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Abstract

We develop an asset pricing model to analyze the joint impact of liquidity costs and market segmentation. The freely traded securities command a premium for liquidity level and global market and liquidity risk premiums whereas securities that can only be held by a subset of investors additionally command a local market and liquidity risk premiums. Based on a new methodology, we find that the liquidity level premium dominates the liquidity risk premiums for our sample of 24 emerging markets. Whereas the local liquidity risk premium is empirically small, the global market liquidity risk premium dramatically increases during crises and market corrections.

JEL Classification: G12, G15, F30, G20, G30

Keywords: International asset pricing, liquidity risk, transaction cost, emerging markets, market integration.

1 Introduction

Liquidity costs and their uncertain variation affect the willingness and the ability of foreign investors to invest in emerging markets (EMs). Unfortunately, most of the asset pricing models under cross-border investment restrictions do not take into account liquidity concerns.[1] We analyze the effect of liquidity cost and systematic liquidity risk factors on the pricing of EM securities by developing a formal international asset pricing model (IAPM) that takes into account cross-border barriers to portfolio flows as well as random transaction costs. Our model allows us to test important issues such as liquidity level and risk pricing effects and their dynamics in a realistic world market setting and to examine the interaction between investability and liquidity. Although our empirical set up focuses on EMs, it is applicable to many global markets characterized by explicit or implicit barriers to portfolio flows.[2]

Our new liquidity-adjusted IAPM exploits the theoretical insights of well known international frameworks. In a two country set-up, we assume that all domestic (for example, the U.S.) securities are investable and hence can be freely traded by all investors whereas the foreign market (for example, an EM) consists of two segments: (a) a non-investable set of securities that can be held only by foreign (for example, EM) investors,[3] and (b) an investable set that can be held by all investors. We include random transaction costs on both investable and non-investable securities.[4]

The investable securities command a liquidity level premium and global market and liquidity risk premiums. The market risk and liquidity shocks are aggregated at the world level and the prices of global market and liquidity risks are the same. Except for the Jensen's inequality term, our pricing equation for investables can be viewed as an extension of Acharya and Pedersen (2005) [AP hereafter] to an international setup.

Additionally, non-investable securities command a risk premium for unspanned local market and liquidity risks. The local market risk is the sensitivity of returns to aggregate local market risk. The local liquidity risks include sensitivity of returns to aggregate local market liquidity,

[1] See for example, Stulz (1981), Errunza and Losq (1985) [hereafter EL], Eun and Janakiramanan (1986), de Jong and Roon (2005), Chaieb and Errunza (2007).

[2] Explicit barriers include legal restrictions on ownership, foreign exchange transactions, repatriation of profits, whereas implicit barriers encompass institutional, informational, governance, and market development variables.

[3] Non-investable assets in the foreign market cannot be or are not traded by domestic investors due to severe explicit and/or implicit barriers.

[4] Liquidity could itself be endogenously determined by other implicit barriers such as asymmetric information (see Johnson, 2006; Huang and Wang, 2009, among others).

the sensitivity of liquidity to aggregate local market risk, and the local commonality in liquidity. All of the local market and liquidity risks are conditional on returns on the substitute assets net of liquidity costs.[5] That is, the unspanned local risk is a residual risk that stems from imperfect spanning of the returns on the non-investable segment of the foreign market by returns on substitute assets. The prices of unspanned local market and liquidity risks are the same.

Thus, our model extends the well-established theoretical asset pricing literature regarding the importance of liquidity for the U.S., and other integrated developed markets (see, for example, Amihud and Mendelson, 1986; Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005). Specifically, our model nests the AP model in the absence of investability constraints. Also, our model nests the EL model in the absence of liquidity and the Grauer, Litzenberger, and Stehle (1976) perfect world market model in the absence of both the investability constraints and liquidity.

Our paper is close to the work of Bekaert, Harvey, and Lundblad (2007) [BHL hereafter] and Lee (2011). BHL analytically derive stylized pricing equations under market integration and segmentation. They also test a mixed model which combines the two polar cases of perfect integration and segmentation to allow for both global and local risk sources. In their model, liquidity is a second risk factor that affects the world pricing kernel in addition to the world market risk factor and hence triggers its own price of liquidity risk. BHL find that local liquidity risk is unconditionally priced for their sample of 19 EMs. Lee (2011) adopts an unconditional econometric specification to obtain his testable equations, and finds that liquidity risk is globally priced in developed markets and locally priced in emerging markets. Whereas these papers investigate the unconditional pricing of liquidity risk, an important feature of liquidity risk premiums in EMs is that they depend on market conditions and the level of market integration. Our paper theoretically demonstrates the effect of global and local systematic liquidity risk factors on expected returns and empirically tests how the pricing relation changes over time. We show that the global liquidity risk is priced and surges during crises and market corrections, whereas local liquidity risk is largely diversifiable.

Our work also adds to the vast empirical literature on the relation between the average stock returns and liquidity documented in several U.S. studies (see, for example, Brennan, Chordia, and Subrahmanyam, 1998), commonality in liquidity (see, for example, Chordia, Roll, and Subrah-

[5] Substitute assets consist of all assets that can be freely traded by all investors including the investable world market portfolio, closed-end country funds, mutual funds, exchange traded funds, and cross-listings. We define cross-listings as direct listings, American Depositary Receipts (ADRs), or Global Depositary Receipts (GDRs).

manyam, 2000; Hasbrouck and Seppi, 2001; Huberman and Halka, 2001; Koch, Ruenzi, and Starks, 2016, for evidence from the U.S.)[6], as well as a number of empirical papers that investigate liquidity effects in international markets, (see, for example, Domowitz, Glen, and Madhavan, 2001; Lesmond, 2005; Bekaert et al., 2007; Lee, 2011; Liang and Wei, 2012; Goyenko and Sarkissian, 2014; Karolyi, Lee, and van Dijk, 2012; Amihud, Hameed, Kang, and Zhang, 2015).[7] The above studies underscore the importance of liquidity in the U.S. and international markets. Our focus on pricing liquidity risk in a conditional setup for investables and non-investables within the context of a formal asset pricing model that accounts for the time-varying partially segmented nature of EMs, along with the flexible empirical methodology used in the estimation, sets the paper apart from the earlier literature.

To test our asset pricing model, we need to define the investable and non-investable set of securities for our sample of 24 EMs. We follow Karolyi and Wu (2017) and use cross-listings to characterize investable stocks.[8] We also use MSCI's Foreign Inclusion Factors as proxy of investability. Next, we need a measure of illiquidity costs. In the theoretical set up, the exogenous illiquidity cost of a security is modeled as the per trade cost. The illiquidity cost could then be measured with the bid-ask spread. But the data are available only for short sample periods and for a small set of emerging countries limiting their use for validation of the asset pricing model and for studying the effect of illiquidity on expected returns. Alternatively, we could use the Amihud (2002)

[6]Additionally, there is ample evidence that liquidity risk is unconditionally priced for the U.S. market although the contribution of the liquidity risk premium varies across studies and depends on the proxy used for liquidity, see for example, Pastor and Stambaugh (2003), Acharya and Pedersen (2005), Sadka (2006), Korajczyk and Sadka (2008), and Kim and Lee (2014). There is also evidence that liquidity risk is conditionally priced in the U.S. Watanabe and Watanabe (2008) investigate the dynamic nature of illiquidity level and risk premia and show that illiquidity is significantly priced only in times of high turnover. Martinez, Nieto, Rubio, and Tapia (2005) estimate a liquidity-adjusted CAPM where the liquidity risk is conditional on the aggregate book-to-market ratio and show that conditional liquidity risk is priced in the U.S. Amihud and Noh (2016) show that conditional liquidity risk measured as the exposure of the stock excess return to the market illiquidity premium conditional on funding liquidity is significantly priced.

[7]Specifically, Domowitz et al. (2001) document that transaction costs in emerging markets are significantly higher than in developed markets. Lesmond (2005) shows that liquidity costs are higher in countries with weak legal enforcement. Liang and Wei (2012) show that liquidity risk is globally and locally priced in 23 developed markets. Karolyi et al. (2012) show that commonality in liquidity has trended down for many countries but is greater for emerging markets compared to developed markets. They also find that commonality in liquidity increases with capital inflows, while it decreases with market openness. Amihud et al. (2015) provide international evidence on the positive relation between expected return and illiquidity, using data from 45 countries including 19 emerging markets. They also show that illiquidity premium measured by the spread between the most and least illiquid stock portfolios rises in times of adverse market conditions. Goyenko and Sarkissian (2014) find that Treasury bond illiquidity is a significantly priced factor in global equity returns. See Amihud and Mendelson (2015) for a review of the work on the effect of liquidity on expected returns.

[8]Although BHL do not formally incorporate the impact of changing market structure on pricing of liquidity risk, they do suggest that expected returns should decline post market liberalization which is related to investability.

absolute return to dollar volume ratio which is related to measures of price impact and fixed trading costs or the incidence of zero returns of Lesmond, Ogden, and Trzcinka (1999) which could proxy for search costs.[9] As we require a measure of the cost of trade to test our asset pricing model, we need to scale these two proxies as in, for example, AP. The paucity of effective bid-ask spread data for emerging markets limits such computation.[10]

Hence, we use the bid-ask spread proxy of Abdi and Ranaldo (2017) (Hereafter, AR). Building on the proxy proposed by Corwin and Schultz (2012), AR use the low, close, and high prices over two consecutive days to construct a measure that disentangles the bid-ask spread from daily volatility. Their measure is similar to the autocovariance measure of Roll (1984), but is independent of trade direction dynamics and uses the richness of daily high-low spreads that are readily available for long samples of EM data. Using this measure, we find that non-investable stocks in emerging markets are on average 15.81% more illiquid than investable stocks.

For each EM, we first estimate its diversification portfolio (DP) held long by the domestic investor that best replicates of the non-investable segment. DP is the dynamic replicating portfolio of substitute assets that is most highly correlated with the portfolio of non-investable assets. Our methodology has two important features. First, the weights of DP are time-varying and computed from the conditional covariance matrices. The dynamics of these conditional covariances are the same as the ones used in the tests of the IAPM, and hence the construction of DP is consistent with the asset pricing framework. Second, our methodology can account for the variation over time in the set of substitute assets as cross-listings (direct listings, ADRs, and GDRs), country funds (open-end and closed-end funds), and ETFs are issued or delisted.[11] To estimate the conditional

[9]Lesmond et al. (1999) show that the proportion of zero returns measure is highly correlated with the effective spread. This measure has been applied in a number of recent papers. See for example, BHL, Lesmond, Schill, and Zhou (2004), Lang, Lins, and Maffett (2012), and Mei, Scheinkman, and Xiong (2009) among others. Levine and Schmukler (2006) use both the proportion of zero returns and the Amihud's measure to examine the relationship between home market liquidity and cross listed trading across 31 home countries. Amihud (2002)'s widely applied price impact measure has been recently used in Karolyi et al. (2012) to analyze the commonality patterns of liquidity, returns, and turnover across 40 countries. Korajczyk and Sadka (2008), Mancini, Ranaldo, and Wrampelmeyer (2013) and Kim and Lee (2014) use a latent liquidity measure constructed from a principal component across different liquidity measures. See also Fong, Holden, and Trzcinka (2017) for a recent review of the different liquidity proxies used in international studies.

[10]See BHL for a detailed discussion of trading costs data issues in EMs.

[11]The past literature has used stepwise regressions with forward and backward threshold criteria that preserves assets with the most significant coefficients to estimate DP while allowing for some dynamics in the weights through dummy variables set to one upon the availability of new cross-listings (see, for example, Carrieri, Errunza, and Hogan, 2007). Our new approach of constructing the DPs with dynamic weights computed from time-varying second moments is internally consistent because the same second moment dynamics are used for asset pricing tests. Also our approach ensures that the different parametrization of the moments conditional on the set of substitute assets

covariance matrices we proceed in two steps. In the first step, we fit an AR-NGARCH on net-of-transaction-cost returns for non-investable securities and all substitute assets to estimate time-varying variances. In the second step, we estimate a dynamic normal copula by using all available assets at each point in time as in Christoffersen, Jacobs, Jin, and Langlois (2018). We then use the dynamic variances from the first step estimations and correlations from the second step estimation to compute the DP weights.

Next, we test the asset pricing implications of our liquidity-adjusted IAPM in a conditional setup using weekly returns on 24 EMs. Our key empirical findings can be summarized as follows. First, we find a significant price of world covariance risk. Its average value of 1.44 is plausible for the world aggregate risk aversion. Second, we find significant prices of unspanned local covariance risk. The cross-country average price of local covariance risk is 3.33 with large variations across markets. The price of local covariance risk is proportional to the differential in risk aversion between an EM average investor and the world average investor and hence again is economically plausible.

Third, we compute the contribution to risk premia of liquidity level and risk. The level of illiquidity costs is the largest contributor with a median across EMs of 3.87% per year. The contribution of world liquidity risk premia has an average of 0.23% per year but greatly varies over time; it is higher than 0.50% during crises and market corrections and reaches more than 3.5% during the global financial crisis. Although unspanned local risk is significantly priced for most markets and is economically sizable, unspanned local liquidity risk premium is close to zero. This result stems from the empirically small differences in liquidity covariances between local market indexes and diversification portfolios. Therefore, the liquidity level and world liquidity risk are the primary channels through which illiquidity costs affect asset prices in these partially segmented markets.

Since our liquidity risk premium for EMs may seem low compared to past studies, especially the AP results, we assess the impact of the choice of our sample period, liquidity measure, and data frequency on the estimation of the magnitude of the liquidity risk premium for the U.S. market. We follow AP's methodology, but use the Abdi-Ranaldo bid-ask spread measure at the market level and at the weekly frequency. We find that compared to AP's results, estimating the liquidity risk premium at the market level over the 1994-2018 period with weekly returns leads to a significantly

are equivalent which is not the case with the approach to construct DP used in past literature.

lower liquidity risk premium of 0.02% for the U.S. Hence, the average world liquidity risk premium of 0.23% underlines the greater importance of liquidity risk for our sample of EMs. Note that we cannot obtain a benchmark for the unspanned local liquidity risk premium because such premium does not prevail in an integrated market such as the U.S.

Finally, although investables are freely available to all investors, past research suggests that they still command a local risk premium. Hence, as a further robustness check, we assume that the whole stock market of the emerging country is non-investable. We find that our results are robust to including all local EM stocks in the set of non-investables.

