{A^D+A^F}\underline{M}_p - \Omega_{pp}^{-1}\Omega_{pk}\underline{T}_k \\ \underline{\pi}_k^F &= (\underline{i}_k - \underline{\omega}_k) \circ \underline{M}_k. \end{aligned}$$

where $\underline{T}_k \triangleq (\frac{A^F}{A^D+A^F}\underline{M}_k - \underline{M}_k \circ \underline{\omega}_k)$.

The domestic investor's portfolio choice of the core assets S_p consists of two terms with the first term being his portfolio holdings in the absence of ownership constraint. Given the binding constraint for the k foreign risky assets, the domestic investor's desirable demand for these assets is greater than the allowed amount; thus $\underline{T}_k$ represents the desirable, however inadmissible demand of the risky assets S_k by the domestic investor. The second component in the domestic investor's portfolio holdings can be interpreted as the portfolio he engineers out of the core assets S_p to replicate $\underline{T}_k$ as closely as possible. This observation highlights the dual role played by the risky assets S_p: they provide investors with traditional investment opportunities as well as an avenue, albeit imperfect, to overcome the ownership constraint.

Some of the foreign assets that belong to the core might be held short by the domestic investor. Therefore if the domestic investor can not short sell foreign stocks, then he would not be able to create his desired hedged position. This could potentially cause the domestic investor to change his demand, and thus affect the expected returns of foreign risky assets. This is the case we now investigate.

[11] Proof is available upon request.

[12] Note that the subscripts of matrix Ω, Ψ denote their appropriate partitions.

4 International Asset Pricing Model with Foreign Ownership and Short-Sale Constraints.

Since the ownership restrictions are binding for foreign risky assets in subset S_k, the short-sale constraint will have no effect on these assets as their demands are non-negative for all investors. On the other hand, the short-sale constraint will affect the foreign risky assets which previously constituted the core assets. Indeed, in conjunction with the ownership constraint, the ban on short sales will have different effect on the domestic and foreign investors. Because the domestic investor faces the ownership constraint on his holdings of foreign securities, he can not clear the foreign market should the foreign investor hold short any foreign securities. Therefore, the short-sale constraint will never be binding for the foreign investor; it can only be binding for the domestic investor.

The foreign risky assets that have binding short-sale constraint for the domestic investor will become non-tradable assets. Note that in Stulz (1981b) although short sales are allowed, if the expected return of a given foreign asset does not offset the cost of acquisition for domestic investors, the asset becomes non-tradable. In our model, without the short-sale constraint, foreign stocks either belong to the core set of assets, are held up to their legal limits by the domestic investor, or are non-investable. With binding short-sale constraint, some foreign stocks become non-tradable. The current section studies the effects of such non-tradable assets on expected returns and investors' portfolio holdings.

4.1 The Market Structure

We maintain the assumption that subset S_k of foreign securities have binding ownership constraint for the domestic investor. We assume that within subset $S_{m\backslash k}$ of foreign assets, there is a subset $S_z(S_z \subseteq S_{m\backslash k})$ for which the short-sale constraint is binding. In the absence of the short-sale constraint, the domestic investor would want to short subset S_z, however when short-selling is banned in the foreign market he will have zero investment on S_z, rendering it the set of non-tradable assets. The union S_r of S_k and S_z $(S_r = (S_k \cup S_z))$ is the subset that contains all restricted assets whose constraints are binding. The domestic investor will hold positive investments in the remaining foreign assets in the set $S_{m\backslash r} = S_m \backslash S_r$, however, his demands for these assets are less than the legal limits, thus making them effectively "constraint-free" assets. The union of the domestic risky assets S_n and the foreign risky assets $S_{m\backslash r}$ forms the core set which is now denoted as $S_q(S_q = S_n \cup S_{m\backslash r})$.

4.2 The Equilibrium Expected Returns and Portfolio Holdings

We start with the first order conditions for optimal portfolio investments. Since the short-sale constraint is not binding for the foreign investor, his first order conditions will remain unchanged as in (7). However, since the domestic investor now faces two constraints for his investments in the foreign market, his Lagrangian function changes to : $L_s = \phi + \sum_{i=1}^{m} \lambda_i(\omega_i M_i - \pi_i^D) + \sum_{i=1}^{m} \gamma_i \pi_i^D$,where ϕ was defined in (8); λ_i, γ_i are the Lagrangian multipliers for the ownership constraint and the short-sale constraint respectively. The domestic investor's first order conditions are as follows,

$$
\begin{aligned}
J_W^D(\mu_i - r) + J_{WW}^D \sum_{j=1}^{N} \pi_i^D \sigma_{ij} &= 0, \quad (i \in S_n) &(18)\\
J_W^D(\mu_i - r) + J_{WW}^D \sum_{j=1}^{N} \pi_i^D \sigma_{ij} - \lambda_i + \gamma_i &= 0, \quad (i \in S_m) &(19)\\
\lambda_i(\omega_i M_i - \pi_i^D) &= 0, \ \lambda_i \geq 0, \pi_i^D \leq \omega_i M_i, &(20)\\
(i &\in S_m)\\
\gamma_i \pi_i^D &= 0, \gamma_i \geq 0, \pi_i^D \geq 0, &(21)\\
(i &\in S_m)
\end{aligned}
$$

As remarked earlier, the short-sale constraint is not binding for assets in S_k, thus $\gamma_i = 0, i \in S_k$, and the first order conditions of the domestic investor can be written as

$$
\underline{\mu}_N - r\underline{i}_N = A^D \ \Omega \ \underline{\pi}_N^D + \frac{1}{J_W^D} \begin{pmatrix} \underline{0}_q \\ -\underline{\gamma}_z \\ \underline{\lambda}_k^s \end{pmatrix} \tag{22}
$$

where $\underline{\gamma}_z, \underline{\lambda}_k^s$ are the Lagrangian multipliers for the short-sale and ownership constraints respectively. Define

$$
\underline{\eta}_r \triangleq \begin{pmatrix} -\underline{\gamma}_z \\ \underline{\lambda}_k^s \end{pmatrix}
$$

We can reduce equation (22) to

$$
\underline{\mu}_N - r\underline{i}_N = A^D \ \Omega \ \underline{\pi}_N^D + \frac{1}{J_W^D} \begin{pmatrix} \underline{0}_q \\ \underline{\eta}_r \end{pmatrix} \tag{23}
$$

The resemblance between (23) and (13) in the previous part suggests that introducing short-sale prohibition is equivalent to augmenting the set of restricted assets S_k with S_z that have self-imposed limit fraction of zero ($\underline{\omega}_z = \underline{0}_z$). The non-tradable assets are thus priced as the binding ownership constraint assets with limit fraction of zero. Proposition 3 follows immediately from the results in previous section.

Proposition 3. In equilibrium, under the restricted foreign ownership and the short-sale constraint, the risk premium of a stock is given by,

$$
E(\widetilde{R}_i - r)^{ss} \quad = \quad AMcov(\widetilde{R}_i, \widetilde{R}_W), \ \forall i \in S_q \tag{24}
$$

$$E(\widetilde{R}_i - r)^{ss} = AMcov(\widetilde{R}_i, \widetilde{R}_W) + (A^F - A)M_{L_1}cov(\widetilde{R}_i, \widetilde{R}_{L_1}|\underline{\widetilde{R}}_q) - A^F M_{K_2}cov(\widetilde{R}_i, \widetilde{R}_{K_2}|\underline{\widetilde{R}}_q), \forall i \in S_r \quad (25)$$

where the local factor $\widetilde{R}_{L_1}$ *is defined as,*

$$\begin{aligned} \widetilde{R}_{L_1} &\triangleq \sum_{i \in S_r} \frac{M_i}{M_{L_1}} \widetilde{R_i} \\ M_{L_1} &\triangleq \sum_{i \in S_r} M_i \end{aligned} \quad (26)$$

The investors' portfolio choices are given below,
for the domestic investor,

$$\begin{aligned} (\underline{\pi}_q^D)^{ss} &= \frac{A^F}{A^D + A^F} \underline{M}_q + \Omega_{qq}^{-1} \Omega_{qr} \underline{T}_r \\ (\underline{\pi}_z^D)^{ss} &= \underline{0}_z \\ (\underline{\pi}_k^D)^{ss} &= \underline{\omega}_k \circ \underline{M}_k \end{aligned} \quad (27)$$

for the foreign investor,

$$\begin{aligned} (\underline{\pi}_q^F)^{ss} &= \frac{A^D}{A^D + A^F} \underline{M}_q - \Omega_{qq}^{-1} \Omega_{qr} \underline{T}_r \\ (\underline{\pi}_z^F)^{ss} &= \underline{M}_z \\ (\underline{\pi}_k^F)^{ss} &= (\underline{i}_k - \underline{\omega}_k) \circ \underline{M}_k \end{aligned} \quad (28)$$

The superscript $()^{ss}$ *denotes values in the presence of the short-sale constraint to distinguish from the previous section. Finally,* $\underline{T}_r$ *is the vector of market capitalizations of the risky assets in* S_r *which is partitioned as* $\binom{\underline{T}_z}{\underline{T}_k}$ *where* $\underline{T}_z$ *equals* $\frac{A^F}{A^D+A^F}\underline{M}_z$*;* $\underline{T}_k$ *is defined in proposition 2 above.*

The key distinction between proposition 1 and 3 is the composition of the first local factor and its price of risk. Whereas the local factor $\widetilde{R}_{K_1}$ only represents the foreign risky assets with positive holdings by the domestic investor, the local factor $\widetilde{R}_{L_1}$ also includes the non-tradable foreign assets in S_z. It is intuitive that the second local factor in (25) remains unchanged since adding non-tradable assets contributes nothing to the benefit of loosening the ownership constraint (the discount effect). On the other hand, the presence of the short-sale constraint auguments the conditional local premium factor with the addition of non-tradable assets. It is tempting to jump to the conclusion that the presence of the non-tradable assets would drive up the risk premium of the restricted assets in S_k. However, the risk premia in propositions 1 and 3 are conditional on the returns of the assets in the core which changes (from S_p to S_q) due to the short-sale constraint. Hence, an appropriate comparison must take into account this change, which is discussed in proposition 4 below.

4.3 The Marginal Effects of The Short-Sale Constraint

In this part we compare the results of proposition 1 and 2 with those of proposition 3, and also relate our model with previous literature. We examine three cases representing various scenarios of the ownership and short-sale constraints.

4.3.1 The ownership restriction is binding for some foreign assets

The short-sale constraint is not binding, $S_z = \varnothing$.

In this scenario, the domestic investor has non-negative holdings for all foreign securities, thus prohibiting short sales by no means has any impact on asset returns and investors' holdings.

The short-sale constraint is binding for some of the foreign securities, $S_z \neq \varnothing$ *and* $S_z \subset S_{m\backslash k}$.

This is the most general and also the underlying setting of our model. Introduction of the short-sale constraint transforms assets in subset S_z into restricted assets. However, the effect on assets in subset S_k is a bit more involved because the introduction of the short-sale constraint changes not only the local premium factor that prices these assets but also the core on which their risk premium and discount are conditioned.