The paper is organized as follows. Section 2 models the effect of liquidity on expected returns in partially segmented markets. Section 3 outlines the empirical methodology. Section 4 presents data and summary statistics. Section 5 reports the results of our liquidity-adjusted IAPM, and examines the statistical and economic significance of the liquidity risk premiums. To calibrate the size of the average global liquidity risk premium estimated for our sample of 24 EMs over 1994-2018, Section 6 reports the estimated unconditional liquidity risk premium based on AP liquidity-adjusted CAPM for the U.S. as a benchmark using Abdi-Ranaldo bid-ask spread measure at the market level and at the weekly frequency. This section also presents a robustness check of our main findings based on an alternative specification of the non-investable set. Section 7 concludes.

2 The asset pricing model

We postulate a two country global capital market: the domestic country D and the foreign country F. We label all securities that can be freely traded by all investors as investable and those that can be held by only foreign investors as non-investable. We can view the domestic market as a well-developed market (such as the United States) that is open to all investors and the foreign market as an EM where foreign participation is limited due to explicit and/or implicit barriers. In this setting, domestic (U.S.) investors can hold domestic securities and the investable segment of the foreign market whereas foreign (EM) investors can freely trade in the domestic and the foreign market. This characterization of the global market is fairly realistic. Of course, a market structure, in which both countries face some segmentation, is more attractive. However, our simplification makes understanding the forces at work easier without much loss of generality.[12]

2.1 Assumptions and notations

We use the subscript i and n as a generic index to represent the investable and non-investable securities respectively, bold letters to denote vectors, and capital letters to denote matrices or portfolio level variables.

- **A1: Market Structure.** There are N risky assets partitioned as follow: The first N_I securities are investable securities and the last N_N assets are non-investable securities. The vector of log-returns can be partitioned as $\boldsymbol{r}_t \equiv \begin{pmatrix} \boldsymbol{r}_{i,t} \\ \boldsymbol{r}_{n,t} \end{pmatrix}$. The vector of market values at time t, $\mathbf{M}_t$, is similarly partitioned as $\mathbf{M}_t \equiv \begin{pmatrix} \mathbf{M}_{i,t} \\ \mathbf{M}_{n,t} \end{pmatrix}$. $M_{N,t}$ is the market capitalization of non-investables at time t defined as $M_{N,t} = \sum_{n=1}^{N_N} M_{n,t}$. Agents can also borrow and lend at the domestic risk-free log-rate of return r_f, which is exogenous.
- **A2: Agents.** Every period, the economy has two agents with CRRA preferences. The first agent is domestic and is restricted to investing only in investable securities. The second agent is foreign and can invest in both non-investable and investable securities. Agents live for one period, invest at time t, and consume at $t+1$. Hence both investors have the same one-period trading horizon and holding period, i.e., the trading frequency and holding period are set exogenously. This is a strong assumption. Allowing for endogenous trading frequency will result in less trading for illiquid assets. Constantinides (1986) shows that transaction costs might then have second-order effects on liquidity premia.[13]
- **A3: Transaction costs.** Transaction costs denoted by the N-by-1 vector C_t are random and include bid-ask spread as well as search costs. They are modeled as the proportional cost of buying and selling an investable or non-investable security j. Short-selling is allowed. Both long and short holders pay transaction costs. As in AP, the one-period investors investing at

[12] As shown by Chaieb and Errunza (2007), the results carry through to the more general market structure with the addition of another premium at equilibrium.

[13] Beber, Driessen, Neuberger, and Tuijp (2018) derive asset pricing implications for investors with heterogeneous investment horizons as in Amihud and Mendelson (1986) and in presence of random transaction costs. Depending on the covariance matrix of the returns and the level of transaction costs, their model could result in endogenous segmentation which may substantially reduce the liquidity risk premium.

t pay transaction costs proportional to the current price when closing the position at time $t+1$. The net log-returns of the agents can then be written as $r_{j,t+1}^{net} = r_{j,t+1} - c_{j,t+1}$ for the investors who are long in asset j and as $r_{j,t+1}^{net} = -r_{j,t+1} - c_{j,t+1}$ for investors who are short in asset j, where $c_{j,t+1} = -ln\left(1 - C_{j,t+1}\right)$ (see Bongaerts, Jong, and Driessen, 2011, for a similar assumption). We assume that the vector of net log-returns $\boldsymbol{r}_t^{net}$ is normally distributed and denote Σ_t as its N-by-N conditional variance-covariance matrix which can be partitioned as $\Sigma_t \equiv \begin{pmatrix} \Sigma_{ii,t} & \Sigma_{in,t} \\ \Sigma_{in,t}^{\top} & \Sigma_{nn,t} \end{pmatrix}$, where $\Sigma_{ii,t}$ is the variance-covariance matrix of the investable assets, $\Sigma_{nn,t}$ is the variance-covariance matrix of the non-investable securities, and $\Sigma_{in,t}$ is the covariance matrix between investable and non-investable securities.

- **A4:** The returns are measured in domestic currency, the reference currency. We follow the asset pricing literature on barriers to cross-border investments and assume that the purchasing power parity holds (see, for example, Stulz, 1981).

2.2 Asset demands

The domestic investor d can invest in the riskless bond and the N_I investable risky assets. Let the vector $\boldsymbol{\omega}_{d,t}$ denote the fraction of his wealth invested in the risky assets at time t and γ^d his coefficient of relative risk aversion. Investor d maximizes at time t the utility of his terminal wealth W_{t+1}^d, that is,

$$\max_{\boldsymbol{\omega}_{d,t}} E_t \left[\left(\frac{W_{t+1}^d}{1-\gamma^d} \right)^{1-\gamma^d} \right]$$

subject to the budget constraint $W_{t+1}^d = \left(1 + R_{P,t+1}^d\right) W_t^d$ where $R_{P,t+1}^d = \boldsymbol{\omega}_{d,t}^{\top} \left(e^{\boldsymbol{r}_{i,t+1}^{net}} - e^{r_f} \boldsymbol{\iota}_{N_I} \right) + e^{r_f}$ is the simple net return on the portfolio of investor d and $\boldsymbol{\iota}_{N_I}$ is an $(N_I \times 1)$ vector of ones. Assuming the portfolio return is log-normal and using the Campbell and Viceira (2002) discrete-time approximation to relate asset log-returns to portfolio log-returns[14], the optimization can be restated as,

[14] Campbell and Viceira (2002) use a second-order Taylor approximation of the non-linear function relating log asset returns to log portfolio returns. In the limit of continuous time, the approximation is exact and can be derived using Ito's Lemma. If portfolio returns are not log-normal, the CRRA investor should also price skewness and kurtosis in returns. Modeling the higher order moments in addition to time-varying liquidity risk and market segmentation will result in additional risk premia and render empirical estimation quite complex. In the empirical tests, we partially address non-normality by using the Student-t distribution to capture the high kurtosis present in the weekly log-returns.

$$\max_{\boldsymbol{\omega}_{d,t}} \boldsymbol{\omega}_{d,t}^{\top} E_t \left[\boldsymbol{r}_{i,t+1} - \boldsymbol{c}_{i,t+1} - r_f \boldsymbol{\iota}_{N_I} + \frac{1}{2} \boldsymbol{\sigma}_{i,t+1}^2 \right] - \frac{1}{2} \gamma^d \boldsymbol{\omega}_{d,t}^{\top} \Sigma_{ii,t+1} \boldsymbol{\omega}_{d,t}$$

where $\boldsymbol{\sigma}_{i,t+1}^2$ is the vector containing the variance of investable asset net log-returns, i.e., the diagonal elements of $\Sigma_{ii,t+1}$. From first order conditions, the solution for the vector of optimal portfolio weights is,

$$\boldsymbol{\omega}_{d,t} = \frac{1}{\gamma^d} \Sigma_{ii,t+1}^{-1} E_t \left[\boldsymbol{r}_{i,t+1} - \boldsymbol{c}_{i,t+1} - r_f \boldsymbol{\iota}_{N_I} + \frac{1}{2} \boldsymbol{\sigma}_{i,t+1}^2 \right].$$

A foreign investor f can invest in the riskless bond, the domestic securities and the foreign securities. Given his investment opportunity set, he solves a similar optimization problem as the domestic investor. The vector $\boldsymbol{\omega}_{f,t}$ of optimal portfolio weights for the foreign investor can be written as,

$$\boldsymbol{\omega}_{f,t} = \frac{1}{\gamma^f} \Sigma_{t+1}^{-1} E_t \left[\boldsymbol{r}_{t+1} - \boldsymbol{c}_{t+1} - r_f \boldsymbol{\iota}_N + \frac{1}{2} \boldsymbol{\sigma}_{t+1}^2 \right]$$

where $\boldsymbol{\sigma}_{t+1}^2$ is the vector containing the variance of investable and non-investable asset net log-returns i.e. the diagonal elements of Σ_{t+1}, γ^f is the coefficient of relative risk aversion of the foreign investor, and $\boldsymbol{\iota}_N$ is an $(N \times 1)$ vector of ones.

Using market clearing conditions and assuming that equities are in net positive supply equal to their market capitalization and the bonds are in zero net supply, we obtain the equilibrium asset pricing relationships.

2.3 Equilibrium risk and return

2.3.1 Investable set

The investable securities are priced as if the market is fully integrated. The expected net excess return for an investable security $i \in \{1, ..., N_I\}$ is given by,

$$E_t \left[r_{i,t+1}^{net} - r_f \right] + \frac{1}{2} var_t \left(r_{i,t+1}^{net} \right) = \gamma_t cov_t \left(r_{i,t+1}^{net}, r_{W,t+1}^{net} \right) \tag{1}$$

where $W \equiv W^d + W^f$ is the aggregate global wealth, the world price of risk $\gamma_t = W_t \left(\frac{W_t^d}{\gamma^d} + \frac{W_t^f}{\gamma^f} \right)^{-1}$ is equal to the aggregate relative risk aversion coefficient, and $r_{W,t+1}^{net}$ is the net log-return on the global market portfolio. We then express the model in terms of gross returns,

$$\begin{aligned} E_t\left[r_{i,t+1}-r_f\right] &= -\frac{1}{2}var_t\left(r_{i,t+1}^{net}\right)+E_t\left[c_{i,t+1}\right]+\gamma_t[cov_t\left(r_{i,t+1},r_{W,t+1}\right) \\ &\quad +cov_t\left(c_{i,t+1},c_{W,t+1}\right)-cov_t\left(c_{i,t+1},r_{W,t+1}\right)-cov_t\left(r_{i,t+1},c_{W,t+1}\right)]. \end{aligned} \tag{2}$$

The asset pricing equation of investable securities is similar to the liquidity-adjusted CAPM of AP but the market risk premium and liquidity risk premiums are aggregated at the world level and with the addition of one-half the variance of excess net returns. Hence, as in BHL local liquidity variables affect expected returns even under full integration. The asset pricing equation under full market integration of BHL is not identical to ours as they assume that liquidity is a second risk factor that affects the world pricing kernel in addition to the world market risk factor and hence triggers its own price of liquidity risk. Except for the Jensen's inequality term, our pricing equation for investables is the extension of AP to an international setup.

2.3.2 Non-investable set

For a non-investable security $n \in \{1,...,N_N\}$, the expected net excess return at equilibrium is given by,

$$\begin{aligned} E_t\left[r_{n,t+1}^{net}-r_f\right]+\frac{1}{2}var_t\left(r_{n,t+1}^{net}\right) &= \gamma_t cov_t\left(r_{n,t+1}^{net},r_{W,t+1}^{net}\right) \\ &\quad +\pi_t cov_t\left(r_{n,t+1}^{net},r_{N,t+1}^{net}\mid \boldsymbol{r}_{i,t+1}^{net}\right) \end{aligned} \tag{3}$$

where $\pi_t=\left(\frac{\gamma^f}{W_t^f}-\frac{\gamma_t}{W_t}\right)M_{N,t}$ is the price of unspanned local risk.

We can express the model in terms of gross returns,

$$\begin{aligned} E_t\left[r_{n,t+1}-r_f\right] &= -\frac{1}{2}var_t\left(r_{n,t+1}^{net}\right)+E_t\left[c_{n,t+1}\right]+\gamma_t[cov_t\left(r_{n,t+1},r_{W,t+1}\right)+cov_t\left(c_{n,t+1},c_{W,t+1}\right) \\ &\quad -cov_t\left(c_{n,t+1},r_{W,t+1}\right)-cov_t\left(r_{n,t+1},c_{W,t+1}\right)] \\ &\quad +\pi_t[cov_t\left(r_{n,t+1},r_{N,t+1}\mid \boldsymbol{r}_{i,t+1}^{net}\right)+cov_t\left(c_{n,t+1},c_{N,t+1}\mid \boldsymbol{r}_{i,t+1}^{net}\right) \\ &\quad -cov_t\left(c_{n,t+1},r_{N,t+1}\mid \boldsymbol{r}_{i,t+1}^{net}\right)-cov_t\left(r_{n,t+1},c_{N,t+1}\mid \boldsymbol{r}_{i,t+1}^{net}\right)]. \end{aligned} \tag{4}$$

The conditional local liquidity risks are

1. $cov_t\left(c_{n,t+1}, c_{N,t+1} \mid \boldsymbol{r}^{net}_{i,t+1}\right)$: the conditional commonality in transaction risk between a security n and the local non-investable market N;
2. $cov_t\left(c_{n,t+1}, r_{N,t+1} \mid \boldsymbol{r}^{net}_{i,t+1}\right)$: the conditional covariance between a security's transaction cost and the local non-investable market return;
3. $cov_t\left(r_{n,t+1}, c_{N,t+1} \mid \boldsymbol{r}^{net}_{i,t+1}\right)$: the conditional covariance between a security's return and the local non-investable market transaction cost.

As in AP, (1) affects required returns positively because investors want to be compensated for holding securities with higher transaction costs when the local market transaction costs increase; (2) and (3) affect required returns negatively because investors are willing to accept a lower return on an asset with lower transaction costs in a down local market, or an asset with higher return when local market transaction costs are high.

Note that the equilibrium asset pricing model implies that global risk is measured vis-à-vis the world market return (and aggregate world liquidity) as the world market portfolio is the correct portfolio to measure risk sharing.