To facilitate the analysis, we use the following partitions

$$\Omega \equiv \begin{bmatrix} \Omega_{pp} & \Omega_{pk} \\ \Omega_{kp} & \Omega_{kk} \end{bmatrix} \equiv \begin{bmatrix} \Omega_{qq} & \Omega_{qz} & \Omega_{qk} \\ \Omega_{zq} & \Omega_{zz} & \Omega_{zk} \\ \Omega_{kq} & \Omega_{kz} & \Omega_{kk} \end{bmatrix} \tag{29}$$

Next, we define Γ_{rr} in terms of Ω_{qq}^{-1} as follows

$$\begin{aligned} \Gamma_{rr} &= \begin{bmatrix} \Omega_{zz} - \Omega_{zq}\Omega_{qq}^{-1}\Omega_{qz} & \Omega_{zk} - \Omega_{zq}\Omega_{qq}^{-1}\Omega_{qk} \\ \Omega_{kz} - \Omega_{kq}\Omega_{qq}^{-1}\Omega_{qz} & \Omega_{kk} - \Omega_{kq}\Omega_{qq}^{-1}\Omega_{qk} \end{bmatrix} \\ &= \begin{bmatrix} \Gamma_{zz} & \Gamma_{zk} \\ \Gamma_{kz} & \Gamma_{kk} \end{bmatrix} \end{aligned} \tag{30}$$

Proposition 4. The introduction of the short-sale constraint causes the expected returns of risky assets in S_k to change as follows

$$E(\underline{\widetilde{R}}_k^{ss} - \underline{\widetilde{R}}_k) = A^F(\Gamma_{kz}\underline{T}_z - \Gamma_{kz}\Gamma_{zz}^{-1}\Gamma_{zk}\underline{T}_k) \tag{31}$$

The change in the expected returns of assets that have binding ownership constraint can be attributed to two forces that operate in opposite directions. The expected return of assets in S_k increases by a term proportional to the conditional covariance of returns of assets in S_k and S_z, offsets by a term proportional to the conditional covariance of returns of asset S_k and the portfolio of assets in S_z that are most highly correlated to S_k (diversification benefit).

As remarked earlier, the introduction of the short-sale constraint results in the reduction in the core and affects portfolio holdings. Specifically, we are interested in how the domestic investor (correspondingly the foreign investor) reshuffles his portfolio composition of the core assets in response to the short-sale constraint.

Proposition 5. The change in the domestic investor's portfolio holdings of the core assets is given by

$$(\underline{\pi}_q^D)^{ss} - \underline{\pi}_q^D = \Omega_{qq}^{-1}\Omega_{qz}\underline{T}_z + \Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1}\Gamma_{zk}\underline{T}_k \tag{32}$$

In the absence of the short-sale constraint, the domestic investor demands the amount $\Gamma_{zz}^{-1}\Gamma_{zk}\underline{T}_k$ of S_z to hedge for his desirable, but inadmissible $\underline{T}_k$. When short sales are precluded and the short-sale constraint is binding for S_z, these assets are no longer available to the domestic investor. As a consequence, he changes his portfolio in two ways: on one hand, he demands the portfolio of the core assets that is most highly correlated with S_z, and on the other hand, he also demands the portfolio of the core assets to hedge for the reduction in the core available to him. The foreign investor, as always, plays the role of clearing the market and supplies these portfolios to the domestic investor.

4.3.2 The ownership constraint is binding for all the foreign risky assets

In this polar case, the domestic investor holds all foreign securities up to the legal limits. Banning short sales of foreign risky assets has absolutely no effect on asset prices and investors' portfolio choices. In fact, this is the major result of EJ.

4.3.3 The ownership constraint is not binding for all investable foreign securities

This is the other polar case where the domestic investor's investments in all investable foreign risky assets are strictly less than the allowed limits. The investable securities are thus effectively integrated before the short-sale constraint is introduced. Depending on the short-sale constraint we can have three following scenarios.

The short-sale constraint is not binding for any foreign risky asset, or $S_z = \varnothing$.

In this extreme scenario, the entire investable foreign market is held long by the domestic investor and the investable securities are effectively integrated.

The short-sale constraint is binding, or $S_z = S_m$.

This is the other extreme scenario when the domestic investor wants to short all investable foreign risky assets. Hence, when short-sale is banned in the foreign market, the domestic investor will hold zero investment in the foreign market, and the entire investable segment of the foreign market becomes nontradable. In this scenario, our model collapses to EL.

The short-sale constraint is only binding for some foreign risky assets, or $S_z \subset S_m$.

This is in fact a refined version of the previous scenario applied to the subset S_z of foreign investable assets. The rest of the foreign investable assets will be integrated with domestic risky assets to form the core set.

5 Econometric Method

In each emerging market, we construct three test assets: the unrestricted, the ownership binding and the non-investable portfolios. We test our model using equation (24) for the unrestricted portfolio and equation (25) for the other two portfolios. We separate the non-investable from the ownership binding portfolio given the significant difference especially in their Investable Weight Factor (defined below) and to increase the power of our test. We should also include a fourth test asset, the non-tradable portfolio. Unfortunately, it is not possible to construct this test asset either as defined in our theoretical framework or in the vein of Stulz (1981b).

It is well established that expected returns are time varying.[13] Hence, we follow Gibbons and Ferson (1985) and estimate a conditional version of our model that allows factor risk premia to vary over time. If Z_{t-1} is the information available at time $t-1$, equations (24) and (25) imply that,

$$\begin{aligned} E(\widetilde{r}_u|Z_{t-1}) = &\quad \beta_{uW}\lambda_W(Z_{t-1}) \\ E(\widetilde{r}_b|Z_{t-1}) = &\quad \beta_{bW}\lambda_W(Z_{t-1}) + \beta_{bL}\lambda_L(Z_{t-1}) - \beta_{bK}\lambda_K(Z_{t-1}) \\ E(\widetilde{r}_n|Z_{t-1}) = &\quad \beta_{nW}\lambda_W(Z_{t-1}) + \beta_{nW}\lambda_L(Z_{t-1}) - \beta_{nK}\lambda_K(Z_{t-1}) \end{aligned} \tag{33}$$

where $\widetilde{r}_i$ is the excess return on asset i; subscripts u, b, and n denote the unrestricted, the ownership binding and the non-investable portfolios respectively; λ_{W_t}, λ_{L_t} and λ_{K_t} are factor risk premia of the global, conditional premium and conditional discount factors, and β are factor loadings.

Assuming returns are governed by a linear factor model:

$$\begin{aligned} \widetilde{r}_{u,t} = &\quad \lambda_{u0,t-1} + \beta_{uW}\widetilde{R}_{W,t} + \widetilde{\varepsilon}_{u,t} \\ \widetilde{r}_{b,t} = &\quad \lambda_{b0,t-1} + \beta_{bW}\widetilde{R}_{W,t} + \beta_{bL}\widetilde{R}_{resL,t} - \beta_{bK}\widetilde{R}_{resK,t} + \widetilde{\varepsilon}_{b,t} \\ \widetilde{r}_{n,t} = &\quad \lambda_{n0,t-1} + \beta_{nW}\widetilde{R}_{W,t} + \beta_{nL}\widetilde{R}_{resL,t} - \beta_{nK}\widetilde{R}_{resK,t} + \widetilde{\varepsilon}_{n,t} \end{aligned} \tag{34}$$

where $\widetilde{R}_{resL,t}$, $\widetilde{R}_{resK,t}$ are the residual of the projection of the local factor $\widetilde{R}_L$ and $\widetilde{R}_K$ on the space spanned by returns of all risky assets in the core.[14] Taking conditional expectations of equation (34) and equating them with equation (33)

[13] See, for examole, Ferson and Harvey (1991) among others.

[14] Here we use the residual factor in place of the conditional factor because of the identity $Cov(x, y|z) = Cov(x, u)$, where u is the residual of the regression of y on z.

delivers the restrictions on the intercepts in (34)

$$\begin{aligned}
\lambda_{u0,t-1} = \quad & \beta_{uW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] \\
\lambda_{b0,t-1} = \quad & \beta_{bW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] + \beta_{bL}[\lambda_L(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resL,t})] - \\
& \beta_{bK}[\lambda_K(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resK,t})] \\
\lambda_{n0,t-1} = \quad & \beta_{nW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] + \beta_{nL}[\lambda_L(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resL,t})] - \\
& \beta_{nK}[\lambda_K(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resK,t})]
\end{aligned}$$

Imposing these restrictions and the rational expectation for the factor returns, we obtain,

$$\begin{aligned}
\widetilde{r}_{u,t} &= \beta_{uW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] + \beta_{uW}\widetilde{R}_{W,t} + \widetilde{\varepsilon}_{u,t} \\
\widetilde{r}_{b,t} &= \beta_{bW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] + \beta_{bL}[\lambda_L(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resL,t})] - \\
& \quad \beta_{bK}[\lambda_K(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resK,t})] + \beta_{bW}\widetilde{R}_{W,t} + \beta_{bL}\widetilde{R}_{resL,t} - \beta_{bK}\widetilde{R}_{resK,t} + \widetilde{\varepsilon}_{b,t} \\
\widetilde{r}_{n,t} &= \beta_{nW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] + \beta_{nL}[\lambda_L(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resL,t})] - \\
& \quad \beta_{nK}[\lambda_K(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resK,t})] + \beta_{nW}\widetilde{R}_{W,t} + \beta_{nL}\widetilde{R}_{res,t} - \beta_{nK}\widetilde{R}_{resK,t} + \widetilde{\varepsilon}_{n,t} \\
\widetilde{R}_{W,t} &= E_{t-1}(\widetilde{R}_{W,t}) + \widetilde{\varepsilon}_{W,t} \\
\widetilde{R}_{resL,t} &= E_{t-1}(\widetilde{R}_{resL,t}) + \widetilde{\varepsilon}_{resL,t} \\
\widetilde{R}_{resK,t} &= E_{t-1}(\widetilde{R}_{resK,t}) + \widetilde{\varepsilon}_{resK,t}
\end{aligned}$$

In order to estimate this model, we need to specify the functional forms of factor risk premia and factors' conditional expectations. We follow De Santis and Gerard (1997) to parameterize the factor risk premia as exponential functions of information variables. We use Harvey (1989, 1991) to model conditional expectations as linear functions of information variables. Specifically,

$$\begin{aligned}
\lambda_W(Z_{t-1}) &= \exp(k'_W Z_{W,t-1}) \\
\lambda_L(Z_{t-1}) &= \exp(k'_L Z_{L,t-1}) \\
\lambda_K(Z_{t-1}) &= \exp(k'_K Z_{K,t-1}) \\
E_{t-1}(\widetilde{R}_{W,t}) &= \delta'_W Z_{W,t-1} \\
E_{t-1}(\widetilde{R}_{resL,t}) &= \delta'_L Z_{L,t-1} \\
E_{t-1}(\widetilde{R}_{resK,t}) &= \delta'_K Z_{K,t-1}
\end{aligned}$$

where (k, δ) are coefficients; and Z_W, Z_L, Z_K are instrumental variables for the world, premium and discount factors respectively.

Under normality assumption[15], the log likelihood function can be written as,

$$\ln L(\theta, \Omega) = -\frac{TN}{2}\ln(2\pi) - \frac{1}{2}T\ln(|\Omega|) - \frac{1}{2}\sum_{t=1}^{T}\varepsilon_t(\theta)'\Omega^{-1}\varepsilon_t(\theta)$$

where θ is the vector of parameters, Ω is the $N \times N$ variance-covariance matrix, $\varepsilon_t(\theta)$ is the $N \times 1$ vector of innovations and N is the number of assets (

[15] Since normality is often violated, we estimate the model and compute the covariance matrix using the quasi-maximum likelihood approach.

in our case $N = 6$). We can concentrate the log likelihood function and iterate between the estimates of θ and Ω[16].

6 Data and Empirical Results

6.1 Data Sources

Country Stock Data

Securities data are obtained from Standard & Poor's emerging markets database (EMDB). We select 18 major emerging markets for our sample: Argentina, Brazil, Chile, China, Colombia, India, Indonesia, Israel, Korea, Malaysia, Mexico, Pakistan, Peru, Philippine, South Africa, Taiwan, Thailand, and Turkey. Our sample period runs from 01 January 1989 to 20 April 2007. The dataset compiles closing stock prices, price index, dividends, market capitalization, outstanding shares, investable weight factor (IWF) and other variables. The weight factor IWF with values ranging from zero to one indicates the fraction of a company market cap a foreign entity may legally hold (0 indicates none of the stock is legally available; 1 indicates 100% of the stock market cap is available for foreign ownership). We use weekly, US dollar denominated data for individual stocks that constitute both the IFCG and IFCI indices in each market to construct test assets and local factors. The S&P/IFCG indices are built bottom up to represent the performance of the most active securities in their respective markets, and to be the broadest possible indicator of market movements with a target market cap of 70 - 80% of the total capitalization of all locally exchange-listed shares. The S&P investable indices (S&P/IFCI) are designed to measure the returns foreign portfolio investors would receive from investing in emerging market securities that are legally and practically available to foreign holders. The calculation method is the same as for the S&P/IFCG, but is applied to the subset of S&P/IFCG constituents that Standard & Poor's has determined to be investable - stocks available to foreign institutional investors which meet size and liquidity screens.[17] Table 1 summarizes the composition of the IFCG universe for each market. For our sample period, the average number of stocks ranges from 21 (Colombia) to 225 (China), while the average IWF goes from 0.14 (China) to 0.78 (South Africa). On average, the IWF suggests that Latin American equity markets are more open to foreigners than Asian markets. Brazil, China, India, Taiwan, Mexico and South Africa are among countries with largest market capitalization. There is large cross-sectional and time variation among our sample markets.

World Market and Global Sectors Data

Global data are from DataStream (DS). We use DS World Total Return Index as a proxy for the world market index. The one-month Eurodollar yields are used to compute the weekly risk-free rates. For the global sector data, we

[16] See Campbell, Lo and MacKinlay (1997) and Green (2003) for details.

[17] See Standard & Poor's S&P Emerging Market Index - Index Methodology for more details.

employ DataStream level 4 data which consists of 115 world sector/industry series.

Country Fund and ADR Data

We use the Country Funds (CFs) and American Depositary Receipts (ADRs) data set of Chaieb and Errunza (2007) to construct the local conditional factors. The data comprises of 28 country funds and 90 ADRs/GDRs. US-based securities data are obtained from CRSP while non-US based securities data are obtained from DataStream.[18]

Information Variables

We select two sets of conditioning variables that have been widely used in the international asset pricing literature[19] to model the dynamics of the prices of risk for the global and local factors. In particular, for the global instruments, we use the world dividend yield in excess of the one-month Eurodollar rate; the week-to-week change in the US term premium, measured by the yield difference between the ten-year US Treasury note and one-month T-Bill; the US default premium, measured by the yield difference between Moody's BAA and AAA rated bonds; and the week-to-week change in the one-month Eurodollar rate. The local instruments include local market volatility[20], local dividend yield and the local IWF, measured by the cross-sectional, value-weighted average of individual stocks in the local market. Yield data are obtained from DataStream while the local market indices are from S&P's EMDB. Summary statistics for information variables are presented in table 2. The global information variables seem to carry non-redundant information as their correlations are quite low. Correlations among local information variables appear to be higher on average, however there is a large difference across markets.

6.2 Constructing Test Portfolios and Factors

In each country, we create three test portfolios which include the non-investable portfolio $\widetilde{r}_{n,t}$, the binding portfolio $\widetilde{r}_{b,t}$ and the non-binding portfolio $\widetilde{r}_{u,t}$. These portfolios are constructed based on the investable weight factor (IWF) as follows.

The Non-Investable Portfolio: This portfolio consists of risky assets in a local market which are not accessible by foreign investors. We approximate this portfolio by taking the difference of the set of constituents of the IFCG and IFCI index for each country. These assets have zero investable weight factor.

The Binding and Non-Binding Portfolios: To construct these portfolios we need to know both the legal limits and the actual holdings of local equities by

[18] See Chaieb and Errunza (2007) for details.

[19] See, for example, Harvey (1991), Bekaert and Harvey (1995), De Santis and Gerard (1997), and many others.

[20] The local market volatility is measured by fitting the local equity return with an appropriate GARCH process (for most countries, it is the standard GARCH(1,1)). A more conventional local instrument is the local equity return. We tried both the market volatility and the return and found that the results are essentially the same. However, for some countries, the estimates using volatility are more stable and faster to converge, probably because volatility is less noisy than return. Hence, we choose to report results based on the local volatility instrument.

foreign investors. Since neither of these data are available, we use the following proxies to approximate these portfolios. Following Bae et al. (2004), we group the constituents of the IFCI index in each country into two subsets: the binding set consisting of stocks with the IWF ≤ 0.5, and the non-binding set consisting of stocks with the IWF > 0.5. Although the chosen cutoff level of 0.5 may seem ad-hoc, we offer the following rationale for it. Theoretically, the cutoff level should equal $\frac{A^F}{A^D+A^F}$, where A^F, A^D are the absolute risk aversion coefficients of the foreign and the domestic investors respectively. While we do not observe investors' risk aversion, there is some evidence that the relative risk aversion does not differ significantly around the world. Notably, using an insurance dataset of 31 countries which includes 11 developing markets, Szpiro (1986) and Szpiro et al. (1988) have shown that the equality of relative risk aversion can not be rejected for 29 countries at 99% level of significance. If indeed the relative risk aversion is similar across countries, then the ratio $\frac{A^F}{A^D+A^F}$ can not be lower than 0.5 (assuming that the total market capitalization in the domestic market is greater than that of the foreign market).[21]

Portfolios are created at the end of each calendar year and rebalanced annually. Table 3 summarizes the composition of the three test portfolios for each country in our sample. Due to space constraint, for each market the data are presented as grand averages that are first averaged cross-sectionally and then over time, which do not allow meaningful generalizations.

Constructing the Local Factors and the Residual Factors

The local premium and discount factors are computed according to equation (26) and (16)[22] from the securities in the non-investable and the binding portfolios. Note that the premium factor is the value-weighted return of all securities in the non-investable and the binding portfolios, whereas the discount factor is the weighted average return of only securities in the binding portfolio taking into account their investable weight factor.

Having constructed the local factors, we obtain the residual factors as the residual of the regression of the local factors on a diversification portfolio consisting of securities in the core that is most highly correlated with the local factors. To build the diversification portfolios, we first regress the return of the local factor on the returns of the 115 world sectors, and the DS World Total Return index using a stepwise regression procedure and obtain the initial diversification portfolio of global securities, RG. In the second step, we regress the return of the local factor on RG, CFs, and ADRs/GDRs. The fitted value from this regression is the return on the final diversification portfolio. See Carrieri, Errunza and Hogan (2007) for details on the construction of the diversification portfolio.

The basic statistics for test portfolios and residual factors are reported in table 4. The returns of test portfolios as well as the residual factors exhibit typical characteristics of emerging markets such as high returns, high volatility,

[21] We also try different cutoff levels and find that the results do not change substantially for levels around and higher than 0.5.

[22] More specifically, it is the equation in the second line for K_2 in (16).

and substantial deviation from normality as documented by Bekaert and Harvey (1995, 1997). Indeed, the Bera - Jarque test of normality rejects the null hypothesis at conventional significance level for all countries in the sample.

Data Breaks and Simulations

Depending on the cut-off level, there may be no observations for certain portfolios for certain subperiods (for example, for Korea the non-investable set has no observations from 05-Nov-1999 to 27-Oct-2000). If the number of missing observations is not too large (less than 10% of the total number of observations) we use simulation to patch up our data series. When the number of missing observations is larger than 10% of the total observations we remove the missing observations. Table 5 summarizes the data breaks in test portfolios and residual factors for countries in our sample. In most countries, the problem is quite mild, except for Colombia and Pakistan where the number of data breaks in the sample period is larger than the number of observable data.

The simulation procedure works as follows. First, we estimate the dynamics of the series. We use the Akaike Information Criterion (AIC) and the Schwarz or Bayesian Criterion (BIC)[23], and the Ljung-Box Portmanteau and Engle's ARCH tests[24] to identify appropriate dynamics for the mean and the variance of the data series. For all cases, the ARMA(1,1)-GARCH(1,1) model appears sufficient to capture the dynamics of the data series. We then fit the series with the ARMA-GARCH process and diagnose the residuals with the Ljung-Box and Engle's ARCH tests again to see if the ARMA-GARCH model can adequately capture the dynamics of the series. Second, based on the ARMA-GARCH model identified in the first step, we simulate 5,000 sample paths for the missing observation period. Finally, for each simulated sample path we insert it into the original data series and refit the whole series with the ARMA-GARCH model. The sample path that gives estimates closest to those of the data-fitting in step one is chosen.

6.3 Results

Table 6 provides the main empirical results of our model. Panel A of table 6 presents point estimates and the robust standard errors of the coefficients for the factor risk premia of the global, local premium and local discount factors. Most of the coefficients are statistically significant. The coefficient on investable weight factor has positive sign and is highly significant in most cases and thus supports our model prediction that the price of risk of the local discount factor is an increasing function of the IWF. Overall, the results in panel A suggest that the global and especially the two local factors are significantly priced. To make formal inference about the significance of the risk factors, we present the results of various hypothesis tests in panel B of table 6. The first hypothesis is whether the local discount factor is priced. Using the likelihood ratio test, we find that the null hypothesis that the local discount factor is not priced is

[23] See for example Greene(2003, page 159) for details.

[24] See Engle (1982).

strongly rejected at conventional level of significance for all countries in our sample. The joint null hypothesis that the local premium factor and the local discount factor are not priced is also strongly rejected in all countries. The null hypothesis that the global factor is not priced is strongly rejected in all countries. Finally, following De Santis and Gerard (1997), we also test whether or not factor risk premia are constant over time. Consistent with the existing literature, we find supporting evidence for time varying specification of the risk premia.

The risk premia for all the three factors are significantly different from zero in all sample countries. Across our sample countries, the average risk premium of the global, the local premium and the local discount factors are 6.36%, 1.83% and 2.93% per annum respectively. The magnitude of the average global risk premium is comparable to the risk premium in the U.S. equity market which is about 7.42%[25].

We plot the risk premium of the global, local premium and local discount factors for the five countries among the largest markets (based on most recent market capitalization) in our sample in figures 1, 2, and 3 respectively. These graphs show a striking difference in the dynamics of the factor risk premia between the global and the two local factors. The global risk premium tends to move together and peak during the period 2001-2003. It remains relatively small in the rest of the sample period. The dynamics of the risk premia of the local premium and discount factors shows greater variation across countries. For some countries like South Africa, Brazil, China and India, the local risk premia appear to peak before their global counterpart in early 1999 prior to the dotcom bubble burst in the U.S. Notably, the risk premium of the local premium factor for India and especially China increases significantly at the end of our sample period.

7 Conclusion

To date, IAPMs have not considered the equilibrium implications of the joint impact of short-sale constraint and ownership constraint on international portfolio investment. Indeed, a more realistic model should take into account the explicit investment barriers in place including the existence of the non-tradable segment of the foreign market and short-sale restrictions. In a two country framework, we first study the benchmark case with only the ownership constraint in the foreign market and then generalize the model by introducing the short-sale constraint. We show that the effect of imposing short-sale prohibition is equivalent to enforcing zero ownership constraint for the assets whose short-sale constraint is binding, rendering them non-tradable. Our analysis shows that the existence of the non-tradable assets does not alter the pricing rule. In equilibrium, the freely traded securities are always priced solely by the covariance risk with the global factor. The restricted stocks are priced with three factors: the risk premium with the global factor, a conditional local risk premium and a conditional

[25] See for example Fama and French (2001), and Kocherlakota (1996).

local discount. The discount reflects the benefit of loosening equity ownership restrictions. The local premium and discount are conditional on the returns of freely traded assets. In the benchmark case, the premium factor is constituted of restricted foreign assets with binding ownership constraint, whereas it also includes non traded assets in the general case where both ownership and short-sale constraints are binding. In both cases, the discount factor is constituted of restricted assets whose ownership constraint is binding. Further the discount factor only includes the portion of the restricted assets that are available to the domestic investor and its price of risk is a linear, increasing function of legal limits on foreign holdings of all restricted securities in the foreign market.

We use maximum likelihood approach to estimate a conditional version of our model for 18 major emerging markets over the period 1989-2007. We find strong support for our model. The factor risk premia of the world and the local factors are positive, highly significant and time varying. Finally, the coefficient on investable weight factor has positive sign and is highly significant in most cases and thus supports our model prediction that the price of risk of the local discount factor is an increasing function of the IWF.