To gain further insight into the price of unspanned risk, we write the conditional covariance as,

$$cov_t\left(r^{net}_{n,t+1}, r^{net}_{N,t+1} \mid \boldsymbol{r}^{net}_{i,t+1}\right) = cov_t\left(r^{net}_{n,t+1}, r^{net}_{N,t+1}\right) - cov_t\left(r^{net}_{n,t+1}, r^{net}_{DP,t+1}\right) \tag{5}$$

where $r^{net}_{DP,t+1}$ is the net return on the diversification portfolio DP with weights,

$$\omega_{DP,t} = \Sigma^{-1}_{ii,t+1}\Sigma_{in,t+1}\boldsymbol{M}_{n,t}/M_{N,t},$$

which is the portfolio of investable assets that is most highly correlated with the market portfolio of non-investable securities. The DP portfolio is the one held long by the domestic investor as the best substitute for the non-investable segment, but short by the foreign investor to reduce his local risk exposure.

If the correlation between returns on the value-weighted market portfolio of non-investable securities and its diversification portfolio, $\rho_{N,DP,t}$, is one, the market is effectively integrated, all of the premiums for unspanned market and liquidity risk disappear and only global market and liquidity risks are priced as in AP. Hence perfect spanning would eliminate the emerging market valuation premium or discount due to local liquidity risk but would not eliminate the global premiums or discounts that result from co-variation of the asset return and its transaction cost with the global market return and global transaction costs. Under complete segmentation, only local market and local liquidity risks are priced. Under partial segmentation, both global and local market return and liquidity risks are priced.

By aggregating Equation (5) over the set of non-investable securities, we can then obtain the conditional expected gross excess return on the local non-investable market portfolio, $r_{N,t+1}$ as,

$$\begin{aligned} E_t\left[r_{N,t+1} - r_f\right] \quad = \quad & -\frac{1}{2} var_t\left(r^{net}_{N,t+1}\right) + E_t\left[c_{N,t+1}\right] + \gamma_t cov_t\left(r^{net}_{N,t+1}, r^{net}_{W,t+1}\right) \\ & + \pi_t[var_t\left(r^{net}_{N,t+1}\right) - cov_t\left(r^{net}_{N,t+1}, r^{net}_{DP,t+1}\right)] \end{aligned} \tag{6}$$

which is the fundamental asset pricing equation that we will use in the empirical analysis.

3 Econometric specification

We describe in this section our empirical methodology. We first describe a system of six equations for the gross returns and the transaction costs of the world market portfolio, the non-investable stock market portfolio, and its diversification portfolio used to test our asset pricing model. We then discuss our new methodology to construct the diversification portfolios for each country.

3.1 Asset pricing tests

We estimate the following system of equations to test the asset pricing model for each country k,

$$
\begin{aligned}
r_{W,t+1} - r_{f,t+1} &= \alpha_W - \frac{1}{2} var_t\left(r^{net}_{W,t+1}\right) + \kappa_W E_t\left[c_{W,t+1}\right] + \gamma_{t+1} var_t\left(r^{net}_{W,t+1}\right) + \epsilon_{1,t+1}, \\
r_{DP^k,t+1} - r_{f,t+1} &= \alpha_{DP^k} - \frac{1}{2} var_t\left(r^{net}_{DP^k,t+1}\right) + \kappa_{DP} E_t\left[c_{DP^k,t+1}\right], \\
&\quad + \gamma_{t+1} cov_t\left(r^{net}_{DP^k,t+1}, r^{net}_{W,t+1}\right) + \epsilon_{2,t+1}, \\
r_{N^k,t+1} - r_{f,t+1} &= \alpha_{N^k} - \frac{1}{2} var_t\left(r^{net}_{N^k,t+1}\right) + \kappa_{N^k} E_t\left[c_{N^k,t+1}\right] + \gamma_{t+1} cov_t\left(r^{net}_{N^k,t+1}, r^{net}_{W,t+1}\right), \\
&\quad + \pi^k_{t+1}\left[var_t\left(r^{net}_{N^k,t+1}\right) - cov_t\left(r^{net}_{N^k,t+1}, r^{net}_{DP^k,t+1}\right)\right] + \epsilon_{3,t+1}, \\
\Delta c_{W,t+1} &= E_t[\Delta c_{W,t+1}] + \epsilon_{4,t+1}, \\
\Delta c_{DP^k,t+1} &= E_t[\Delta c_{DP^k,t+1}] + \epsilon_{5,t+1}, \\
\Delta c_{N^k,t+1} &= E_t[\Delta c_{N^k,t+1}] + \epsilon_{6,t+1}.
\end{aligned} \tag{7}
$$

The first two equations are for the expected gross returns of the world market and the diversification portfolio, both of which are priced as investable assets (see Equation 1). The third equation is for the expected gross return on the non-investable market portfolio for country k, which is priced as in Equation (6). To account for the autocorrelation in the transaction costs time series, we model in the last three equations, the change in transaction costs for each portfolio, $\Delta c_{j,t+1} = c_{j,t+1} - c_{j,t}$ for $j = W, DP^k$, or N^k, using as in AP an auto-regressive process AR(P), $E_t\left[\Delta c_{j,t+1}\right] = \phi_{j,0} + \sum_{p=1}^{P} \phi_{j,p} \Delta c_{j,t+1-p}$.

The expected gross returns in the first three equations depend on the expected transaction cost and on conditional covariances of net returns. We obtain expected transaction costs using the expected value of the corresponding AR process, $E_t\left[c_{j,t+1}\right] = c_{j,t} + \phi_{j,0} + \sum_{p=1}^{P} \phi_{j,p} \Delta c_{j,t+1-p}$. We obtain the conditional covariances of net returns from the covariance matrix H_t of the 6×1 vector $\boldsymbol{\epsilon}_t = (\epsilon_{1,t}, ..., \epsilon_{6,t})^\top$.

We model the covariance matrix H_t as a diagonal asymmetric GARCH process in which the variances depend only on past squared residuals and an autoregressive component while the covariances depend on the past cross-product of residuals and an autoregressive component,

$$
H_t = H_0 \circ (\boldsymbol{\iota}\boldsymbol{\iota}^\top - \boldsymbol{b}\boldsymbol{b}^\top - \boldsymbol{a}\boldsymbol{a}^\top) - \bar{H}_0 \circ \boldsymbol{c}\boldsymbol{c}^\top + \boldsymbol{b}\boldsymbol{b}^\top \circ H_{t-1} + \boldsymbol{a}\boldsymbol{a}^\top \circ \boldsymbol{\epsilon}_{t-1}\boldsymbol{\epsilon}_{t-1}^\top + \boldsymbol{c}\boldsymbol{c}^\top \circ \bar{\boldsymbol{\epsilon}}_{t-1}\bar{\boldsymbol{\epsilon}}_{t-1}^\top \tag{8}
$$

where $\boldsymbol{\iota}$ is a (6×1) vector of ones, $\boldsymbol{a}$, $\boldsymbol{b}$, and $\boldsymbol{c}$ are (6×1) vectors of unknown parameters, and $\circ$ is the Hadamard (element by element) matrix product. The shocks $\bar{\boldsymbol{\epsilon}}_{i,t-1} = -\mathbb{I}_{\boldsymbol{\epsilon}_{i,t-1}<0}\boldsymbol{\epsilon}_{i,t-1}$ capture the asymmetric response of covariances to lagged shocks (see Bekaert and Wu, 2000; Cappiello, Engle, and Sheppard, 2006). The matrices H_0 and $\bar{H}_0$ are set using the sample covariance matrix of $\boldsymbol{\epsilon}$ and $\bar{\boldsymbol{\epsilon}}$ respectively. The advantage of this multivariate GARCH parameterization is that it ensures positive definiteness of the covariance matrix while reducing the number of parameters to be estimated.

We allow the price of world market risk to change through time as suggested in the literature (see, among others, Harvey, 1991; de Santis and Gerard, 1997). Because the model implies that the price of world market risk should be positive, we model its dynamics using a square function of the global instruments $\boldsymbol{Z}_{W,t}$,

$$\gamma_{t+1} = (\lambda_{W,0} + \lambda_W^\top \boldsymbol{Z}_{W,t})^2. \tag{9}$$

If the world market risk is priced, we should reject the hypothesis that the $\lambda_{W,j} = 0$, for $j \geq 0$. If the world market risk is time-varying, we should reject that $\lambda_{W,j} = 0$, for $j > 0$.

Similarly, we allow the price of unspanned local risk to be time-varying. Because the price of unspanned local risk should be positive, we model the price dynamics using a square function of the local instruments $\boldsymbol{Z}_{k,t}$,

$$\pi_{t+1}^k = (\lambda_{k,0} + \lambda_k^\top \boldsymbol{Z}_{k,t})^2.$$

If unspanned local risk is priced, we should reject the hypothesis that the $\lambda_{j,k} = 0$, for $j \geq 0$. If unspanned local risk is time-varying, we should reject the hypothesis that the $\lambda_{j,k} = 0$, for $j > 0$.

The choice of instruments used in the parametrization of the prices of risk follow the literature (see, among others Ferson and Harvey, 1993, 1994; Dumas and Solnik, 1995; de Santis and Gerard, 1997). The global instruments include the world dividend yield in excess of the risk free rate and the U.S. term premium, measured by the yield difference between the 10-year and one-year T-bond. The local instruments include the local market dividend yield in excess of the U.S. risk-free rate.

Finally, bid-ask spreads overestimate the true cost of trading as we assume that investors have the same investment horizon as the return frequency we use in our econometric tests, an assumption unlikely to be verified in reality. Therefore, we estimate $\kappa_i = (\bar{\kappa}_i)^2$ to account for the fact that the investment horizon may differ in reality. AP similarly estimate κ in some of their specifications.

We allow for two other levels of model misspecifications. First, we use an intercept α_j for each portfolio in the estimation but the model implies that the intercepts are zero. Second, we use a Student t distribution for the shocks $\boldsymbol{\epsilon}_{t+1}$. Our model assumes log-normal returns, but given that the weekly log-returns we use in our empirical tests display high levels of kurtosis, we use the Student t distribution to ensure that risk premia parameters are not too impacted by large shocks.

Since the theory predicts that the world price of risk should be the same for each country, we first estimate the world equation in the system of Equations (7) to obtain the time-varying world price of risk (see, for example, Bekaert and Harvey, 1995). We then impose the $\hat{\gamma}_t$, in the country estimations.

3.2 Estimation of the diversification portfolio

The set of substitute assets, $\boldsymbol{S^k}$, used to construct the diversification portfolio for country k is composed of (i) the investable value-weighted world market portfolio, W_I, which includes developed markets and investable local stocks in emerging markets, (ii) the value-weighted portfolio, DR^k, which includes ADRs, GDRs, and direct listings, and (iii) all the funds of country k, $F_n^k, n = \{1, ..., N_F^k\}$, where N_F^k is the number of funds of country k. Funds include Country Funds as well as Exchange Traded Funds of country k and of its region. We define Country Funds as mutual funds, investment trusts and regional funds, i.e., all funds except ETFs. We discuss in Section 4 our construction methodology for each of these portfolios.

We form a dynamic replicating portfolio whose allocation at time t uses conditional covariances:

$$\boldsymbol{\omega}_{DP^k,t} = \Sigma_{S^k,t}^{-1} \Sigma_{S^k - N^k,t} \tag{10}$$

where $\Sigma_{S^k,t}$ is the covariance matrix at time t of the vector

$$\boldsymbol{r}_{S^k,t}^{net} = \left[r_{W_I,t}^{net}, r_{DR^k,t}^{net}, r_{F_1^k,t}^{net}, r_{F_2^k,t}^{net}, ..., r_{F_{N_F^k}^k,t}^{net} \right]^\top$$

and $\Sigma_{S^k - N^k,t}$ is the vector of covariances between the net return on the value-weighted portfolio of non-investable securities $r_{N^k,t}^{net}$ and the vector $\boldsymbol{r}_{S^k,t}^{net}$.

Estimating conditional covariances is complicated by the fact that the replicating assets have different time series length, with some series not overlapping at all. In addition, there are a large number of replicating assets which further complicates the estimation of conditional covariances. To address these issues, we use the methodology of Christoffersen et al. (2018). We estimate one volatility model for each asset and then obtain the correlations from a dynamic normal copula (DNC) estimated on the residuals. We use the conditional variances, $\boldsymbol{\sigma}_{t+1}$, obtained from the volatility models and the conditional correlations, C_{t+1}, obtained from the DNC model to obtain the conditional covariances, $\Sigma_{t+1} = diag\left(\boldsymbol{\sigma}_{t+1}\right) C_{t+1} diag\left(\boldsymbol{\sigma}_{t+1}\right)$, needed to estimate the diversification portfolio weights (see Equation 10).[15]

To estimate the conditional covariances, Σ_{t+1}, we proceed in two steps. In a first step, we estimate for each asset j a simplified version of Equation (7) in which we directly model net returns, $r_{j,t+1} - c_{j,t+1}$. In our asset pricing tests, we examine the impact of liquidity level and risk on expected gross returns and therefore have a separate equation for gross returns, $r_{j,t+1}$, and transaction costs, $c_{j,t+1}$. Here we form the best replicating portfolio and separating gross returns from transaction costs would complicate the estimation without much benefit.[16]

In a second step, we estimate a dynamic normal copula on the standardized shocks, $u_{j,t+1} = \frac{\epsilon_{j,t+1}}{\sigma_{j,t+1}}$. The conditional correlations follow the same dynamic as in Equation (8),

$$\Gamma_{t+1} = \Omega_C \left(1 - b_C - a_C\right) - \bar{\Omega}_C c_C + b_C \Gamma_t + a_C u_t u_t^{\top} + c_C \bar{u}_t \bar{u}_t$$

where Ω_C is the long-run correlation matrix of u_t, $\bar{\Omega}_C$ is the long-run correlation matrix of $\bar{u}_t$, a_C, b_C, and c_C are scalar parameters for the correlation dynamic, and $\bar{u}_{i,t} = -\mathbb{I}_{u_{i,t}<0} u_{i,t}$. We obtain the dynamic correlation through the standardization $C_{j,l,t+1} = \frac{\Gamma_{j,l,t+1}}{\sqrt{\Gamma_{j,j,t+1}\Gamma_{l,l,t+1}}}$.

To account for the unequal length of the time series, we estimate the parameters by maximizing the composite log-likelihood (i.e., pair-wise log-likelihood) using all available assets at each time period. This estimation procedure allows us to estimate one correlation model on a unbalanced

[15] To prevent extreme weights in the DP portfolio, we examine at each period t the full correlation matrix. For each pair of replicating assets whose cross-correlation in absolute term at time t is higher than a threshold (e.g., 0.85), we keep only the one with the highest correlation with the non-investable portfolio. We repeat the exercise with a lower correlation threshold (e.g., 0.8) until the condition number of the correlation matrix is below 15. The condition number is the square root of the ratio of the maximum eigenvalue to the minimum eigenvalue of the correlation matrix. Working with a set of replicating assets whose correlation matrix's condition number is below 15 ensures that we do not work with redundant assets.

[16] We also use an AR(p) process for the conditional expectation of net returns. The focus here is on conditional covariances and all we need is to remove autocorrelation in net returns. Our estimation of the vector weights is robust to alternative specifications for the conditional expectation of net returns.

panel of asset returns. Once an asset j becomes available, we set its first conditional correlations with other available assets l to its long-run parameter $\Omega_{j,l,C}$.

Our approach has several advantages. First, the covariance dynamic used to form the diversification portfolio is the same as the one used in asset pricing tests. As barriers to investment fall and the composition of the non-investable portfolio changes, our dynamic approach captures the changing nature of the diversification portfolio. A second advantage is that our approach allows for a large number of replicating assets. Previous studies use a selected number of portfolios and cross-listings and usually estimate weights in a sequential regression approach.[17] We estimate directly over the full set of replicating assets.

4 Data

This section describes the securities used to construct the test assets, i.e., the investable and non-investable portfolios and the securities used to form the set of substitute assets and build the diversification portfolios. We also describe how we classify securities into investable and non-investable. Further, we detail the AR liquidity measure and report basic statistics on portfolio returns and the liquidity measure.

4.1 Distribution of securities

From S&P Compustat (xpressFeed), we retrieve daily data for 81,708 stocks from 47 countries listed on major stock exchanges.[18] For most countries, we identify one major stock exchange on which the majority of stocks are listed, but we use more than one exchange for a few countries.[19]

[17] Carrieri et al. (2007), Carrieri, Chaieb, and Errunza (2013), and Errunza and Ta (2015) run time-series stepwise regressions to form diversification portfolios where the weights assigned to previous securities vary upon the availability of new cross-listings.

[18] There are 94 countries with listed securities on Compustat. 47 countries are excluded because of data limitations, notably, a short period with less than five years of data or a small number of securities with less than 10 stocks.

[19] Countries with multiple stock exchanges are: Brazil (BM and F Bovespa SA Bolsa De Valores Mercadorias E Futuros, Rio de Janeiro), Canada (Toronto Stock Exchange, TSX Venture Exchange), China (Shenzhen Stock Exchange, Shanghai Stock Exchange, Shenzhen-Hong Kong Stock Connect (NB), Shanghai-Hong Kong Stock Connect (NB)), France (NYSE Euronext Paris, Paris), Germany (Deutsche Boerse AG, XETRA), Hong Kong (Hong Kong Exchanges and Clearing Ltd, Hong Kong-Shenzhen Stock Connect (SB), Hong Kong-Shanghai Stock Connect (SB)), India (BSE Ltd, National Stock Exchange of India), Japan (Tokyo Stock Exchange, Osaka Securities Exchange), South Korea (Korea Exchange Stock Market, Korea Exchange KOSDAQ), Switzerland (Swiss Exchange, Zurich), Taiwan (TAIPEI EXCHANGE, Taiwan Stock Exchange), United Arab Emirates (Abu Dhabi Securities Exchange, Dubai Financial Market), United States of America (NASDAQ, New York Stock Exchange, NYSEArca, NYSE MKT).

We also obtain daily data for $2,826$ cross-listings, 76 mutual funds and investment trusts, and 409 ETFs.

We test our asset pricing model on emerging market stocks. However, we use a broader set of securities for several reasons. First, we need stocks in both developed and emerging markets to build the world market portfolio. Second, we use cross-listed firms in other markets to determine the degree of investability of local stocks in emerging markets. Finally, we use the investable world market portfolio, cross-listings, and funds as substitute assets to build diversification portfolios. We discuss further in Section 4.4 how we construct the set of substitute assets. Following Karolyi and Wu (2017), we use only cross-listings and funds listed on open stock exchanges to ensure that they are investable for global investors. We use their list of stock exchanges considered to be open to foreign investors.[20]

Table 1 presents the start dates and number of securities per country. The start dates of time series are mainly determined by the availability of high and low prices needed to compute bid-ask spreads, as explained below. Data for 14 EMs start in the mid 1990s, while they start in the 2000s for the rest of EMs. Notably, our time series for Chile and Israel start only in 2009 and 2006, respectively, as few high and low prices are available before these dates. The minimum (maximum) number of local stocks is 75 ($11,035$) in Colombia (U.S.). In our empirical work we use cross-listings and funds for emerging markets, but we also provide in Table 1 the number of such securities for developed markets for comparison. All emerging markets have cross-listings in our sample. Four frontier markets, namely Bangladesh, Morocco, Sri Lanka, and Tunisia, have no depositary receipts. Note that one company may have more than one cross-listing at any point in time. Therefore, their number is not a direct indication of the number of investable local stocks in emerging markets. Most emerging markets also have at least one fund. There are a lot more ETFs than country funds.[21]

For each security, we retrieve daily low, high, and closing prices, adjustment and total return

[20] The set of open stock exchanges include the United States (NYSE, AMEX, NASDAQ, NYSE Arca, and OTC), United Kingdom (London Stock Exchange, SEAQ International, London OTC, and London Plus Markets), Europe (NYSE Euro next Amsterdam, Brussels, Lisbon, and Paris, Deutsche Boerse, XETRA, Luxembourg Stock Exchange, and OTC), Singapore, and Hong Kong.

[21] Figure 1 in the Online Appendix shows the growth of country funds and ETFs over time and across all countries. The growth of country funds stops in the early 2000s when ETFs' growth takes off. Of the more than 700 funds at the beginning of 2017, less than 100 are mutual funds or investment trusts. Some ETFs such as iShares MSCI Denmark (EDEN) are not included because they are not listed on the set of open stock exchanges.

factors, trading volumes, and market capitalizations in U.S. dollars. We apply filters and a list of data corrections for Compustat stock data provided in Griffin, Kelly, and Nardari (2010) and in Chaieb, Langlois, and Scaillet (2017). All returns are weekly using Wednesdays, denominated in U.S. dollars, and are in excess of the U.S. Treasury bill rate. We use weekly returns instead of monthly returns to have enough observations to capture the time-dynamics in covariances, and use weekly returns instead of daily to alleviate the problem of non-synchronous trading. We use the longest time series available for each security, and our sample ends in January 2018.

4.2 The AR Liquidity Measure

To test our asset pricing model, we need direct measures of transaction costs such as bid-ask spreads. However the data on bid-ask spreads are not available for many stocks in our sample of EMs. For all securities, we therefore use the bid-ask spread estimator of Abdi and Ranaldo (2017). Building on Roll (1984) and Corwin and Schultz (2012), they derive two equations linking the bid-ask spread and daily volatility to functions of the close, low, and high log-prices. Isolating the bid-ask spread produces the estimator

$$c_t = \sqrt{4E\left[\left(p_t - \frac{l_t + h_t}{2}\right)\left(p_t - \frac{l_{t+1} + h_{t+1}}{2}\right)\right]} \tag{11}$$

where p_t, l_t, and h_t are respectively the close, low, and high log-prices at time t. Their methodology produces estimates of the log bid-ask spread, c_t, needed to test our asset pricing model (see Assumption A3).[22]

By applying Abdi and Ranaldo (2017) methodology, we obtain daily estimates of the bid-ask spread. Following their suggestion, we set negative daily spreads to zero. The weekly spread measure is the average of daily measures within a week for weeks during which there are at least two daily spreads available. Given the small number of daily observations in a week, these averages are noisy estimates of the bid-ask spread proxy. In our empirical analysis, we aggregate these stock estimates at the portfolio level, which produces reasonable time series of portfolio bid-ask spread

[22] In a previous version of this paper, we used the Corwin and Schultz (2012) measure and obtained similar results. We use the Abdi and Ranaldo (2017) measure for two reasons. First, it directly estimates the log bid-ask spread whereas Corwin and Schultz (2012) rely on an approximation to get an estimate of the bid-ask spread. Second, it performs better when there are few trades which is the case for some emerging markets we consider.

proxies. While it is a good estimate for the cost of a round-trip transaction of small size, this measure may not capture other dimensions of liquidity such as market depth, resilience, and search costs. This is also a shortcoming of alternative measures of bid-ask spreads. In Section 5.1 below, we empirically verify that the estimated bid-ask spreads are positively but not highly correlated with stock market volatilities.

We classify a security as a local stock when its issue type is common or ordinary share, it is listed on a major stock exchange in the same country as the issuing company is incorporated, and is classified by S&P Compustat as a primary issue. Each week, we use all local stocks with a valid market capitalization and for which there are at least two weekly bid-ask spreads during the last month. We refer to these securities as available stocks.

Using all available stocks listed in 47 developed and emerging markets, we build value-weighted return and bid-ask spread time series for the world market portfolio W.

4.3 Classifying securities

To test our asset pricing model with partial segmentation and liquidity risk, we focus on 24 emerging markets for which data is available (Argentina, Brazil, Chile, China, Colombia, Egypt, Greece, Hungary, India, Indonesia, Israel, Malaysia, Mexico, Morocco, Philippines, Poland, Portugal, South Africa, South Korea, Sri Lanka, Taiwan, Thailand, Turkey, United Arab Emirates).[23]

Each week, we classify available local stocks as investable or non-investable. Our primary filter for investability follows Karolyi and Wu (2017). We characterize a stock as investable if there exists a related available cross-listed stock listed on an open stock exchange for the same week. We also classify as investable stocks whose MSCI foreign inclusion factor (FIF) is larger than 50%. FIFs are an estimate of the proportion of a stock's market capitalization available to foreign investors.[24] We also use country specific filters; B shares in China and Philippines are classified as investable. The set of investable stocks can change every week.

Alternative determinants of investability include the investability weight factor (IWF) computed

[23]We remove Bangladesh and Tunisia because of missing dividend yields.

[24]We use MSCI foreign inclusion factors (FIF) for large- and mid-cap stocks. MSCI started to adjust its indexes for free-float in two steps in November 2001 and May 2002. Before June 2002, the foreign inclusion factors reported by MSCI are often 100%. We therefore use FIFs starting in June 2002. Figure 2 in the Online Appendix shows the cross-sectional distribution of FIFs across all emerging markets from 2002 to 2017. The median lies between 25% and 40%, but the 5%-95% percentile range goes from around 10% to 95%, indicating that there are important cross-sectional differences in FIF across emerging market stocks.

by S&P/IFC and the foreign ownership holdings used in Errunza and Ta (2015). The foreign ownership holdings data from Lionshare start in 1999 but the sample of investable stocks does not change significantly over time compared to the use of depository receipts (ADRs, GDRs) and direct listings as in Karolyi and Wu (2017). Bekaert, Harvey, Lundblad, and Siegel (2011) and Carrieri et al. (2013) show that implicit barriers to foreign investments results in investable stocks not being effectively integrated with the world economy. Therefore, we use in Section 6 the portfolio of all local stocks as our non-investable set as a robustness check.[25]

Then, we build different value-weighted return and bid-ask spread indices: one that contains all local stocks, one with all investable stocks, and one with all non-investable stocks. Table 2 reports for each EM summary statistics for the three portfolios. We report the number of stocks at the end of the sample period, the annualized average and volatility of portfolio returns, and the average and volatility of bid-ask spreads.[26]

In January 2018, the split of non-investable versus investable stocks greatly varies across countries. The average proportion of non-investable stocks is 65% (not reported), but some countries have no investable stocks (Sri Lanka and United Arab Emirates) and Thailand has only 8% of its stocks considered non-investable. Portfolios display levels of average returns and volatility typical of emerging markets. The average bid-ask spread for each country's overall market varies from 0.64% to 1.45%. But most importantly, we find that most non-investable portfolios are more illiquid than investable stock portfolios. In the last column, we report the percentage difference in average bid-ask spread between non-investables and investables relative to the bid-ask spread of investable stocks. The difference is positive in all countries except Greece, India, Malaysia, South Africa, and Taiwan. The (unreported) cross-country average of the percentage difference is 16%.

Figure 1 shows the percentage relative difference between the value-weighted cross-sectional average bid-ask spread of non-investable and the value-weighted cross-sectional average bid-ask spread of investable stocks in our sample of emerging markets. We use beginning of week total market capitalization in U.S. dollars to compute the value-weighted average. The time-series average (red dashed line) is 15.81% indicating that the equal-weighted average of 16% is not driven

[25]In this robustness check, we put all local stocks in the non-investable set and use only developed market stocks in the investable world market portfolio when forming the diversification portfolio.

[26]We report in Section 4 of the Online Appendix the summary statistics of weekly returns and bid-ask spreads for developed markets.

by small countries. Notice that the variability in the illiquidity for investables and non-investables drops over time because of increased number of countries and firms covered.

4.4 Constructing the set of substitute assets

For each country, we build a portfolio of securities, DR^k, that contains all eligible cross-listings. The objective is to obtain the best replicating asset for the portfolio of local non-investable stocks. Hence, for each stock j of country k with a cross-listing, we form a value-weighted portfolio, DR_j^k, of all cross-listings using their respective market capitalizations. That is, DR_j^k allocates more to larger depository receipts and direct listings. The weight of each of these portfolios, DR_j^k, in the portfolio of securities, DR^k, is proportional to the market capitalization of their respective local stock j. Finally, we use the investable world market portfolio, W_I, which includes developed markets and investable local stocks in emerging markets, the value-weighted portfolio, DR_k, which includes ADRs, GDRs, and direct listings, and all the funds of country k, to build the diversification portfolios.[27] Hence, we obtain a replicating portfolio that is as close as possible to the non-investable portfolio of local stocks.

5 Results

In this section, we estimate our asset pricing model and test whether world and unspanned local risks are priced. We also examine the economic contribution and the dynamics of the different risk premia, specifically the global and local liquidity risk premia.

5.1 Prices of risk and total risk premia

We first estimate the time-varying price of world market risk using the world market portfolio over the period 1984-2018. We report model estimates in Panel A of Table 3 and the time-varying prices in Figure 2.

Columns (i) and (ii) of Panel A report the intercept α_W and the expected liquidity coefficient

[27] We search for all securities whose issue type is mutual fund, investment trust, or ETF, that are listed on an open stock exchange and whose company name includes the country name. We also use region keywords for some countries (Latin America, Asia Pacific, Central European, BRIC, Emerging Asia, Middle East & Africa, and Eastern Europe). We manually add the Lyxor ETF FTSE Athex 20 for Greece. We remove any short or levered ETFs and sector funds. The complete list of funds is available from the authors.