Our work has major policy and portfolio management implications. Given a very realistic world market structure, it provides a more precise estimate of cost of equity capital as well as facilitate better global asset allocation. This is critical in a rapidly liberalizing world market characterized by increasing importance of emerging markets. From a regulatory perspective, the model provides a better understanding of gains from opening of equity markets to foreign portfolio investors.

References

[1] Adler, Michael, and Bernard Dumas, 1983, “International portfolio selection and corporation finance: A synthesis”, *Journal of Finance,* 38, 925-984.

[2] Bae, Kee-Hong, Keloh Chan, and Angela Ng, 2004, "Investability and return volatility", *Journal of financial Economics*, 71, 239-263.

[3] Bekaert, Geert and Campbell Harvey, 1995, “Time-varying world market integration”, *Journal of Finance,* 50, 403-444.

[4] Bekaert, Geert and Campbell Harvey, 1997, “Emerging equity market volatility,” *Journal of Financial Economics,* 43, 29-77.

[5] Bergstrom, Clas, Kristian, Rydqvist, and Peter Sellin, 1993, "Asset pricing with in- and outflow constraints: Theory and empirical evidence from Sweden", *Journal of Business Finance and Accounting*, 20, 865-879.

[6] Bris, Arturo, William Goetzmann and Ning Zhu, 2007, "Efficiency and the bear: short sales and markets around the world", *Journal of Finance,* 63, 1029-1079.

[7] Campbell, John, Andrew Lo, and Craig MacKinlay, 1997, "The econometrics of financial markets", Princeton University Press.

[8] Carrieri, Francesca, Vihang Errunza and Ked Hogan, 2007, “Characterizing world market integration through time”, *Journal of Financial Quantitative Analysis*, 42, 915-940.

[9] Chaieb, Ines and Vihang Errunza, 2007, "International asset pricing under segmentation and PPP deviations", *Journal of Financial Economics,* 86, 543-578.

[10] Charoenrook, Anchada and Hazem Daouk, 2005, "A study of market-wide short-selling restrictions", working paper, Vanderbilt University.

[11] De Santis, Giorgio and Bruno Gerard, 1997, "International asset pricing and portfolio diversification with time-varying risk", *Journal of Finance*, 52, 1881–1912

[12] Edison, Hali and Francis Warnock, 2003, "A simple measure of the intensity of capital controls", *Journal of Empirical Finance* 10, 81-103.

[13] Edison, Hali and Francis Warnock, 2004, " US investors’ emerging market equity portfolios: a security-level analysis", *Review of Economics and Statistics*, 86, 691-704.

[14] Engle, Robert, 1982, "Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflations", *Econometrica*, 50, 987-1008.

[15] Errunza, Vihang and Etienne Losq, 1985, "International asset pricing under mild segmentation: Theory and test", *Journal of Finance*, 40, 105–124.

[16] Errunza, Vihang and Etienne Losq, 1989, "Capital flow controls, international asset pricing and investors' welfare: A multi country framework", *Journal of Finance*, September, 1025–1037.

[17] Eun, Cheol, and S. Janakiramanan, 1986, "A model of international asset pricing with a constraint on the foreign equity ownership", *Journal of Finance*, 41, 897–914.

[18] Fama, Eugene and Kenneth French, 2001, "The equity premium", working paper, University of Chicago.

[19] Ferson, Wayne E., and Campbell R. Harvey, 1991, "The variation of economic risk premiums", *Journal of Political Economy*, 99, 385-415

[20] Ferson, Wayne E., and Campbell R. Harvey, 1993, "The risk and predictability of international equity returns", *Review of Financial Studies,* 6, 527-566.

[21] Fleming, Wendell and Thaleia Zariphopoulou, 1991, "An optimal investment/consumption model with borrowing", *Mathematics of Operations Research*, 16, 802-822.

[22] Gibbons, Michael and Wayne Ferson, 1985, "Testing asset pricing models with changing expectations and an unobservable market portfolio", *Journal of Financial Economics,* 14,217-236.

[23] Greene, William, 2003, "Econometric Analysis", 5th Edition, Pearson Education Inc.

[24] Harvey, Campbell, 1989, "Time varying conditional covariances in tests of asset pricing models", *Journal of Financial Economics*, 24, 289-317.

[25] Harvey, Campbell, 1991, "The world price of covariance risk", *Journal of Finance*, 46, 111 - 157.

[26] Kang, Jun and Rene Stulz, 1997, "Why is there a home bias? An analysis of foreign portfolio equity ownership in Japan", *Journal of Financial Economics,* 46, 3-28.

[27] Kocherlakota, Narayana, 1996, "The equity premium: It's still a puzzle", *Journal of Economic Literature*, XXXIV, 42-71.

[28] Merton, Robert, 1969, "Lifetime portfolio selection under uncertainty: The continuous time case", *Review of Economic Statistics*, 51,247-257.

[29] Merton, Robert, 1971, "Optimum consumption and portfolio rules in a continuous-time model", *Journal of Economic Theory*, 3, 373-413.

[30] Merton, Robert, 1973, “An intertemporal capital asset pricing model”, *Econometrica*, 41, 867-87.

[31] Merton, Robert, 1987,"A simple model of capital market equilibrium with incomplete information", *Journal of Finance,* 42, 483-510.

[32] Shanken, J., 1992, "On the estimation of beta-pricing models", *Review of Financial Studies*, 5, 1-33.

[33] Shanken, J. and G. Zhou, 2007, "Estimating and testing beta pricing models: alternative methods and their performance in simulations", *Journal of Financial Economics*, 84, 40-86.

[34] Solnik, Bruno, 1974, “An equilibrium model of the international capital market”, *Journal of Economic Theory,* 8, 500-524.

[35] Stulz, Rene, 1981a, “A model of international asset pricing”, *Journal of Financial Economics,* 9, 383-406.

[36] Stulz, Rene, 1981b, “On the effects of barriers to international investment”, *Journal of Finance*, 36, 923–934.

[37] Stulz, Rene, 1987,"An Equilibrium Model of Exchange Rate Determination and Asset Pricing with Non-Traded Goods and Imperfect Information," Journal of Political Economy, 95, 1024-1040.

[38] Stulz, Rene and Rodolfo Martell, 2003,"Equity Market Liberalizations as Country IPOs," American Economic Review, Papers and Proceedings, 93, 97-101.

[39] Szpiro, Goerge, 1986, "Relative risk aversion around the world", *Economic Letters*, 20, 19 - 21.

[40] Szpiro, Goerge and J.F. Outreville, 1988, "Relative risk aversion around the world: Further results", *Studies in Banking and Finance*, 6, 127 - 128.

[41] Tepla, Lucie, 2000, "Optimal portfolio policies with borrowing and short-sale constraints", *Journal of Economic Dynamics & Control*, 24, 1623 - 1639.

[42] Uppal, Raman, 1993, “A general equilibrium model of international portfolio choice”, *Journal of Finance*, 48(2), 529-553.

[43] Zariphopoulou,Thaleia , 1991, "Consumption - investment models with constraints", *Proceedings of the 30th Conference on Decision and Control.*

A Proofs

A.1 Proposition 1

To characterize the extra risk premium we partition the vector of expected returns and the covariance matrix as follows,

$$\left(\underline{\mu}_N - r\underline{i}_N\right) = \begin{pmatrix} \underline{\mu}_p - r\underline{i}_p \\ \underline{\mu}_k - r\underline{i}_k \end{pmatrix}; \quad \Omega = \begin{bmatrix} \Omega_{pp} & \Omega_{pk} \\ \Omega_{kp} & \Omega_{kk} \end{bmatrix} = \begin{bmatrix} \Omega_{pN} \\ \Omega_{kN} \end{bmatrix} \tag{35a}$$

Using the partition in (35a), we expand equation (13) as,

$$\left(\underline{\mu}_p - r\underline{i}_p\right) = A\ \Omega_{pN}\ \underline{M}_N \tag{36a}$$

$$\left(\underline{\mu}_k - r\underline{i}_k\right) = A\ \Omega_{kN}\ \underline{M}_N + \frac{A}{A^D J_W^D}\underline{\lambda}_k \tag{36b}$$

Taking the domestic investor's demand for the foreign securities S_k as given, we expand equation (13) as,

$$\left(\underline{\mu}_N - r\underline{i}_N\right) = A^D \begin{bmatrix} \Omega_{pp} & \Omega_{pk} \\ \Omega_{kp} & \Omega_{kk} \end{bmatrix} \begin{pmatrix} \underline{\pi}_p^D \\ \underline{\pi}_k^D \end{pmatrix} + \frac{1}{J_W^D} \begin{pmatrix} \underline{0}_p \\ \underline{\lambda}_k \end{pmatrix}$$

which is equivalent to,

$$\left(\underline{\mu}_p - r\underline{i}_p\right) = A^D(\Omega_{pp}\underline{\pi}_p^D + \Omega_{pk}\underline{\pi}_k^D) \tag{37a}$$

$$\left(\underline{\mu}_k - r\underline{i}_k\right) = A^D(\Omega_{kp}\underline{\pi}_p^D + \Omega_{kk}\underline{\pi}_k^D) + \frac{1}{J_W^D}\underline{\lambda}_k \tag{37b}$$

From (37a), we obtain,

$$\underline{\pi}_p^D = \frac{1}{A^D}\Omega_{pp}^{-1}\left(\underline{\mu}_p - r\underline{i}_p\right) - \Omega_{pp}^{-1}\Omega_{pk}\underline{\pi}_k^D \tag{38a}$$

Plug (38a) into (37b), solve for the vector of Lagrangian multipliers,

$$\begin{aligned} \frac{1}{J_W^D}\underline{\lambda}_k &= \left(\underline{\mu}_k - r\underline{i}_k\right) - A^D[\Omega_{kp}(\frac{1}{A^D}\Omega_{pp}^{-1}\left(\underline{\mu}_p - r\underline{i}_p\right) \\ &\quad -\Omega_{pp}^{-1}\Omega_{pk}\underline{\pi}_k^D) + \Omega_{kk}\underline{\pi}_k^D] \qquad (39a) \\ &= \left(\underline{\mu}_k - r\underline{i}_k\right) - \Omega_{kp}\Omega_{pp}^{-1}\left(\underline{\mu}_p - r\underline{i}_p\right) + A^D(\Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk} - \Omega_{kk})\underline{\pi}_k^D \end{aligned}$$

Substitute equation (39a) in equation (36b), to solve for the expected returns of the risky assets in S_k,

$$\begin{aligned} \frac{1}{A}\left(\underline{\mu}_k - r\underline{i}_k\right) &= \Omega_{kN}\ \underline{M}_N + \frac{1}{A^D J_W^D}\underline{\lambda}_k \\ \frac{1}{A}\left(\underline{\mu}_k - r\underline{i}_k\right) &= \Omega_{kN}\ \underline{M}_N + \frac{1}{A^D}[\left(\underline{\mu}_k - r\underline{i}_k\right) \\ &\quad -\Omega_{kp}\Omega_{pp}^{-1}\left(\underline{\mu}_p - r\underline{i}_p\right) + A^D(\Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk} - \Omega_{kk})\underline{\pi}_k^D] \end{aligned}$$

Recall that the aggregate risk aversion satisfies the identity $\frac{1}{A} = \frac{1}{A^F} + \frac{1}{A^D}$, we can simplify the above equation as,

$$\frac{1}{A^F}\left(\underline{\mu}_k - r\underline{i}_k\right) = \Omega_{kN}\ \underline{M}_N - \frac{1}{A^D}\Omega_{kp}\Omega_{pp}^{-1}\left(\underline{\mu}_p - r\underline{i}_p\right) + (\Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk} - \Omega_{kk})\underline{\pi}_k^D$$