κ_W with their t-ratio below in parentheses. As mentioned in Section 3, both parameters capture model misspecifications: the first captures the level of returns not explained by our IAPM and the second accounts for the fact that investors' trading horizon may not align in reality with the data frequency used in our empirical tests. The intercept is significant at 10% level but the size is small at 0.22%. The expected liquidity coefficient, κ, is estimated at 0.02 and is not significant. When estimating an unconstrained κ, AP find a negative but insignificant value for the U.S. market.

The next column reports the time-series average of the world price of risk of 1.44. The price of world risk is equal to the aggregate risk aversion. Hence, a value of 1.44 is economically meaningful.

We report in the last two columns robust Wald test statistics and their p-value for the significance and time variation in the price of world risk. We find that the price of risk is significant. Although the test statistic for time-varying price is not statistically significant, the time-varying price of world risk as reported in Figure 2 shows large fluctuations over time. The gray areas indicate NBER recessions (July 1990 to March 1991, March to November 2001, and December 2007 to June 2009), the European exchange rate mechanism (ERM) crisis (September 1992 to August 1993), the Tequila crisis (December 1994 to January 1995), the East Asia crisis (June to December 1997), the Russian default and Long-Term Capital Management crisis (August to December 1998), and the Euro-sovereign debt crisis (January 2010 to December 2012). Other important events, such as the bankruptcy of Lehman Brothers (September 2008) and the U.S. debt downgrade (August 2011) coincide with these other events. Figure 2 shows that the world price of risk is especially high at the onset and during the global financial crisis.[28]

Panel B of Table 3 presents the estimation results for each emerging market. Note that the standard errors of our estimates ignore the sampling error associated with earlier stage estimation. We find that the intercept, α_{N^k}, is only significant for Brazil, Portugal, and UAE. The expected liquidity coefficient, κ_{N^k}, is positive and significant for 4 markets. We use a 10% significance level. At the aggregate level, Lee (2011) finds a negative but insignificant value of the expected liquidity coefficient for his sample of 28 EMs, whereas BHL find a positive but insignificant value of the expected liquidity coefficient in the case of full integration or segmentation for 19 EMs. Our estimated κ shows significant variation across countries. It tends to be higher in the more

[28]Unreported estimated coefficients show that the world price of risk is positively related to the dividend yield and negatively to the term structure slope.

active markets such as China, while it is rather low in the less active markets such as Argentina. For example, it is estimated at 0.60 for China, while it is only 0.10 for Argentina. Some of the cross-sectional variability is due to estimation and measurement errors which is particularly severe in countries with short time span. Some estimates are less reasonable. This is particularly the case for Mexico with a low κ of 0.01. The positive correlation between illiquidity and volatility makes identifying the expected liquidity coefficient especially difficult. In unreported results, we find that the average correlation across EMs between the expected cost and return volatility is 0.55.[29]

Panel B also shows the average price of unspanned local risk for each country, a test of whether these prices are significant and whether they are time-varying. The average price of unspanned local risk over time and across countries is 3.33. The price of local risk is proportional to the differential in risk aversion between an EM average investor and the world average investor and hence the size seems economically plausible. Nevertheless, the average price of unspanned local risk varies across countries. It ranges from 0.11 for Portugal to more than 10 in Hungary. The prices are significant for 18 emerging markets at the 10% level. Of these 18 countries, the prices of risk are significantly time-varying in 6 cases.[30]

We present for each emerging market in Figure 3 the contributions to the total risk premium from world covariance risk premium with a blue thin line and from the unspanned local risk premium with a thick black line. Unsurprisingly, the effect of the 2008-2009 financial crisis is clear in most graphs as the world risk premium spikes. The contribution from local risk premium shows the effect of local crises. For example, we see the spike caused by the default in Argentina in 2002, the recent spike in 2016 due to the currency devaluation in Egypt, and the effect of the Asian crises in 1997 in Indonesia, Malaysia, Philippines, and Thailand. In addition, highly integrated countries such as Brazil, South Korea, and Portugal, show a small contribution of the local risk premium. However, largely segmented countries such as Colombia, Egypt, Morocco, and Sri Lanka show a significant contribution of the local risk premium relative to the world risk premium.

[29] The positive correlation between illiquidity and volatility is well documented in the literature, see, for example, Amihud (2002).

[30] The complete set of model estimates is available from the authors.

5.2 Liquidity risk premia

We examine the economic contributions of the liquidity level, world liquidity risk, and unspanned local liquidity risk premia to the total risk premium. For each EM, we compute the time-series of the liquidity level expected return component as,

$$\kappa_{N^k} E_t \left[c_{N^k,t+1} \right], \tag{12}$$

the expected return component coming from the Jensen's term as,

$$cov_t \left(r_{N^k,t+1}, c_{N^k,t+1} \right) - \frac{1}{2} var_t \left(c_{N^k,t+1} \right), \tag{13}$$

the expected return component coming from the world liquidity risk premium as,

$$\gamma_{t+1} \left(-cov_t \left(r_{N^k,t+1}, c_{W,t+1} \right) - cov_t \left(c_{N^k,t+1}, r_{W,t+1} \right) + cov_t \left(c_{N^k,t+1}, c_{W,t+1} \right) \right), \tag{14}$$

and finally the expected return component coming from the unspanned local liquidity risk premium as,

$$\begin{aligned} \pi^k_{t+1}(-cov_t \left(r_{N^k,t+1}, c_{N^k,t+1} - c_{DP,t+1} \right) - cov_t \left(c_{N^k,t+1}, r_{N^k,t+1} - r_{DP,t+1} \right) \\ + cov_t \left(c_{N^k,t+1}, c_{N^k,t+1} - c_{DP,t+1} \right)). \end{aligned} \tag{15}$$

Table 4 reports for each EM, the time-series average of each liquidity-related risk premium component and their median across all EMs on the last line. Column (i) presents the contribution from the liquidity level, which is by far the biggest contributor to the overall risk premium with a cross-country median of 3.87% per year. This result is in line with earlier evidence from the U.S. on the significance of the premium for the liquidity level.[31] Also, Amihud et al. (2015) find that a liquidity-level factor delivers positive average return in a wide cross-section of countries. Column (ii) reports the Jensen's term contribution which is on average small and negative.

Columns (iii)-(vi) report the time-series averages for each of the three world covariance risk

[31] See Amihud, Mendelson, and Pedersen (2005) for a review of the literature on the positive relation between expected return and illiquidity.

premiums and their sum. World liquidity risk premium is the second contributor to overall impact of liquidity on risk premium and has a cross-country median of 0.24%. This average is higher than the 0.02% estimate for the U.S. benchmark market index over 1994-2018 as discussed in the section 6.1, i.e., world liquidity risk premium is a bigger component of risk premia in emerging markets than in a developed market like the U.S. Of all three world systematic liquidity risk components, the largest is the sensitivity of returns to aggregate world liquidity. The relevance of this risk factor was first uncovered by Pastor and Stambaugh (2003) for the U.S. market. Of all three world liquidity risk contributions, the smallest is the covariance of illiquidity costs. This is in line with AP who report that the commonality in liquidity is the smallest contributor.

The last four columns report each local liquidity covariance risk premium and their sum. Total local liquidity risk premium is small with a cross-country median of 0.07%. The intuition for this result is the following. Whereas unspanned local risk is significantly priced in most markets as reported in Panel B of Table 3, unspanned *liquidity risk* is modest because the differences between covariances with the local market N^k and with the diversification portfolio DP^k are not large. Therefore, in emerging markets, liquidity is mainly priced through the level effect and world covariances, and not through local covariances. Unspanned local liquidity risk is largely diversifiable.[32]

The global liquidity risk premium component greatly varies over time. We plot in Figure 4 the value-weighted total world liquidity risk premia over the 1994-2018 period. While the time-series average is 0.23% (red dashed line), there is considerable time variation. The contribution is large during the Asian crisis in 1997, the LTCM crisis in 1998, the global financial crisis, and in the weeks leading to the U.S. downgrade in 2011. We also experience spikes in the world liquidity risk premium during the market corrections in May 2006 and in late 2015 and early 2016.[33] Therefore, world liquidity risk premium is small on average but spikes to more than 0.50% during crisis periods and to more than 3.5% during the financial crisis of 2007-2009. This interesting and new finding is in line with the earlier evidence of conditional pricing of liquidity risk in the U.S.

[32]Figure 3 shows, for each country, the contribution from both unspanned local market and local liquidity risk premia. Given that local liquidity risk premium is small, most of the unspanned local risk premium is due to local market risk premium.

[33]From May 9^{th} to June 13^{th} 2006, the S&P 500 Index fell by 7.66%, the MSCI EAFE Index by 14.63%, and the MSCI Emerging Market Index by 24.24%. From November 3^{rd} 2015 to February 11^{th} 2016, the S&P 500 Index fell by 13.31%, the MSCI EAFE Index by 14.76%, and the MSCI Emerging Market Index by 16.79%.

6 Robustness

We check the robustness of our results by first assessing the impact of the choice of our sample period, liquidity measure, and data frequency on the estimation of the magnitude of the liquidity risk premium at the market level for the U.S. Second, we repeat our tests under the assumption that the whole emerging country stock market is non-investable.

6.1 Benchmark case: Liquidity risk premium in the U.S.

This section has two objectives. We first replicate the empirical methodology of AP to estimate the AP liquidity-adjusted CAPM for 25 illiquidity sorted portfolios for the U.S. Using this benchmark analysis we can assess the effects of the choice of our sample frequency and time period, liquidity measure, and level of aggregation of our test assets on the estimation of the magnitude of the liquidity risk premium compared to AP.

As a by-product of this analysis, we achieve a second objective: we obtain a benchmark for the size of the average liquidity risk premium that we expect for our sample of 24 EMs based on results from an integrated and large market, the U.S. equity market. Our setup differs from AP on three main aspects:

1. AP use the price impact measure of Amihud (2002) which is the daily absolute return divided by the daily dollar volume and then average this ratio over all days to get a monthly measure. Their and our economic model require a measure of transaction cost. To obtain a measure of transaction cost, AP adjust the price impact for the growth in the stock market capitalization to account for inflation, standardize the measure such that size-sorted portfolios have approximately the same cross-sectional distribution as the effective half spreads reported by Chalmers and Kadlec (1998), and also cap the measure at 30% to remove potential outliers. Bid and ask prices are scarce in emerging markets. Therefore, we use the bid-ask spread proxy proposed by Abdi and Ranaldo (2017) which only requires low, high, and close daily prices. Their measure is a direct estimator of the bid-ask spread.
2. AP test their model on a cross-section of 25 illiquidity-sorted portfolios in the U.S. To measure the economic significance of liquidity risk, they report the annualized difference in liquidity risk premium between the 25^{th} portfolio (i.e. the most illiquid) and the first portfolio (i.e. the

most liquid). Unfortunately, the low number of stocks in many emerging markets prevents us from creating such a wide array of portfolios. Instead, we run our test at the country portfolio level.

3. We test the economic model in a conditional framework with weekly data whereas AP test the unconditional implication of their model with monthly returns. Testing the conditional version is crucial in our case as the gradual market integration of many emerging markets during our sample period implies that their covariance structure with global assets evolves over time. We rely on data at the weekly frequency instead of monthly because it helps us capture the time-dynamics of covariances.

To assess the impact of these differences on the economic magnitude of our estimated liquidity risk premium, we construct 25 illiquidity-sorted portfolios in the U.S using both weekly and monthly returns and bid-ask spreads.[34] We restrict our analysis to the sample period starting in May 1994 used in our empirical results when data for the emerging markets are first available.

A first concern is to examine whether our choice of liquidity measure impacts the importance of liquidity risk. We form 25 value-weighted portfolios by ranking U.S. stocks by the average of their bid-ask spread over the past four periods (either months or weeks). In Panel A of Table 5 we report the summary statistics for the $P_1, P_5, P_9, P_{15}, P_{21}, P_{25}$ illiquidity-sorted portfolios from Table 1 in AP. In Panel B, we report the same summary statistics for our monthly illiquidity-sorted portfolios over the period 1994-2018. We first report the annualized average return and volatility in columns (i) and (ii), and the average and volatility of the bid-ask spread measures in columns (iii) and (iv).[35] As expected, the sort on the past four months average bid-ask spread creates a monotonically increasing average bid-ask spreads. Average bid-ask spreads in column (iii) range from 0.46% to 4.74%, whereas AP's portfolio average spreads go from 0.25% to 3.02% for the 23^{rd} portfolio (unreported) and 8.83% for the 25^{th} portfolio. In line with AP, we find volatility of returns in column (ii) and volatility of bid-ask spreads in column (iv) increasing with portfolio illiquidity.

In the last five columns, we report the market and liquidity betas. As in AP's main results we use an equal-weighted U.S. market portfolio and discuss results with a value-weighted market

[34] When constructing the monthly averages of daily bid-ask spreads, we follow Abdi and Ranaldo (2017) and require at least 12 daily observations during the month.

[35] Only the return volatility measures are not comparable. AP report the average of the daily stock return volatility whereas we report the volatility of monthly returns of the illiquidity-sorted portfolios.

portfolio later. We first estimate an auto-regressive model with two lags (AR(2)) on the bid-ask spread time series of the market portfolio and each of the 25 liquidity portfolios.[36] Then, we compute the covariances between illiquidity shocks and returns. To facilitate the comparison, we report the covariances in beta form and multiply by 100 as in AP. We compute the betas by dividing each covariance by the variance of net market returns, $Var\left(r_{m,t} - E[r_{m,t}] - (c_{m,t} - E_{t-1}[c_{m,t}])\right)$, where $E[r_m]$ is estimated by the sample average and $E_{t-1}[c_{m,t}]$ is the expected value from the AR process.

The market beta in column (v) displays a wider dispersion than in AP, ranging from 0.27 to 1.23 compared to their 0.55-0.84 range. Most importantly for liquidity risk, the beta involving transaction costs display similar ranges across the 25 portfolios. The beta ($\times 100$) of portfolio returns with market transaction costs in column (vi) (equivalent to their β_3) ranges from -0.46 to -2.11 compared to -0.80 to -1.69. The beta ($\times 100$) of portfolio transaction cost with market returns in column (vii) (equivalent to their β_4) ranges from -0.92 to -3.52 compared to 0 to -4.52. The transaction cost commonality beta in column (viii) ($\times 100$) (i.e. their β_2) ranges from 0.07 to 0.26 compared to a 0 to 0.42 range in AP. The 25 portfolios sorted by the bid-ask spread measure display increasing liquidity risk as shown in the last column where we report the sum of liquidity betas (i.e., the transaction cost commonality beta minus the two return-cost betas) which ranges from 1.44 to 5.89 compared to 0.80 to 6.63.