Finally, replacing the term $(\underline{\mu}_p - r\underline{i}_p)$ with the result in (36a) gives,

$$\begin{aligned}
\frac{1}{A^F}\left(\underline{\mu}_k - r\underline{i}_k\right) &= \Omega_{kN}\ \underline{M}_N - \frac{A}{A^D}\Omega_{kp}\Omega_{pp}^{-1}\ \Omega_{pN}\ \underline{M}_N - (\Omega_{kk} - \Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk})\underline{\pi}_k^D \\
&= Q - (\Omega_{kk} - \Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk})\underline{\pi}_k^D \qquad (40a) \\
\text{where } Q &= \Omega_{kN}\ \underline{M}_N - \frac{A}{A^D}\Omega_{kp}\Omega_{pp}^{-1}\Omega_{pN}\underline{M}_N
\end{aligned}$$

Next we compute Q using the matrix partition as in (35a) and noting that $A = \frac{A^D A^F}{A^D + A^F}$,

$$\begin{aligned}
Q &= \Omega_{kk}\underline{M}_k + \Omega_{kp}\underline{M}_p - \frac{A^F}{A^D + A^F}\Omega_{kp}\Omega_{pp}^{-1}(\Omega_{pp}\underline{M}_p + \Omega_{pk}\underline{M}_k) \\
&= \Omega_{kk}\underline{M}_k + \Omega_{kp}\underline{M}_p - \frac{A^F}{A^D + A^F}\Omega_{kp}\underline{M}_p - \frac{A^F}{A^D + A^F}\Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk}\underline{M}_k \\
&= \Omega_{kk}\underline{M}_k + \frac{A^D}{A^D + A^F}\Omega_{kp}\underline{M}_p - \frac{A^F}{A^D + A^F}\Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk}\underline{M}_k \\
&= \frac{A^D}{A^D + A^F}(\Omega_{kk}\underline{M}_k + \Omega_{kp}\underline{M}_p) + \frac{A^F}{A^D + A^F}(\Omega_{kk} - \Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk})\underline{M}_k \\
&= \frac{A^D}{A^D + A^F}\Omega_{kN}\underline{M}_N + \frac{A^F}{A^D + A^F}(\Omega_{kk} - \Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk})\underline{M}_k
\end{aligned}$$

Substitute Q back into equation (40a) we obtain,

$$\frac{1}{A^F}\left(\underline{\mu}_k - r\underline{i}_k\right) = \frac{A^D}{A^D + A^F}\Omega_{kN}\underline{M}_N + (\Omega_{kk} - \Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk})(\frac{A^F}{A^D + A^F}\underline{M}_k - \underline{\pi}_k^D)$$

Collecting terms and noting $\underline{\pi}_k^D = \underline{\omega}_k \circ \underline{M}_k$, we get,

$$\begin{aligned}
\left(\underline{\mu}_p - r\underline{i}_p\right) &= A\ \Omega_{pN}\ \underline{M}_N \qquad (41a) \\
\left(\underline{\mu}_k - r\underline{i}_k\right) &= A\ \Omega_{kN}\ \underline{M}_N + A^F\Phi_{kk}\underline{T}_k
\end{aligned}$$

where $\Phi_{kk} = (\Omega_{kk} - \Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk})$, and $\underline{T}_k = (\frac{A^F}{A^D + A^F}\underline{M}_k - \underline{M}_k \circ \underline{\omega}_k)$.

With the aid of the world factor $\widetilde{R}_W$ and the local factors $\widetilde{R}_{K_1}, \widetilde{R}_{K_2}$, we have the following identities,

$$\begin{aligned}
\Omega_{pN}\ \underline{M}_N &= M cov(\underline{\widetilde{R}}_p, \widetilde{R}_W) \\
\Phi_{kk}\underline{M}_k &= M_{K_1} cov(\underline{\widetilde{R}}_k, \widetilde{R}_{K_1} | \underline{\widetilde{R}}_p) \\
\Phi_{kk}\underline{M}_k \circ \underline{\omega}_k &= M_{K_2} cov(\underline{\widetilde{R}}_k, \widetilde{R}_{K_2} | \underline{\widetilde{R}}_p)
\end{aligned}$$

where M, M_{K_1}, M_{K_2} are the total capitalization of the respective factors. Replacing these in equation (41a), obtain equations (14) and (15).

A.2 Proposition 2.

The domestic investor's holdings of the foreign securities in S_k are given by the binding ownership constraint $\underline{\pi}_k^D = \underline{\omega}_k \circ \underline{M}_k$. His holdings of the other risky assets are derived from (38a); using the result in (41a) gives,

$$\begin{aligned}
\underline{\pi}_p^D &= \frac{A}{A^D}\Omega_{pp}^{-1}\ \Omega_{pN}\ \underline{M}_N - \Omega_{pp}^{-1}\Omega_{pk}\underline{\pi}_k^D \\
&= \frac{A^F}{A^D + A^F}\Omega_{pp}^{-1}(\Omega_{pp}\underline{M}_p + \Omega_{pk}\underline{M}_k) - \Omega_{pp}^{-1}\Omega_{pk}\underline{\pi}_k^D \\
&= \frac{A^F}{A^D + A^F}\underline{M}_p + \Omega_{pp}^{-1}\Omega_{pk}(\frac{A^F}{A^D + A^F}\underline{M}_k - \underline{\pi}_k^D) \\
&= \frac{A^F}{A^D + A^F}\underline{M}_p + \Omega_{pp}^{-1}\Omega_{pk}\underline{T}_k \qquad (42a)
\end{aligned}$$

The foreign investor, facing no constraint on his investment opportunities, will be forced to clear the market. Therefore, his holdings are given by,

$$\begin{aligned}
\underline{\pi}_p^F &= \frac{A^D}{A^D + A^F}\underline{M}_p - \Omega_{pp}^{-1}\Omega_{pk}\underline{T}_k \qquad (43a) \\
\underline{\pi}_k^F &= (\underline{i}_k - \underline{\omega}_k) \circ \underline{M}_k.
\end{aligned}$$

A.3 Proposition 4

Instead of using the covariance form of expected returns, we make use of their matrix form as in (41a) and transform the conditional variance-covariance matrices Φ_{kk} and $\Gamma_{rr}$to have the core set S_q. First we note that the expected return for assets in S_k under the short-sale constraint can be rewritten as follows

$$\left(\underline{\mu}_k - r\underline{i}_k\right)^{ss} = A\Omega_{kN}\underline{M}_N + A^F(\Gamma_{kz}\underline{T}_z + \Gamma_{kk}\underline{T}_k) \qquad (44a)$$

where we recall that $\underline{T}_r = \binom{\underline{T}_z}{\underline{T}_k}$.

Employing the partition (29) and the formula of Blockwise Inversion of Matrices, one can expand the term Ω_{pp}^{-1} in (41a) and (42a) as a function of Ω_{qq}^{-1}. Note that $\Omega_{pp} = \begin{bmatrix} \Omega_{qq} & \Omega_{qz} \\ \Omega_{zq} & \Omega_{zz} \end{bmatrix}$, using the Blockwise Inversion formula gives

$$\Omega_{pp}^{-1} = \begin{bmatrix} \Omega_{qq}^{-1} + \Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1}\Omega_{zq}\Omega_{qq}^{-1} & -\Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1} \\ -\Gamma_{zz}^{-1}\Omega_{zq}\Omega_{qq}^{-1} & \Gamma_{zz}^{-1} \end{bmatrix} \qquad (45a)$$

Finally, plug the inverse (45a) into the expression of Φ_{kk}, we obtain

$$\begin{aligned}
\Phi_{kk} &= \Omega_{kk} - \Omega_{kp}\Omega_{pp}^{-1}\Omega_{pk} \\
&= \Omega_{kk} - \begin{bmatrix} \Omega_{kq} & \Omega_{kz} \end{bmatrix} \begin{bmatrix} \Omega_{qq}^{-1} + \Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1}\Omega_{zq}\Omega_{qq}^{-1} & -\Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1} \\ -\Gamma_{zz}^{-1}\Omega_{zq}\Omega_{qq}^{-1} & \Gamma_{zz}^{-1} \end{bmatrix} \\
&\quad \times \begin{bmatrix} \Omega_{qk} \\ \Omega_{zk} \end{bmatrix} \\
&= \Omega_{kk} - \begin{bmatrix} \Omega_{kq}\Omega_{qq}^{-1} - \Gamma_{kz}\Gamma_{zz}^{-1}\Omega_{zq}\Omega_{qq}^{-1} & \Gamma_{kz}\Gamma_{zz}^{-1} \end{bmatrix} \begin{bmatrix} \Omega_{qk} \\ \Omega_{zk} \end{bmatrix} \\
\Phi_{kk} &= \Gamma_{kk} + \Gamma_{kz}\Gamma_{zz}^{-1}\Gamma_{zk} \qquad (46a)
\end{aligned}$$

where in line 4 and 5 we use the results in (30).

Equation (46a) explains the change in the conditional covariance of the k assets when there is a shrinkage in the core - the set of free assets reduces from p to q, and, more important, allows us to study the marginal effect of banning short-sale on expected returns of the k assets after controlling for the change in the basis. Taking the difference between (41a) and (44a) and using the identity (46a) gives the desired result.

A.4 Proposition 5.

First, we expand the portfolio holdings (27) of the assets in S_q by the domestic investor

$$\begin{aligned}
(\underline{\pi}_q^D)^{ss} &= \frac{A^F}{A^D + A^F}\underline{M}_q + \Omega_{qq}^{-1}\Omega_{qr}\underline{T}_r \\
&= \frac{A^F}{A^D + A^F}\underline{M}_q + \Omega_{qq}^{-1}\begin{bmatrix} \Omega_{qz} & \Omega_{qk} \end{bmatrix}\begin{bmatrix} \underline{T}_z \\ \underline{T}_k \end{bmatrix} \\
&= \frac{A^F}{A^D + A^F}\underline{M}_q + \Omega_{qq}^{-1}\Omega_{qz}\underline{T}_z + \Omega_{qq}^{-1}\Omega_{qk}\underline{T}_k \qquad (47a)
\end{aligned}$$

Next, replace the matrix inverse of Ω_{pp}^{-1} in (45a) into (42a)

$$\begin{aligned}
\underline{\pi}_p^D &= \frac{A^F}{A^D + A^F}\underline{M}_p + \Omega_{pp}^{-1}\Omega_{pk}\underline{T}_k \\
&= \frac{A^F}{A^D + A^F}\underline{M}_p + \begin{bmatrix} \Omega_{qq}^{-1} + \Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1}\Omega_{zq}\Omega_{qq}^{-1} & -\Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1} \\ -\Gamma_{zz}^{-1}\Omega_{zq}\Omega_{qq}^{-1} & \Gamma_{zz}^{-1} \end{bmatrix}\begin{bmatrix} \Omega_{qk}\underline{T}_k \\ \Omega_{zk}\underline{T}_k \end{bmatrix} \\
&= \frac{A^F}{A^D + A^F}\underline{M}_p + \begin{bmatrix} \Omega_{qq}^{-1}\Omega_{qk}\underline{T}_k - \Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1}\Gamma_{zk}\underline{T}_k \\ \Gamma_{zz}^{-1}\Gamma_{zk}\underline{T}_k \end{bmatrix}
\end{aligned}$$

Therefore,

$$\underline{\pi}_q^D = \frac{A^F}{A^D + A^F}\underline{M}_q + \Omega_{qq}^{-1}\Omega_{qk}\underline{T}_k - \Omega_{qq}^{-1}\Omega_{qz}\Gamma_{zz}^{-1}\Gamma_{zk}\underline{T}_k \qquad (48a)$$

$$\underline{\pi}_z^D = \frac{A^F}{A^D + A^F}\underline{M}_z + \Gamma_{zz}^{-1}\Gamma_{zk}\underline{T}_k \qquad (48b)$$

Comparing (47a) with (48a) gives the change in the domestic investor's portfolio holdings.

Table 1. Summary Statistics of Country IFCG Indices, 30/12/1988 - 20/04/2007

This table reports the composition of weekly S&P IFCG Index for 18 countries. The variables include the number of stocks, average market capitalization, and average investable weight factor (IWF). Market capitalization is measured in millions of US dollars. Statistics are first computed cross-sectionally and then across time.

	Number of Stocks			Average Market Cap			Average IWF		
	mean	min	max	mean	min	max	mean	min	max
Argentina	26.07	17	34	682.29	37.74	2888.27	0.77	0.32	0.99
Brazil	79.26	41	123	1529.06	115.42	5941.77	0.54	0.12	0.77
Chile	41.97	25	56	1017.37	180.73	2953.85	0.46	0.15	0.89
China	224.93	61	415	944.53	102.13	5630.43	0.14	0.03	0.28
Colombia	20.90	14	28	493.61	45.10	2757.91	0.40	0.00	0.96
India	114.37	40	196	920.09	180.97	3942.94	0.19	0.00	0.32
Indonesia	56.25	34	71	609.98	62.92	2684.82	0.45	0.30	0.72
Israel	52.39	42	72	966.10	458.11	1791.34	0.62	0.53	0.71
Korea	151.58	61	305	1122.75	156.06	2830.31	0.38	0.00	0.75
Malaysia	107.89	47	157	908.31	191.47	2106.29	0.62	0.33	0.86
Mexico	62.19	45	85	1680.59	160.15	7916.64	0.75	0.11	0.98
Pakistan	53.91	38	80	205.74	27.03	909.42	0.33	0.00	0.78
Peru	30.88	18	38	382.62	81.28	2527.71	0.65	0.25	0.94
Philippines	42.52	18	60	541.79	135.19	2033.36	0.39	0.22	0.56
South Africa	75.45	57	146	1860.08	942.50	3150.16	0.78	0.62	1.00
Taiwan	96.70	62	176	1888.79	768.09	3486.41	0.32	0.00	0.77
Thailand	63.15	19	88	751.10	192.08	1618.37	0.30	0.15	0.38
Turkey	44.37	14	61	782.59	36.68	2825.71	0.68	0.00	1.00

Table 2. Summary Statistics for Information Variables

Panel A. Global Information Variables

The global information set includes the world dividend yield in excess of the return on the one-month Eurodollar (XWDY), the change in the U.S. term premium (ΔUSTP), the U.S. default premium (USDP), and the change in the one-month Eurodollar return (ΔRF). The world dividend yield is the dollar-denominated dividend yield on the DataStream world index. The U.S. term premium is equal to the yield on the 10-year U.S. T-Note in excess of the yield of the 3-month U.S. T-Bill. The U.S. default premium is the yield on Moody's BAA rated bonds in excess of the yield on Moody's AAA rated bonds. The sample period is from 30/12/1988 to 20/04/2007 (955 observations).

					Correlations			
	Mean	Std Dev	Min	Max	XWDY	ΔUSTP	USDP	ΔRF
XWDY	-2.688	2.207	-8.120	1.410	1	-0.006	0.207	-0.005
ΔUSTP	-0.001	0.128	-0.442	0.896		1	0.073	-0.023
USDP	0.842	0.205	0.500	1.490			1	-0.065
ΔRF	-0.005	0.172	-3.120	2.250				1

Panel B. Local Information Variables

The local information set includes the local dividend yield (LDY), the local market volatility (VOL), and the investable weight factor (IWF). The local dividend yield is from DataStream, the local market volatility is derived by fitting the local market return with an appropriate GARCH process, and the investable weight factor is from S&P EMDB.

					Correlations		
Argentina	Mean	Std Dev	Min	Max	LDY	VOL	IWF
LDY	2.347	1.758	0.000	11.900	1	0.264	0.535
VOL	5.000	2.024	2.803	20.314		1	-0.047
IWF	0.648	0.275	0.318	0.985			1
Brazil							
LDY	3.882	1.673	0.000	10.070	1	0.249	-0.206
VOL	5.391	1.496	2.976	9.401		1	0.253
IWF	0.583	0.055	0.475	0.692			1
Chile							
LDY	3.507	1.520	0.000	9.120	1	0.220	-0.102
VOL	2.761	0.623	2.076	5.378		1	0.438
IWF	0.603	0.219	0.316	0.887			1
China							
LDY	1.461	0.758	0.000	2.970	1	-0.253	0.648
VOL	3.265	0.878	2.053	6.965		1	-0.274
IWF	0.186	0.045	0.107	0.278			1
Colombia							
LDY	4.309	1.760	0.000	7.870	1	-0.049	0.193
VOL	3.461	1.253	2.293	13.579		1	0.102
IWF	0.281	0.309	0.000	0.730			1

Table 2 (Continued)

Panel B. Local Information Variables

India							
LDY	1.793	0.593	0.000	3.190	1	-0.083	-0.202
VOL	3.588	0.711	2.480	6.083		1	-0.390
IWF	0.255	0.035	0.188	0.316			1
Indonesia							
LDY	2.409	1.148	0.000	4.950	1	-0.236	-0.585
VOL	6.384	4.376	2.386	30.256		1	0.696
IWF	0.448	0.136	0.312	0.722			1
Israel							
LDY	1.705	0.975	0.000	3.930	1	0.183	0.301
VOL	3.183	0.508	2.557	6.538		1	0.097
IWF	0.624	0.042	0.526	0.713			1
Korea							
LDY	1.641	0.588	0.000	3.230	1	-0.052	0.076
VOL	4.874	2.614	2.086	21.067		1	0.222
IWF	0.483	0.262	0.094	0.748			1
Malaysia							
LDY	2.348	1.181	0.000	6.200	1	0.100	-0.582
VOL	3.357	2.283	1.230	16.671		1	0.269
IWF	0.617	0.180	0.334	0.859			1
Mexico							
LDY	1.787	0.608	0.000	4.210	1	-0.029	-0.249
VOL	4.024	1.479	2.303	12.449		1	0.504
IWF	0.767	0.166	0.412	0.984			1
Pakistan							
LDY	6.534	3.418	0.000	16.660	1	0.364	-0.040
VOL	4.153	1.345	2.481	11.096		1	0.252
IWF	0.259	0.282	0.000	0.781			1
Peru							
LDY	2.673	1.333	0.000	6.180	1	-0.304	-0.341
VOL	3.130	0.907	1.992	7.478		1	0.225
IWF	0.644	0.242	0.251	0.936			1
Philippines							
LDY	1.355	0.672	0.000	2.970	1	-0.243	-0.694
VOL	3.712	1.479	2.335	10.233		1	0.288
IWF	0.355	0.080	0.224	0.557			1
South Africa							
LDY	2.968	1.287	0.000	5.960	1	-0.011	-0.402
VOL	3.486	0.892	2.214	7.675		1	0.060
IWF	0.779	0.121	0.625	0.995			1

Table 2 (Continued)

Panel B. Local Information Variables

Taiwan							
LDY	1.558	1.073	0.000	4.360	1	-0.420	0.721
VOL	4.136	1.318	1.999	9.008		1	-0.542
IWF	0.535	0.132	0.300	0.773			1
Thailand							
LDY	2.391	1.183	0.000	8.360	1	0.140	-0.232
VOL	4.711	1.922	2.799	13.691		1	0.062
IWF	0.302	0.030	0.151	0.380			1
Turkey							
LDY	1.992	1.152	0.000	6.890	1	-0.142	0.084
VOL	7.718	2.570	5.172	24.023		1	0.404
IWF	0.530	0.159	0.275	0.772			1

Table 3. Summary Statistics of Test Portfolios, 30/12/1988 - 20/04/2007

This table summarizes the composition of test asset portfolios for 18 countries. In each country, there are three test portfolios: the non-investable portfolio, the binding ownership constraint portfolio, and the non-binding ownership constraint portfolio. The non-investable portfolio is constructed as the difference between the constituents of the IFCG and IFCI indices. Securities with $0 < IWF \leq 0.5$ are classified into the binding portfolio, and securities with $IWF > 0.5$ are classified into the non-binding portfolio. Market capitalization is measured in millions of US dollars. The weekly data are averaged first cross-sectionally and then across time.

	Non-investable			Binding			Non-binding		
	No. of stocks	Market cap	IWF	No. of stocks	Market cap	IWF	No. of stocks	Market cap	IWF
Argentina	6.42	99.21	0.00	6.81	1560.16	0.39	17.19	587.71	0.92
Brazil	17.72	1540.53	0.00	20.80	2308.15	0.37	43.09	1348.61	0.91
Chile	10.78	369.65	0.00	15.87	1266.74	0.30	24.80	1156.28	0.81
China	163.02	726.91	0.00	24.73	7003.54	0.27	47.29	400.45	0.94
Colombia	14.00	387.66	0.00	1.83	434.51	0.28	10.83	486.63	0.94
India	45.88	220.13	0.00	84.41	1407.36	0.25	7.16	3190.33	0.72
Indonesia	21.84	106.40	0.00	23.78	1065.92	0.41	17.47	756.91	0.77
Israel	3.87	205.73	0.00	21.47	1020.20	0.35	27.05	1096.52	0.86
Korea	23.59	547.01	0.00	69.35	2498.88	0.27	139.72	1384.40	0.84
Malaysia	15.48	197.09	0.00	24.53	2438.59	0.29	73.21	692.94	0.86
Mexico	14.69	406.77	0.00	9.83	1849.19	0.29	40.28	2096.66	0.93
Pakistan	42.18	170.26	0.00	2.41	725.94	0.25	16.63	172.93	0.96
Peru	16.49	149.68	0.00	2.48	944.57	0.20	12.27	604.92	0.88
Philippines	20.90	356.92	0.00	15.87	889.08	0.35	6.63	723.19	0.91
South Africa	4.53	489.59	0.00	14.82	1866.39	0.37	58.76	1906.57	0.86
Taiwan	17.36	508.65	0.00	51.27	2424.19	0.24	96.07	2286.01	0.63
Thailand	12.90	149.60	0.00	48.13	934.61	0.30	2.56	385.24	0.69
Turkey	7.30	194.31	0.00	19.97	1332.86	0.26	27.93	877.11	0.85

Table 4. Summary Statistics of Excess Returns

The table summarizes weekly US dollar returns on the test portfolios and the local factors for 18 countries. All test portfolios and the local factors are value-weighted, constructed from individual stock data from S&P Emerging Market Database (EMDB). Excess returns are obtained by substracting the weekly return of the Eurodollar one-month rate. Returns are in percentage per week. The sample covers the period from 30/12/1988 - 20/04/2007.