The next line in Panel A of Table 5 shows the annualized risk premium coming from each liquidity risk component. AP use their estimated risk premium of $\lambda = 1.512\%$ to compute the spread in risk premium between the most illiquid and the most liquid portfolio. They find a contribution of 0.16% for the covariance of r_j with c_m, 0.82% for the covariance of c_j with r_m, and 0.08% for the covariance of transaction costs, for a total of 1.06%. Using the AP estimated risk premium of 1.512%, we obtain corresponding values of 0.30%, 0.47%, and 0.03%, for a total of 0.81%. Hence, using the bid-ask spread approximation of Abdi and Ranaldo (2017) leads to an economically significant magnitude of liquidity risk but lower than the magnitude estimated by AP using a rescaled price impact measure.

We cannot form 25 portfolios in emerging markets due to the limited number of stocks. Instead

[36] AP also use an AR(2) on monthly returns. We use below six lags when working on weekly data because weekly bid-ask spread are more auto-correlated. None of the Ljung-Box tests are rejected at the 5% confidence level.

of examining the spread between 25 portfolios, we look at market portfolios. We therefore want to compare the liquidity risk premium importance between using a portfolio spread versus using a broad market index. We report in the next line in Panel B the liquidity risk premium contribution for the market portfolio. We find a total liquidity risk premium of 0.63%. Therefore, we can expect the liquidity risk premium to be smaller when looking at the overall market rather than the spread between illiquidity-sorted portfolios.

We also check whether the sample period makes a difference in terms of estimated risk premium. AP estimate a risk premium of $\lambda = 1.512\%$ using monthly data on stocks listed on the NYSE and AMEX from 1964 to 1999. We re-estimate the risk premium using our data from NYSE, NYSE Arca, AMEX, and NASDAQ that covers the period 1994-2018. Based on AP methodology, we find a risk premium, $\lambda = 0.114\%$, which is significantly lower than AP's estimate over 1964-1999 period. Therefore, the total liquidity risk premia contribution are much lower in the later period, decreasing from 0.81% to 0.06% for the portfolio spread and from 0.63% to 0.05% for the market portfolio. Clearly, estimating the risk premium for the last 25 years leads to a significantly lower liquidity risk premium.

The next important difference is that we test the asset pricing model on weekly returns to better capture the time dynamics in covariances. We repeat the analysis in Panel C using weekly returns. The portfolios have increasing volatility, bid-ask spread average and volatility, and liquidity risk betas. Using AP's risk premium appropriately scaled, we find higher liquidity risk premium contribution for the portfolio spread (1.05% compared to 0.81% for monthly returns) and for the market portfolio (1.20% compared to 0.63% for monthly returns). Using the risk premium, $\lambda = 0.005\%$, estimated over the 1994-2018 period with weekly returns, the liquidity risk premia are 0.02% and 0.02% for the portfolio spread and the market portfolio, respectively.

We also find very similar results (see Section 1 in the Online Appendix) when we replace the equally-weighted market by the value-weighted market that we also use in our empirical tests for the emerging markets. The difference in annualized expected returns between portfolio 1 and 25 that can be attributed to the total liquidity risk is 0.90% using the AP estimated risk premium of $\lambda = 2.495\%$ and is only 0.03% using our estimated risk premia over 1994-2018 of $\lambda = 0.089\%$.

Our benchmark analysis shows that we should expect a smaller global liquidity risk premium contribution to the total risk premium because we use value-weighted market portfolios which put less weight on small and illiquid stocks rather than illiquidity-sorted portfolios and because the price of market risk is much smaller when estimated over our more recent sample period. Ideally, we should also compare what our respective methodologies entail for the liquidity level. AP use the average stock turnover to calibrate the expected premium due to liquidity level. Unfortunately, we find that turnover in emerging markets varies over time and is highly volatile early in the sample period which complicates the calibration of an average turnover level as AP use. Hence, we use our estimated κ in Equation (12) to compute the contribution of liquidity level.

Finally, we cannot obtain a benchmark for the local liquidity risk premium because such premium does not prevail in an integrated market such as the U.S. and is not priced in the AP liquidity adjusted CAPM.

6.2 Alternate securities classification

Past studies (see, for example, Carrieri et al., 2013) suggest that although investables are freely available to non-local investor they still command a local risk premium. We therefore assume as a robustness check that the whole stock market of the emerging country is non-investable. We form the diversification portfolios for the local market portfolio that includes both investables and non-investables and estimate the system of Equations (7) with the world market portfolio, the portfolio of local stocks, and its diversification portfolio. When forming the diversification portfolio, we include only developed market stocks in the investable world market portfolio.

Tables 6-7 reproduce Tables 3-4 using all local stocks as the market portfolio of non-investables. The intercepts are significant at the 10% level for 6 countries, namely Brazil, Hungary, India, Mexico, Portugal, and Thailand. The coefficients for expected liquidity, κ_{N^k}, are strictly positive in 17 cases, but statistically significant in three cases. The cross-country average price of local risk is 2.97, which is smaller than in Table 3. The prices of risk are significant at the 10% level for 19 markets. Prices are time-varying for 6 markets.

The liquidity risk premium contributions reported in Table 7 are similar to those in Table 4. The liquidity level contribution is the largest with a cross-country median of 1.60% and the world liquidity risk premium has a cross-country median of 0.23%. Unspanned local liquidity premium still plays a small role with a median of 0.05%. Overall, our results are robust to including all local stocks in the set of non-investables.

7 Conclusion

We develop a formal international asset pricing model that takes into account cross-border investment barriers as well as random transaction costs to analyze the effects of liquidity cost and systematic liquidity risk factors on the pricing of EM securities. In our model, the freely traded securities command a premium for liquidity level and global market and liquidity risk premiums whereas the securities that can be held by only a subset of investors command additional premiums for unspanned local market and liquidity risks.

We estimate the model in a conditional setup allowing for prices and quantities of risk to vary over time for 24 EMs using weekly returns. Empirical test results support theoretical predictions. Specifically, the price of world market risk is statistically and economically significant. The cross-country average price of unspanned local risk is 3.33 , however the magnitude varies across countries. The level of illiquidity costs is the biggest contributor to the total risk premium. The importance of the world liquidity risk premium greatly increases during crises periods and market corrections.

Although unspanned local risk is significantly priced for most markets and is economically sizable, unspanned local liquidity risk premium is close to zero for our sample of emerging markets. Empirically, the differences in liquidity covariances between local market indexes and diversification portfolios are small. Hence, unspanned liquidity risk is largely diversifiable. Liquidity level and world liquidity risk are the main channels through which liquidity affects asset prices in partially segmented markets.

To provide a benchmark for the economic significance of our global liquidity risk premium estimates, we examine the size of the liquidity risk premium in the largest and most integrated market, the U.S. We replicate AP's methodology to assess the impact of our choice of illiquidity measure, sample frequency and time period, on the estimated size of the liquidity risk premium for the U.S. market portfolio. We find an annualized liquidity risk premium of 0.02%, which is smaller than the average of 0.23% we estimate for the emerging markets.

In conclusion, our model provides a formal framework for testing liquidity level and risk pricing effects and dynamics in a realistic world market setting and for examining the interaction between investability and illiquidity. Our empirical results shed light on the channels through which liquidity affects asset prices in partially segmented markets and how this pricing relation changes over time.

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Figures and Tables

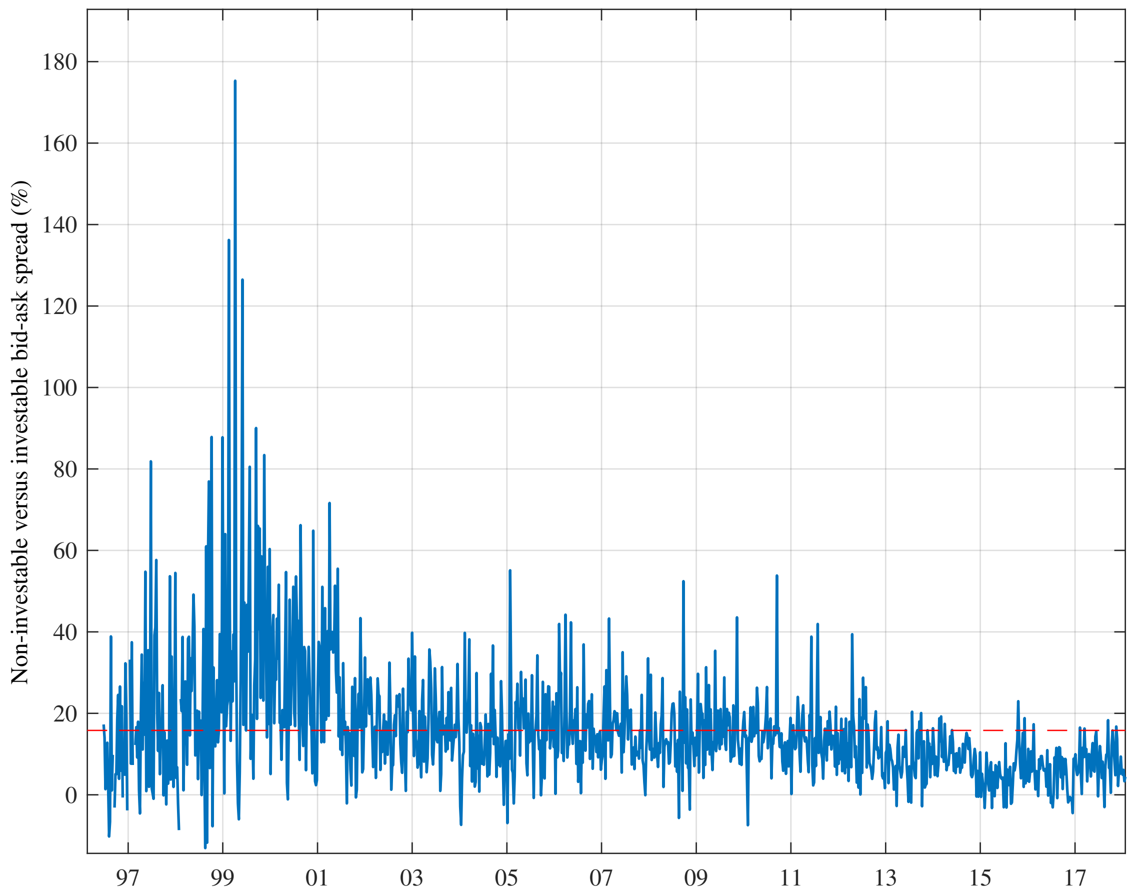


Figure 1 Percentage difference between the bid-ask spread for non-investable versus investable stocks

We report the percentage difference between the bid-ask spreads of the non-investable portfolio and of the investable portfolio. For each EM and each week, we classify a local stock as investable if (1) there exists a direct listing or a depositary receipt listed on an open market with a valid price at the end of the previous week, or (2) the proportion of the stock's market capitalization available to foreign investors, as measured by its MSCI FIF, is above 50%. Open stock exchange are the following: United States (NYSE, AMEX, NASDAQ, NYSE Arca, and OTC), United Kingdom (London Stock Exchange, SEAQ International, London OTC, and London Plus Markets), Europe (NYSE Euro next Amsterdam, Brussels, Lisbon, and Paris, Deutsche Boerse, XETRA, Luxembourg Stock Exchange, and OTC), Singapore, and Hong Kong. We then build the non-investable portfolio and the investable portfolio as value-weighted portfolios of the non-investable and investable stocks, respectively. We compute the value-weighted averages across all 24 EMs using each market total market capitalization in U.S. dollars. The red dashed line shows the time-series average of 15.81%. We use the Abdi and Ranaldo (2017) measure to estimate daily bid-ask spreads and average them over the week.