	Non-investable Portfolio						Binding Portfolio					
	Mean	StdDev	Skew	Kurt	B-J	LJQ(12)	Mean	StdDev	Skew	Kurt	B-J	LJQ(12)
Argentina	0.32	8.41	0.07	18.99	10078.69***	16.22	0.50	5.05	-1.58	13.05	1307.16***	21.99**
Brazil	0.57	6.71	-0.22	4.83	140.97***	17.27	0.38	7.03	-1.28	15.61	6582.99***	10.44
Chile	0.32	2.61	0.36	4.58	120.31***	135.07***	0.33	3.24	0.08	5.07	170.92***	37.36***
China	0.26	5.18	3.79	52.01	76440.02***	12.26	0.39	5.10	-0.06	5.05	76.50***	17.54
Colombia	0.32	3.51	0.35	10.60	2317.67***	78.10***	-0.19	6.18	0.06	8.13	286.43***	21.57**
India	0.33	4.22	0.05	5.69	288.20***	35.24***	0.29	3.60	-0.40	4.68	107.69***	22.30**
Indonesia	0.23	7.79	0.35	17.43	7378.28***	71.99***	0.09	6.55	-0.50	20.51	11077.26***	81.15***
Israel	0.44	5.53	-0.07	6.88	332.47***	27.20***	0.24	3.82	-0.64	5.40	165.63***	25.25***
Korea	0.00	5.67	-0.20	10.06	1881.63***	62.19***	0.16	5.26	-1.22	17.62	6833.66***	61.60***
Malaysia	0.29	3.79	0.30	8.12	751.26***	18.32*	0.13	4.06	-0.23	17.13	7948.43***	45.95***
Mexico	0.39	3.90	-1.54	20.15	12084.33***	115.15***	-0.05	5.71	-0.39	9.61	1279.98***	37.89***
Pakistan	0.36	3.76	-0.25	4.68	107.67***	64.21***	-0.44	6.61	-0.25	4.62	31.37***	23.66***
Peru	0.49	3.79	2.11	24.34	14703.36***	10.15	0.32	4.30	0.22	6.39	286.64***	20.73**
Philippines	0.19	3.80	-0.54	8.04	1057.57***	45.61*	0.10	4.99	-0.13	7.83	830.56***	34.13***
South Africa	0.36	4.91	-0.49	9.68	921.75***	72.66	0.41	4.54	0.13	5.76	222.13***	10.62
Taiwan	-0.10	6.41	-0.29	7.12	407.29***	39.13*	0.10	4.66	0.40	7.91	770.71***	22.92**
Thailand	0.06	5.88	-0.43	14.23	5008.28***	22.16	0.17	5.03	-0.04	6.45	475.07***	36.76***
Turkey	0.42	11.02	-0.83	16.20	5052.51***	9.81	0.32	8.57	-0.82	12.48	2073.80***	15.88

Table 4 *(continued)*

	Non-binding Portfolio					
	Mean	StdDev	Skew	Kurt	B-J	LJQ(12)
Argentina	0.38	8.07	-0.43	15.96	6709.62***	26.78***
Brazil	0.30	7.16	-0.69	10.42	2140.81***	14.95
Chile	0.20	2.98	-0.38	4.84	88.80***	34.55***
China	0.21	4.60	0.01	6.27	332.73***	29.05***
Colombia	0.01	4.15	0.08	5.51	137.82***	28.66***
India	0.82	3.46	0.12	6.44	111.70***	13.97
Indonesia	0.27	7.35	-0.54	17.41	5136.20***	41.11***
Israel	0.25	3.21	-0.69	4.39	85.51***	15.70
Korea	0.64	6.03	0.37	6.00	193.08***	10.27
Malaysia	0.22	4.16	0.74	21.19	13251.22***	45.57***
Mexico	0.42	4.10	-0.47	6.60	550.25***	37.76***
Pakistan	0.05	4.81	-0.05	4.96	90.42***	45.56***
Peru	0.40	3.67	0.27	5.30	173.63***	8.88
Philippines	0.07	4.24	-0.61	7.38	822.30***	23.96**
South Africa	0.36	3.59	-0.42	4.91	136.06***	12.04
Taiwan	0.07	4.43	0.22	5.59	124.30***	7.50
Thailand	0.20	5.19	0.37	6.78	493.36***	15.44
Turkey	0.34	7.97	-0.74	12.21	3275.30***	19.37*

Table 4 *(continued)*

	Local Premium Factor						Local Discount Factor					
	Mean	StdDev	Skew	Kurt	B-J	LJQ(12)	Mean	StdDev	Skew	Kurt	B-J	LJQ(12)
Argentina	0.32	8.35	0.02	19.52	10758.93***	17.28	0.52	5.12	-1.47	12.63	1196.69***	22.51**
Brazil	0.45	6.48	-0.52	5.68	329.58***	12.23	0.37	7.06	-1.34	16.91	7989.24***	10.52
Chile	0.34	2.86	0.08	4.38	76.85***	56.32***	0.34	3.20	0.13	4.79	129.44***	34.84***
China	0.28	5.14	3.81	53.35	80605.92***	13.15	0.38	4.86	-0.11	4.92	67.85***	17.89
Colombia	0.32	3.60	0.20	10.07	1992.84***	79.20***	-0.48	5.78	0.80	6.61	141.45***	17.06
India	0.31	3.85	-0.20	5.39	233.01***	22.31**	0.28	3.65	-0.36	4.62	97.80***	21.05**
Indonesia	0.11	6.45	-0.51	21.59	12483.60***	83.79***	0.12	6.53	-0.56	21.00	11712.57***	83.09***
Israel	0.25	3.80	-0.65	5.41	166.90***	24.97***	0.25	3.79	-0.65	5.51	178.85***	24.21**
Korea	0.10	4.95	-1.04	17.45	8483.28***	62.04***	0.16	5.31	-1.15	17.07	6326.75***	57.60***
Malaysia	0.13	4.03	-0.23	17.63	8529.89***	45.99***	0.13	4.05	-0.23	17.32	8164.42***	44.92***
Mexico	0.36	3.95	-1.49	18.36	9741.96***	107.65***	0.03	5.87	-0.15	9.19	1111.05***	31.07***
Pakistan	0.26	4.24	-0.45	6.21	388.50***	46.24***	-0.34	6.54	-0.20	4.49	25.00***	24.42**
Peru	0.47	3.56	0.35	6.10	312.74***	29.43***	0.26	4.30	0.25	6.58	297.25***	21.90**
Philippines	0.13	4.29	-0.53	9.15	1548.67***	49.67***	0.10	4.99	-0.13	7.81	823.65***	35.64***
South Africa	0.25	3.86	-0.42	5.23	177.53***	10.89	0.42	4.55	0.09	5.82	231.09***	9.03
Taiwan	0.08	5.33	-0.29	9.15	1503.82***	58.57***	0.09	4.70	0.40	7.72	714.69***	21.79**
Thailand	0.17	4.92	-0.14	6.36	453.06***	33.45***	0.17	5.11	-0.02	6.60	514.80***	39.53***
Turkey	0.57	10.27	-0.09	8.69	1150.72***	17.00	0.35	8.26	-0.82	13.18	2382.11***	20.16**

****, **, and * denote the statistical significance at the 1%, 5%, and 10% levels respectively.*

Table 5. Summary of Data Breaks in Portfolio Returns

This table reports the ratio of the total number of observations in the breaks over the total number of observable data points in a time series of returns of a test portfolio or of local factors. The weekly data cover the period from 30/12/1988 - 20/04/2007.

	Non-investable	Binding	Non-binding	Premium factor	Discount factor
Argentina	0.01	0.00	0.00	0.01	0.00
Brazil	0.00	0.28	0.00	0.00	0.29
Chile	0.00	0.00	0.00	0.00	0.00
China	0.00	0.00	0.00	0.00	0.00
Colombia	0.00	1.06	0.53	0.00	1.48
India	0.00	0.00	0.00	0.00	0.00
Indonesia	0.02	0.00	0.00	0.00	0.00
Israel	0.02	0.00	0.00	0.00	0.00
Korea	0.06	0.00	0.00	0.00	0.00
Malaysia	0.41	0.00	0.00	0.00	0.00
Mexico	0.00	0.00	0.00	0.00	0.01
Pakistan	0.00	1.33	0.49	0.00	1.43
Peru	0.00	0.26	0.00	0.00	0.37
Philippines	0.00	0.00	0.00	0.00	0.00
South Africa	0.54	0.07	0.00	0.00	0.07
Taiwan	0.69	0.24	0.12	0.01	0.24
Thailand	0.01	0.00	0.00	0.00	0.00
Turkey	0.39	0.00	0.00	0.12	0.00

Table 6. Panel A: Model Estimation
We estimate the following model

$$
\begin{aligned}
\widetilde{r}_{u,t} &= \beta_{uW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] + \beta_{uW}\widetilde{R}_{W,t} + \widetilde{\varepsilon}_{u,t} \\
\widetilde{r}_{b,t} &= \beta_{bW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] + \beta_{bL}[\lambda_L(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resL,t})] - \\
&\quad \beta_{bK}[\lambda_K(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resK,t})] + \beta_{bW}\widetilde{R}_{W,t} + \beta_{bL}\widetilde{R}_{resL,t} - \beta_{bK}\widetilde{R}_{resK,t} + \widetilde{\varepsilon}_{b,t} \\
\widetilde{r}_{n,t} &= \beta_{nW}[\lambda_W(Z_{t-1}) - E_{t-1}(\widetilde{R}_{W,t})] + \beta_{nL}[\lambda_L(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resL,t})] - \\
&\quad \beta_{nK}[\lambda_K(Z_{t-1}) - E_{t-1}(\widetilde{R}_{resK,t})] + \beta_{nW}\widetilde{R}_{W,t} + \beta_{nL}\widetilde{R}_{res,t} - \beta_{nK}\widetilde{R}_{resK,t} + \widetilde{\varepsilon}_{n,t} \\
\widetilde{R}_{W,t} &= E_{t-1}(\widetilde{R}_{W,t}) + \widetilde{\varepsilon}_{W,t} \\
\widetilde{R}_{resL,t} &= E_{t-1}(\widetilde{R}_{resL,t}) + \widetilde{\varepsilon}_{resL,t} \\
\widetilde{R}_{resK,t} &= E_{t-1}(\widetilde{R}_{resK,t}) + \widetilde{\varepsilon}_{resK,t}
\end{aligned}
$$

where the risk premia are parameterized as exponential functions of instrumental variables and conditional expectations are assumed to be linear functions of instrumental variables,

$$
\begin{aligned}
\lambda_W(Z_{t-1}) &= \exp(k'_W Z_{W,t-1}) \\
\lambda_L(Z_{t-1}) &= \exp(k'_L Z_{L,t-1}) \\
\lambda_K(Z_{t-1}) &= \exp(k'_K Z_{K,t-1}) \\
E_{t-1}(\widetilde{R}_{W,t}) &= \delta'_W Z_{W,t-1} \\
E_{t-1}(\widetilde{R}_{resL,t}) &= \delta'_L Z_{L,t-1} \\
E_{t-1}(\widetilde{R}_{resK,t}) &= \delta'_K Z_{K,t-1}
\end{aligned}
$$

The world instruments $Z_{W,t-1}$ include a constant, the world dividend yield in excess of the one-month Eurodollar rate (XWDY), the change in the U.S. term premium (ΔUSTP), the U.S. default premium (USDP), and the change in the one-month Eurodollar rate(ΔRF). The local premium instruments $Z_{L,t-1}$ include a constant, the local market volatility (VOL), and the local dividend yield (LDY). The local discount instruments $Z_{K,t-1}$ include a constant, the local market volatility (VOL), the local dividend yield (LDY), and the Investable Weight Factor (IWF). All instruments are lagged one period.

Estimates based on weekly dollar-denominated returns from 30/12/1988 to 20/04/2007. Test portfolio returns are constructed from S&P EMDB, the world portfolio is from Datastream's world index. One-month Eurodollar rates and yields are from DataStream.

Table 6 *(continued)*

Panel A. Parameter Estimates

	Global Factor					Local Premium Factor			Local Discount Factor			
	k1	**k2**	**k3**	**k4**	**k5**	**k6**	**k7**	**k8**	**k9**	**k10**	**k11**	**k12**
Country	**Const**	**USDP**	ΔUSTP	**XWDY**	ΔRF	**Const**	**VOL**	**LDY**	**Const**	**VOL**	**LDY**	**IWF**
Argentina												
Estimates	2.342	0.702	-9.590	1.172	2.927	-3.565	0.293	0.592	-3.584	0.323	0.053	2.683
StdErr	0.109	0.083	0.566	0.037	0.375	0.147	0.006	0.014	0.009	0.016	0.071	0.053
Brazil												
Estimates	-4.997	4.288	0.391	-0.714	0.007	0.993	-0.857	0.857	-1.177	0.288	0.920	-6.060
StdErr	0.105	0.026	0.057	0.002	0.110	0.042	0.012	0.001	0.466	0.031	0.149	0.231
Chile												
Estimates	3.824	-0.964	-4.005	0.759	13.683	-3.070	0.932	0.113	-6.000	0.999	0.721	1.724
StdErr	0.080	0.086	0.437	0.003	2.112	0.356	0.019	0.118	0.091	0.009	0.049	0.058
China												
Estimates	-3.566	3.229	1.819	1.425	-4.971	-3.500	1.143	-0.571	-7.172	1.351	0.137	2.795
StdErr	0.023	0.026	0.028	0.005	0.316	0.152	0.015	0.016	0.152	0.021	0.001	0.338
Colombia												
Estimates	4.752	-2.469	-19.897	0.895	-6.453	-2.502	0.286	0.500	-1.780	0.280	0.934	0.305
StdErr	0.360	0.771	2.900	0.199	3.526	1.544	0.032	0.497	0.128	0.138	0.101	0.186
India												
Estimates	0.469	2.281	4.796	0.633	-3.194	-3.500	1.428	-1.428	-4.432	1.722	-1.266	0.105
StdErr	0.001	0.001	0.008	0.000	0.003	0.059	0.008	0.022	0.012	0.009	0.033	0.039

Table 6 *(continued)*

Panel A. Parameter Estimates

Indonesia												
Estimates	0.505	1.549	12.110	0.670	-5.053	-3.500	0.182	0.599	0.482	0.077	-0.549	1.495
StdErr	0.013	0.021	0.048	0.024	0.084	0.155	0.008	0.009	0.173	0.018	0.023	0.140
Israel												
Estimates	3.224	-1.447	0.387	0.679	12.728	-1.601	1.004	-0.755	-1.767	0.524	0.049	3.562
StdErr	0.068	0.092	0.257	0.035	1.089	0.175	0.329	0.572	0.339	0.093	0.046	0.158
Korea												
Estimates	1.534	-1.246	-7.230	0.632	-3.970	-2.002	0.266	0.056	-1.818	-0.210	1.258	1.966
StdErr	0.045	0.037	0.003	0.075	0.004	0.082	0.025	0.093	0.023	0.028	0.051	0.015
Malaysia												
Estimates	2.983	-0.167	6.912	0.587	4.884	-3.174	0.495	-0.549	-4.545	0.390	0.286	0.666
StdErr	0.039	0.078	0.417	0.036	0.341	0.077	0.378	0.049	0.097	0.010	0.013	0.040
Mexico												
Estimates	3.339	-2.496	25.498	0.461	-2.000	-3.500	0.495	-0.132	-1.752	0.390	-0.027	0.113
StdErr	0.058	0.093	0.616	0.009	0.136	0.381	0.077	0.274	0.169	0.112	0.249	0.132
Pakistan												
Estimates	-2.858	3.586	2.533	-0.004	-6.999	-2.559	-0.457	0.711	-5.839	0.413	0.332	5.237
StdErr	1.670	1.601	0.012	0.624	0.075	0.321	0.030	0.038	0.962	0.031	0.101	1.272

Table 6 *(continued)*

Panel A. Parameter Estimates

Peru												
Estimates	0.130	2.710	4.441	0.977	-0.741	-3.178	0.251	1.097	-4.024	-0.297	1.608	2.413
StdErr	0.008	0.005	0.063	0.010	0.031	0.003	0.003	0.002	0.010	0.009	0.009	0.010
Philippines												
Estimates	-0.805	2.081	9.868	0.614	-0.708	-3.500	0.599	-0.132	-1.194	0.390	-0.549	1.219
StdErr	0.012	0.004	0.027	0.007	0.015	0.044	0.008	0.035	0.019	0.004	0.007	0.003
South Africa												
Estimates	-0.896	3.495	9.931	0.496	13.680	-2.349	0.495	0.495	-2.869	0.599	-0.027	1.495
StdErr	0.032	0.026	0.115	0.001	0.067	0.060	0.013	0.019	0.016	0.004	0.012	0.021
Taiwan												
Estimates	-2.994	4.288	0.765	0.714	-1.062	-4.790	0.693	1.295	-2.471	0.470	0.072	2.915
StdErr	0.454	0.309	0.045	0.195	0.089	0.155	0.013	0.026	0.530	0.230	0.203	1.242
Thailand												
Estimates	-2.421	2.876	3.582	0.712	-2.634	-3.497	0.063	0.902	-7.553	-0.220	1.011	21.664
StdErr	0.375	0.587	0.105	0.123	0.418	0.214	0.033	0.057	0.212	0.008	0.023	0.620
Turkey												
Estimates	0.408	1.035	1.930	0.728	7.398	-4.425	0.286	0.495	-4.894	0.267	0.600	1.988
StdErr	0.049	0.047	0.625	0.026	0.321	0.442	0.035	0.067	0.038	0.010	0.043	0.236

Table 6 *(continued)*

Panel B: Specification Tests

Null Hypotheses:

H1: Are the risk premia of the discount factor equal to zero ? $k_{K,i} = 0 \ \forall i$

H2: Are the risk premia of the local premium and discount factors equal to zero ? $k_{K,i} = 0$ and $k_{L,i} = 0 \ \forall i$

H3: Are the risk premia of the global factor equalt to zero? $k_{W,i} = 0 \ \forall i$

H4: Are the factor risk premia constant ? $k_{W,i} = 0$ & $k_{L,i} = 0$ & $k_{K,i} = 0 \ \forall i > 1$

where i denotes the index of the coefficient vectors.

	Argentina	**Brazil**	**Chile**	**China**	**Colombia**	**India**	**Indonesia**	**Israel**	**Korea**
Hypotheses					**P-Value**				
H1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
H2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
H3	0.042	0.000	0.003	0.000	0.001	0.000	0.000	0.000	0.051
H4	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009

	Malaysia	**Mexico**	**Pakistan**	**Peru**	**Philippines**	**S Africa**	**Taiwan**	**Thailand**	**Turkey**
Hypotheses					**P-Value**				
H1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
H2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
H3	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000
H4	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.044

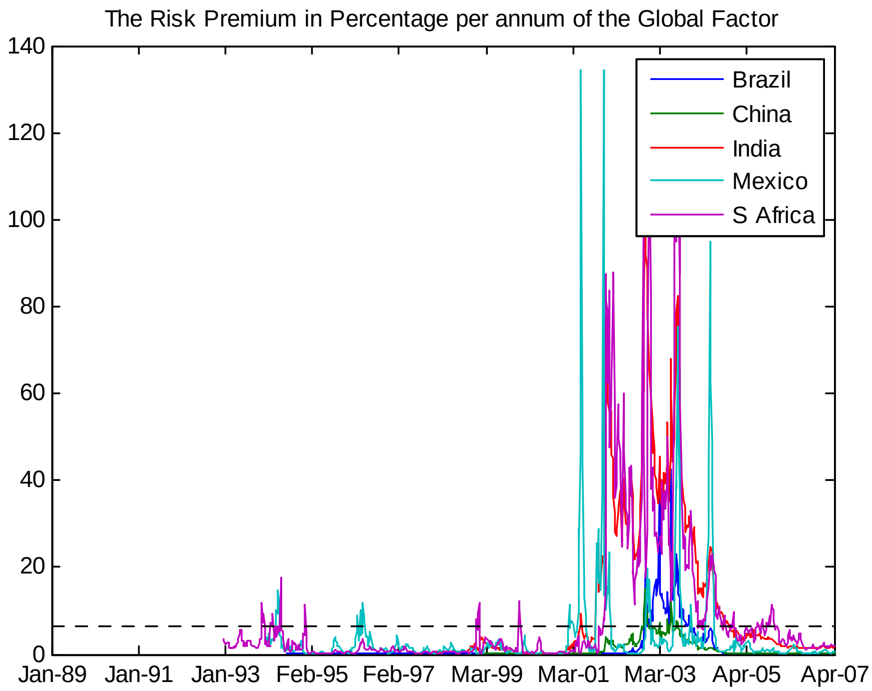

Figure 1. The risk premium of the global factor. The figure plots the estimated risk premium of the global risk in percentage per annum. The dash line represents the average across the all countries in the sample.

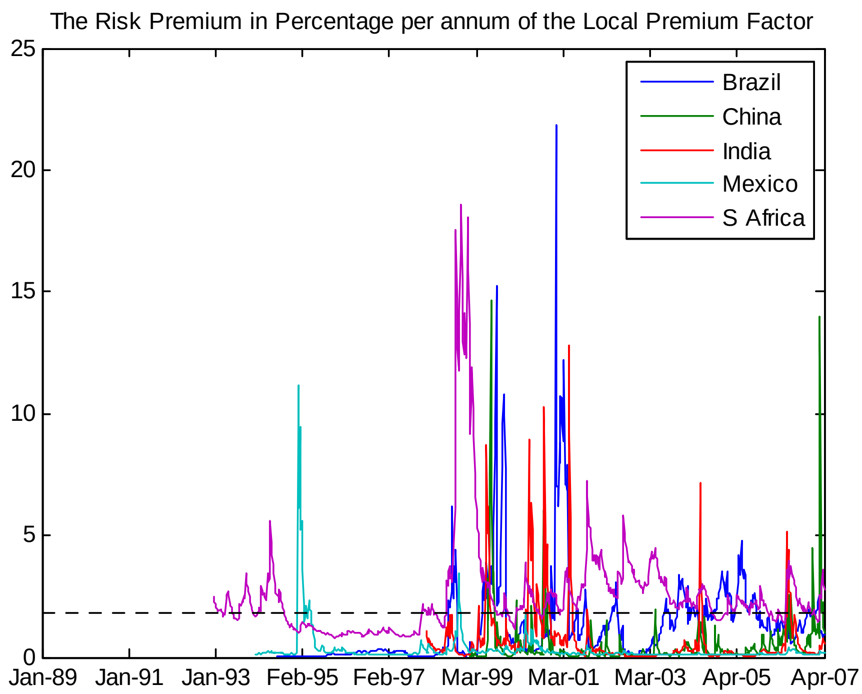

Figure 2. The risk premium of the local premium factor. The figure plots the estimated risk premium of the local premium factor in percentage per annum. The dash line represents the average across all countries in the sample.

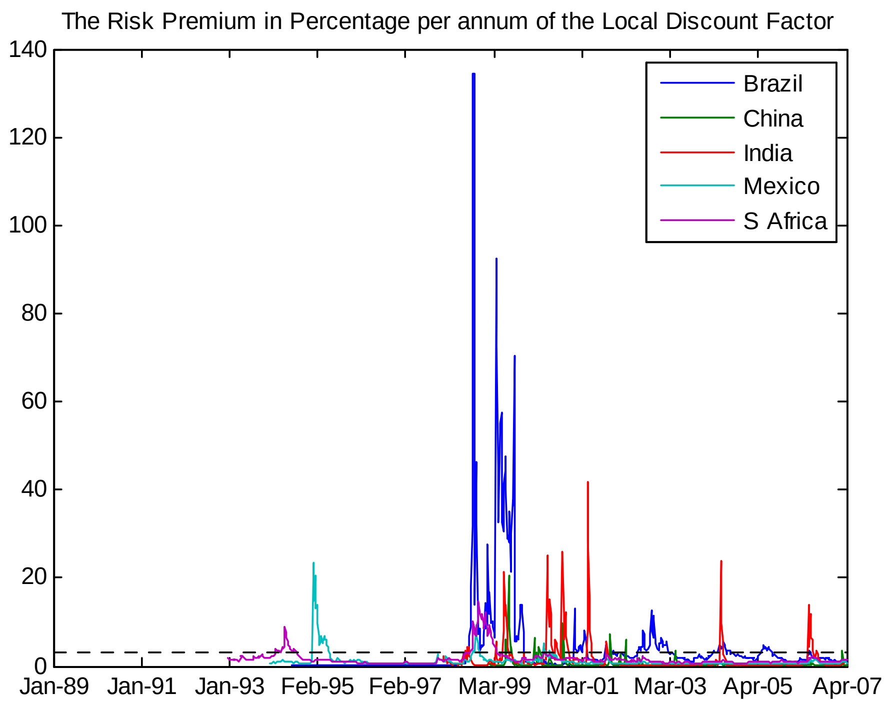

Figure 3. The risk premium of the local discount factor. The figure plots the estimated risk premium of the local discount factor in percentage per annum. The dash line represents the average across all countries in the sample.