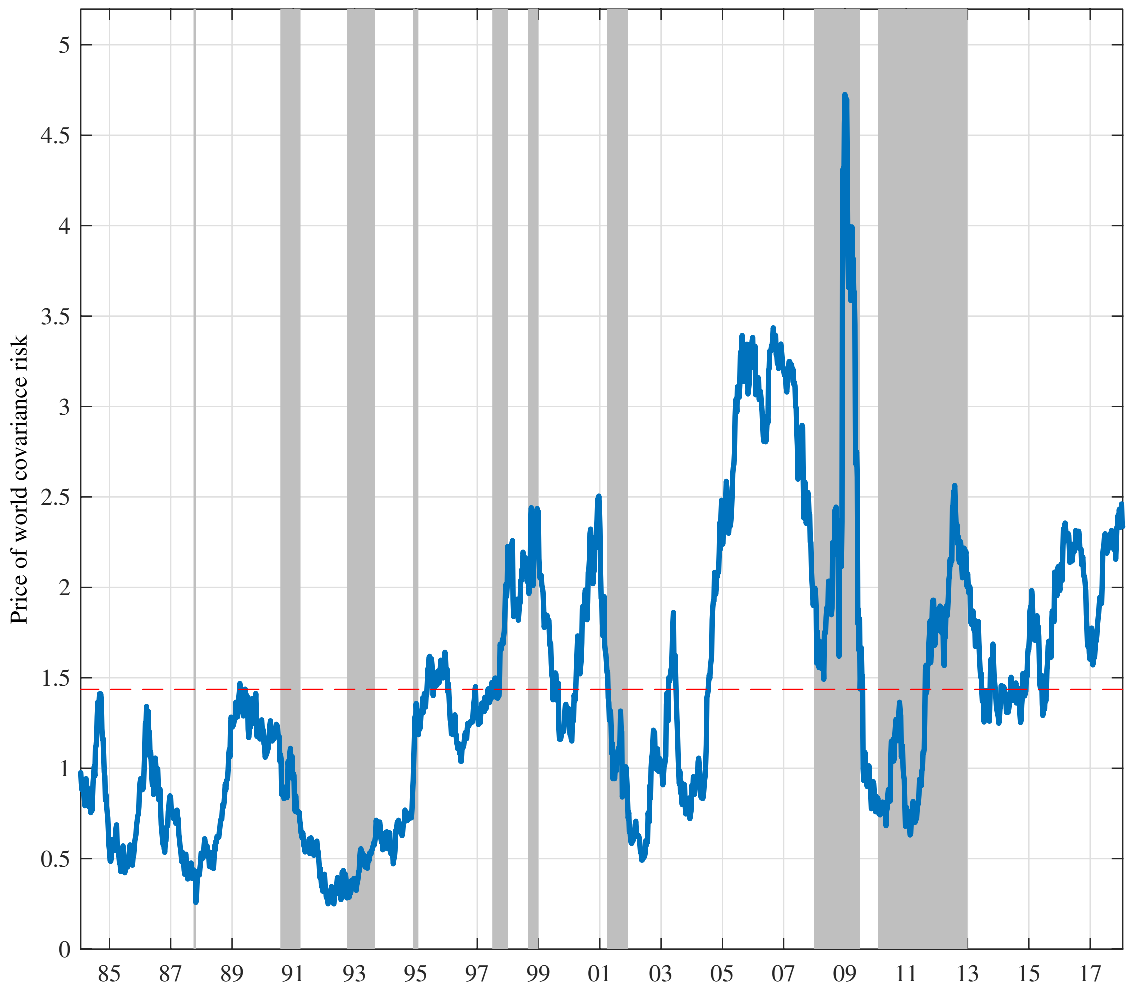
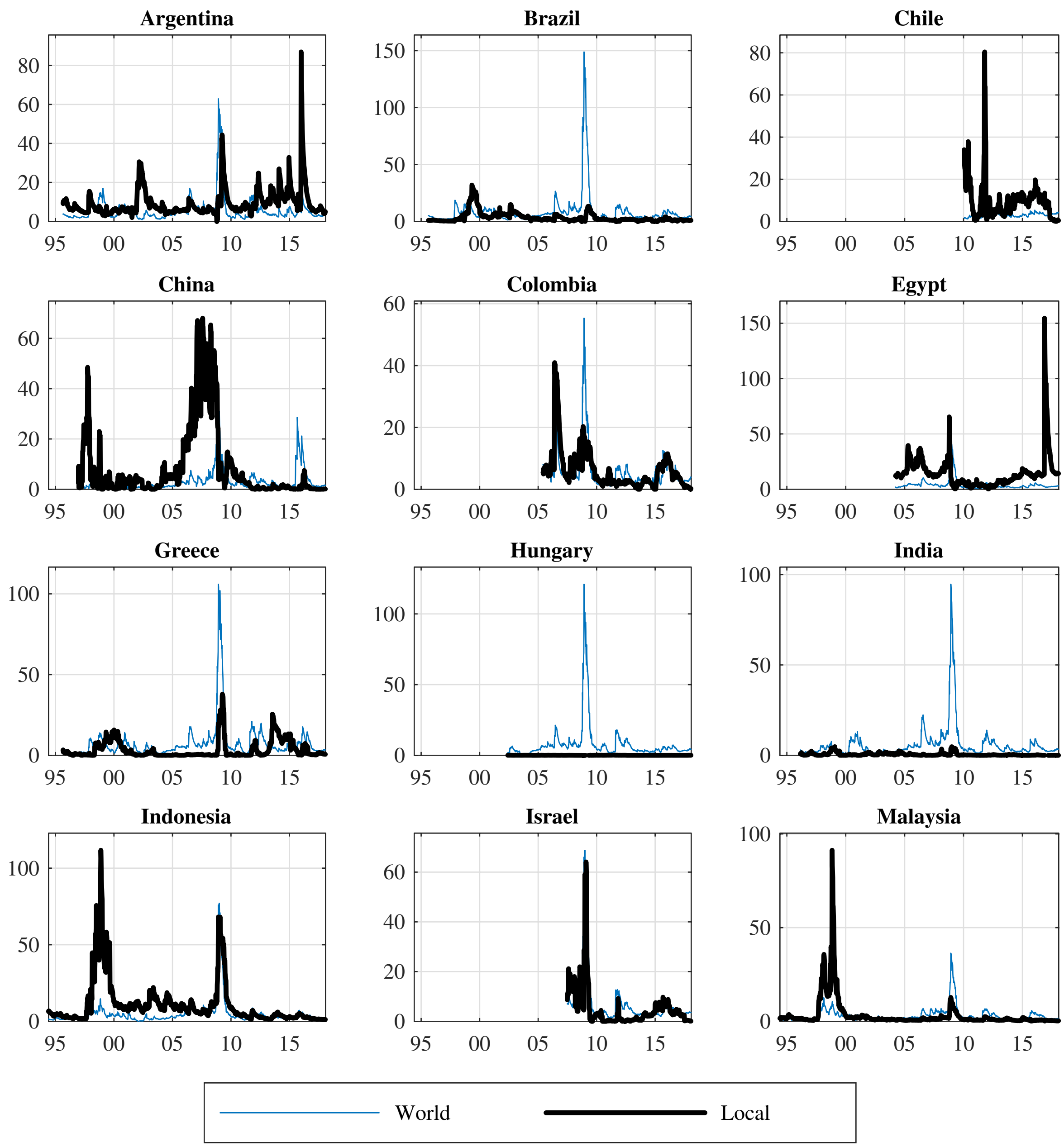


Figure 2 Price of world covariance risk - 1984-2018
We report the time-varying price of world risk, γ_t, from January 1984 to January 2018. We build a world market portfolio by value-weighting each week all available stocks in 47 countries. We estimate the system of equations (7) for the gross return and transaction costs of the world market portfolio. We specify the time-varying price of risk as a quadratic function of world instruments, $\gamma_{t+1} = (\lambda_{W,0} + \lambda_W^\top \boldsymbol{Z}_{W,t})^2$. We use as instruments the World dividend yield in excess of the U.S. T-Bill rate and the slope of the U.S. term structure of government bonds. The horizontal line reports the time-series average of the price of world risk. Gray areas indicate NBER recessions (July 1990 to March 1991, March to November 2001, and December 2007 to June 2009), the European exchange rate mechanism crisis (September 1992 to August 1993), the Tequila crisis (December 1994 to January 1995), the East Asia crisis (June to December 1997), the Russian default and Long-Term Capital Management crisis (August to December 1998), and the Euro-sovereign debt crisis (January 2010 to December 2012).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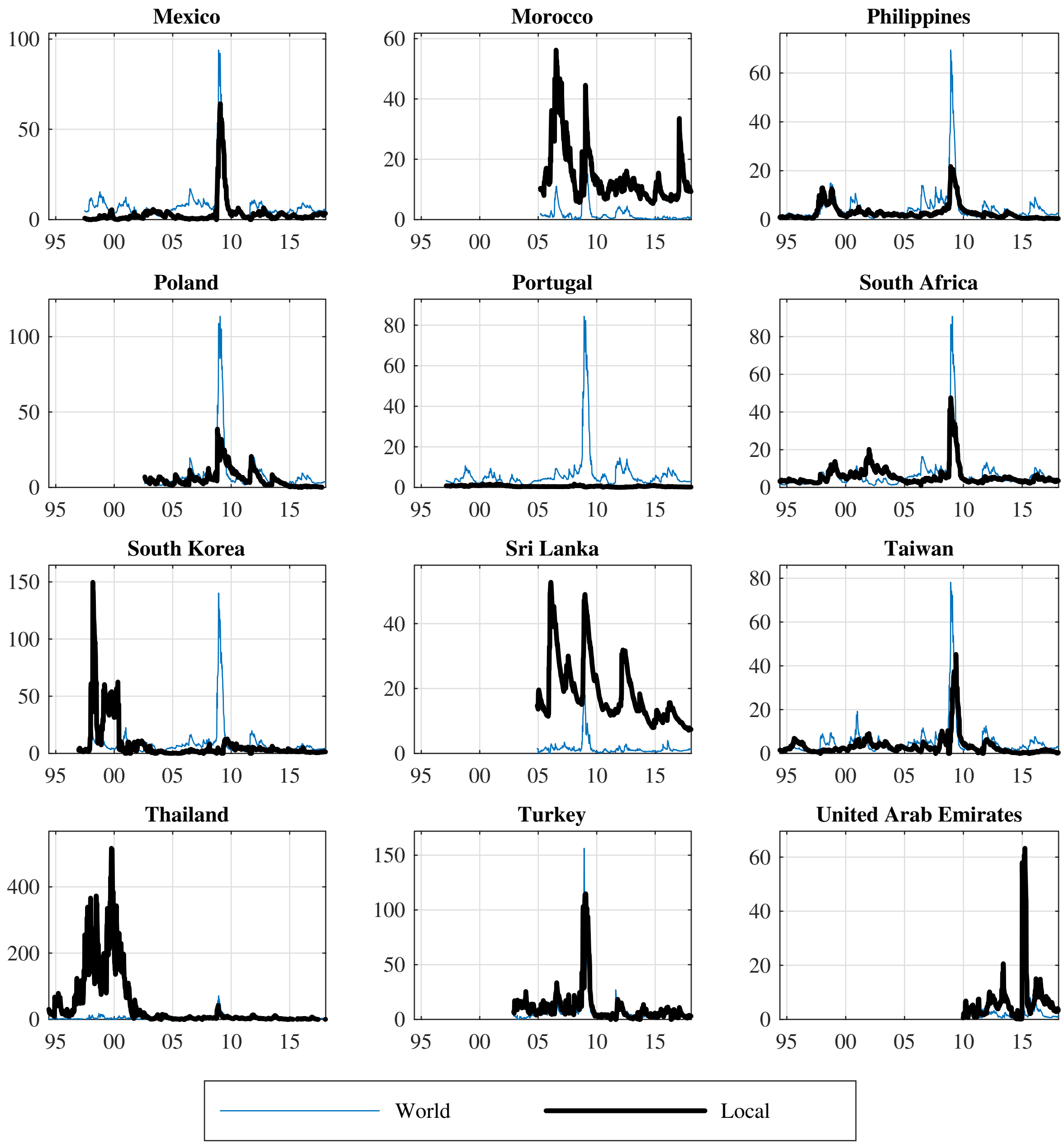

Figure 3 Premia for world and unspanned local risk
We report the annualized world risk premium, $\gamma_t cov_t\left(r^{net}_{N,t+1}, r^{net}_{W,t+1}\right)$, in percent, with thin blue lines and unspanned local risk premium, $\pi_t\left(var_t\left(r^{net}_{N,t+1}\right) - cov_t\left(r^{net}_{N,t+1}, r^{net}_{DP,t+1}\right)\right)$, using thick black lines. The risk premia are estimated from the model (7) with time-varying prices. The sample covers the period May 1994 to January 2018.

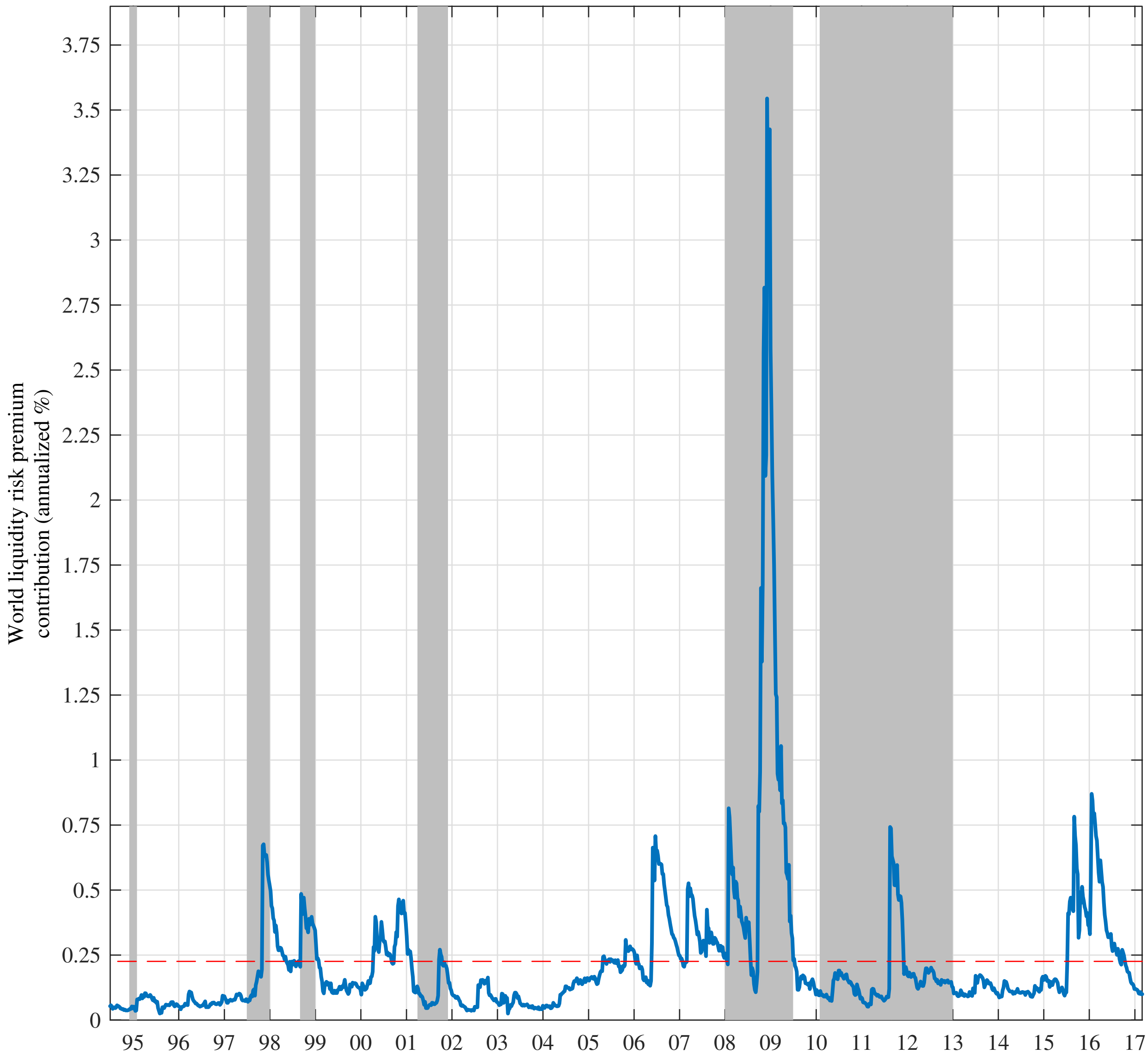

Figure 4 Value-weighted average world liquidity risk premium contribution
We report the value-weighted average world liquidity risk premium across all 24 emerging markets. For each market, we compute the world liquidity risk premium as in Equation (14). We compute the value-weighted average using each market's total market capitalization in U.S. dollars. The red dashed line reports the time-series average of 0.23%. Gray areas indicate NBER recessions (March to November 2001, and December 2007 to June 2009), the Tequila crisis (December 1994 to January 1995), the East Asia crisis (June to December 1997), the Russian default and Long-Term Capital Management crisis (August to December 1998), and the Euro-sovereign debt crisis (January 2010 to December 2012). We use the Abdi and Ranaldo (2017) measure to estimate daily bid-ask spreads and average them over the week.

Table 1 Number of securities by country

Country	Start Date	Local Stocks	Depositary Receipts	Direct Listings	Country Funds	ETFs
Argentina	August 94	175	43	66	5	8
Australia	August 96	3,252	141	437	1	12
Austria	September 00	180	6	78	1	1
Bangladesh	July 04	331	0	3	0	1
Belgium	May 96	300	12	168	0	2
Brazil	August 94	294	103	385	6	19
Canada	January 84	3,195	28	5,198	0	9
Chile	January 09	274	35	15	5	7
China	December 95	3,588	28	352	8	60
Colombia	June 04	75	11	13	4	10
Denmark	May 93	366	16	67	0	0
Egypt	March 03	261	16	4	0	2
Finland	May 93	258	25	80	0	0
France	May 93	1,784	103	193	1	8
Germany	February 94	1,252	93	204	1	11
Greece	August 94	411	10	29	0	2
Hong Kong	May 93	2,020	97	156	0	11
Hungary	May 01	102	8	39	2	7
India	February 95	4,383	127	28	4	18
Indonesia	May 93	677	11	122	2	11
Ireland	January 97	121	24	114	1	2
Israel	June 06	728	31	94	1	3
Italy	May 93	621	28	213	1	3
Japan	May 93	4,065	197	72	3	53
Malaysia	May 93	1,319	3	149	2	10
Mexico	June 96	235	79	159	7	14
Morocco	March 04	97	0	3	0	1
Netherlands	May 93	360	38	126	0	3
New Zealand	May 93	249	13	63	0	3
Norway	May 93	467	20	42	0	1
Philippines	May 93	328	5	41	1	7
Poland	August 01	1,084	7	268	2	10
Portugal	February 96	141	8	20	1	1
Singapore	May 93	916	33	46	2	4
South Africa	May 93	965	49	191	1	7
South Korea	December 95	2,909	44	278	0	7
Spain	May 93	379	34	62	2	5
Sri Lanka	December 03	344	0	29	0	0
Sweden	May 93	1,047	51	414	0	1
Switzerland	December 93	429	44	191	0	5
Taiwan	May 93	2,248	81	48	3	16
Thailand	May 93	996	702	514	2	8
Tunisia	October 03	89	0	2	0	1
Turkey	November 01	515	19	160	1	5
UAE	December 08	117	1	7	0	1
UK	August 93	4,534	290	957	6	11
USA	January 84	11,035	112	3,677	0	28

We report the start date and the number of local stocks, depositary receipts, direct listings, country funds, and exchange trade funds by country. The start date reflects the starting date of availability of high and low prices used in the Abdi and Ranaldo (2017) proxy for bid-ask spreads. We define a local stock as a common or ordinary stock traded on a major stock exchange in the same country as its issuing company is incorporated and classified as a major security by S&P Compustat. Depositary receipts include ADRs and GDRs for local stocks traded on an open stock exchange. Direct listings are common or ordinary shares of local companies cross-listed on an open stock exchange. Country funds are any mutual or investment trust traded on an open stock exchange whose long name include either the country name or one of its key region name (Latin America, Asia Pacific, Central European, BRIC, Emerging Asia, Middle East & Africa, and Eastern Europe). ETFs are Exchange Traded Funds traded on an open stock exchange whose long name include either the country name or one of its key region name. Open stock exchange are the following: United States (NYSE, AMEX, NASDAQ, NYSE Arca, and OTC), United Kingdom (London Stock Exchange, SEAQ International, London OTC, and London Plus Markets), Europe (NYSE Euro next Amsterdam, Brussels, Lisbon, and Paris, Deutsche Boerse, XETRA, Luxembourg Stock Exchange, and OTC), Singapore, and Hong Kong.

Table 2 Summary statistics for emerging market portfolios

			Return		*Bid-ask spread*		
Country	Portfolio	Nb of stocks January 2018	average (%)	volatility (%)	average (%)	volatility (%)	Relative spread between non-investables and investables
Argentina	All	72	11.88	32.49	1.06	0.50	
	Non-investable	57	12.66	33.76	1.14	0.47	13.23%
	Investable	15	12.59	34.60	1.01	0.58	
Brazil	All	174	10.59	34.92	1.16	0.49	
	Non-investable	39	13.13	36.11	1.27	0.55	16.85%
	Investable	135	16.85	39.11	1.09	0.65	
Chile	All	78	13.42	19.24	0.64	0.18	
	Non-investable	69	14.30	19.47	0.66	0.18	10.87%
	Investable	9	12.16	20.06	0.59	0.23	
China	All	3,184	11.98	29.59	0.97	0.42	
	Non-investable	1,359	11.58	31.19	0.99	0.43	3.28%
	Investable	1,825	14.19	32.91	0.96	0.48	
Colombia	All	20	18.70	26.51	0.75	0.38	
	Non-investable	18	19.94	24.92	0.79	0.35	14.28%
	Investable	2	18.32	33.12	0.69	0.57	
Egypt	All	181	15.55	27.67	0.81	0.31	
	Non-investable	179	14.53	27.28	0.86	0.35	31.69%
	Investable	2	19.74	33.49	0.65	0.41	
Greece	All	134	2.41	34.65	1.15	0.55	
	Non-investable	132	4.00	33.08	1.15	0.51	-10.90%
	Investable	2	-19.92	67.55	1.29	1.29	
Hungary	All	31	14.78	31.35	0.88	0.40	
	Non-investable	27	11.02	24.00	1.02	0.44	23.97%
	Investable	4	15.47	35.01	0.83	0.45	
India	All	2,772	10.23	28.18	1.00	0.36	
	Non-investable	970	10.53	28.08	0.98	0.36	-3.12%
	Investable	1,802	8.94	28.62	1.02	0.38	
Indonesia	All	459	11.51	37.40	1.45	0.75	
	Non-investable	222	12.14	39.06	1.56	0.89	46.02%
	Investable	237	11.49	39.01	1.07	0.65	
Israel	All	386	7.24	18.97	0.81	0.37	
	Non-investable	195	11.19	24.05	0.88	0.47	23.44%
	Investable	191	3.77	17.84	0.71	0.34	
Malaysia	All	839	6.15	27.17	0.96	0.44	
	Non-investable	243	6.23	27.73	0.92	0.45	-12.02%
	Investable	596	5.27	26.64	1.04	0.44	
Mexico	All	79	11.15	27.05	0.86	0.37	
	Non-investable	58	11.91	27.93	0.89	0.39	9.06%
	Investable	21	8.05	27.82	0.81	0.40	
Morocco	All	42	11.18	17.11	0.88	0.29	
	Non-investable	41	11.85	18.10	1.03	0.33	109.86%
	Investable	1	8.71	19.69	0.49	0.37	

Country	Portfolio	Nb of stocks January 2018	*Return* average (%)	*Return* volatility (%)	*Bid-ask spread* average (%)	*Bid-ask spread* volatility (%)	*Bid-ask spread* Relative spread between non-investables and investables
Continued...							
Philippines	All	235	8.29	27.13	1.14	0.33	
	Non-investable	230	8.13	27.25	1.19	0.34	32.92%
	Investable	5	9.15	32.28	0.89	0.48	
Poland	All	609	13.61	28.19	1.01	0.28	
	Non-investable	207	15.52	28.11	1.01	0.29	1.05%
	Investable	402	7.95	32.25	1.00	0.41	
Portugal	All	35	5.36	22.52	0.73	0.27	
	Non-investable	33	6.55	22.65	0.77	0.28	21.33%
	Investable	2	4.37	27.33	0.63	0.41	
South Africa	All	224	8.67	26.34	0.93	0.31	
	Non-investable	62	9.21	27.32	0.90	0.31	-6.11%
	Investable	162	9.21	27.57	0.96	0.35	
South Korea	All	1,994	8.16	35.37	1.19	0.50	
	Non-investable	634	7.63	38.58	1.28	0.53	11.80%
	Investable	1,360	9.85	34.71	1.15	0.51	
Sri Lanka	All	199	10.55	20.71	1.08	0.29	
	Non-investable	199	10.55	20.71	1.08	0.29	
	Investable						
Taiwan	All	1,770	4.59	24.81	0.96	0.34	
	Non-investable	789	3.66	24.44	0.95	0.35	-0.52%
	Investable	981	10.28	29.68	0.95	0.41	
Thailand	All	670	7.68	30.16	1.11	0.51	
	Non-investable	53	6.92	30.09	1.21	0.49	5.33%
	Investable	617	6.23	28.68	1.14	0.54	
Turkey	All	389	16.49	36.16	1.00	0.44	
	Non-investable	308	16.85	36.35	1.00	0.43	2.96%
	Investable	81	17.49	40.89	0.97	0.70	
UAE	All	57	14.60	23.35	0.89	0.36	
	Non-investable	57	14.60	23.36	0.89	0.36	
	Investable						

We report summary statistics for weekly data for three portfolios in each emerging market; one that includes all available local stocks, one that includes all available non-investable local stocks, and one that contains all available investable local stocks. For each portfolio, we report the number of stocks at the end of our sample period, the annualized average and volatility of returns, the average and volatility of bid-ask spreads, and the percentage difference in average bid-ask spread between non-investable and investable portfolios relative to the average bid-ask spread of the investable portfolio. Each week, we classify a local stock as investable if (1) there exists a direct listing or a depositary receipt listed on an open market with a valid price at the end of the previous week, or (2) the proportion of the stock's market capitalization available to foreign investors, as measured by its MSCI FIF, is above 50%. Start dates, reported in Table 1, differ across countries. All data ends on January 24^{th}, 2018. Open stock exchange are the following: United States (NYSE, AMEX, NASDAQ, NYSE Arca, and OTC), United Kingdom (London Stock Exchange, SEAQ International, London OTC, and London Plus Markets), Europe (NYSE Euro next Amsterdam, Brussels, Lisbon, and Paris, Deutsche Boerse, XETRA, Luxembourg Stock Exchange, and OTC), Singapore, and Hong Kong. We use the Abdi and Ranaldo (2017) measure to estimate daily bid-ask spreads and average them over the week.

Table 3 Model estimates - Non-investable market portfolio

Panel A: World market

Country	Start date	Intercept α_W (i)	Liquidity level κ_W (ii)	Average price γ_t (iii)	Test for $\gamma_t > 0$ (iv)	Test for time-varying γ_t (v)
World	January 84	0.22	0.02	1.44	11.18	0.97
		(1.75)	(0.03)		(0.01)	(0.62)

Panel B: Emerging markets

Country	Start date	Intercept α_{N^k}	Liquidity level κ_{N^k}	Average price π_t	Test for $\pi_t > 0$	Test for time-varying π_t
Argentina	August 95	-0.42	0.10	7.43	18.33	0.35
		(1.05)	(0.23)		(0.00)	(0.56)
Brazil	August 95	0.51	0.00	0.86	1.10	0.05
		(1.99)	(0.00)		(0.58)	(0.82)
Chile	January 10	-0.42	0.90	6.90	19.05	6.23
		(0.95)	(2.62)		(0.00)	(0.01)
China	December 96	-0.44	0.60	1.14	31.08	14.63
		(1.61)	(3.18)		(0.00)	(0.00)
Colombia	June 05	0.13	0.04	5.50	28.08	0.86
		(0.56)	(0.06)		(0.00)	(0.35)
Egypt	March 04	0.00	0.00	6.39	29.96	1.96
		(0.01)	(0.00)		(0.00)	(0.16)
Greece	August 95	0.19	0.10	1.16	3.11	0.17
		(0.99)	(0.32)		(0.21)	(0.68)
Hungary	May 02	-0.29	0.18	10.46	16.04	0.58
		(0.75)	(0.68)		(0.00)	(0.45)
India	February 96	0.17	0.34	2.18	5.35	0.50
		(0.84)	(1.66)		(0.07)	(0.48)
Indonesia	May 94	0.27	0.00	1.29	16.89	3.06
		(1.50)	(0.00)		(0.00)	(0.08)
Israel	June 07	0.22	0.09	0.73	13.84	3.02
		(1.17)	(0.25)		(0.00)	(0.08)
Malaysia	May 94	0.16	0.00	1.01	2.28	0.00
		(1.26)	(0.00)		(0.32)	(0.96)
Mexico	June 97	0.33	0.01	1.68	32.74	14.01
		(1.79)	(0.01)		(0.00)	(0.00)
Morocco	March 05	-0.14	0.07	5.79	13.62	0.12
		(0.45)	(0.13)		(0.00)	(0.73)
Philippines	May 94	0.04	0.14	2.46	23.90	2.84
		(0.14)	(0.32)		(0.00)	(0.09)
Poland	August 02	0.34	0.02	2.44	6.28	0.22
		(1.14)	(0.01)		(0.04)	(0.64)
Portugal	February 97	0.34	0.01	0.11	0.01	0.00
		(1.90)	(0.00)		(0.99)	(0.97)
South Africa	May 94	0.25	0.00	1.69	7.27	0.44
		(1.10)	(0.00)		(0.03)	(0.51)
South Korea	December 96	0.21	0.16	0.05	0.01	0.00
		(0.74)	(0.45)		(1.00)	(0.98)
Sri Lanka	December 04	-0.16	0.06	5.47	20.87	1.69
		(0.44)	(0.07)		(0.00)	(0.19)
Taiwan	May 94	0.04	0.10	1.76	11.62	2.60
		(0.26)	(0.35)		(0.00)	(0.11)
Thailand	May 94	0.29	0.00	0.35	2.68	0.34
		(1.44)	(0.00)		(0.26)	(0.56)
Turkey	November 02	0.11	0.31	6.66	53.20	0.00
		(0.40)	(1.08)		(0.00)	(0.99)
United Arab Emirates	December 09	-0.51	0.70	6.29	40.96	2.18
		(1.91)	(3.57)		(0.00)	(0.14)

We report estimation results for the asset pricing model for the world market portfolio in Panel A and for 24 emerging markets in Panel B. For each country, we report the estimation start date, the intercept in % per week in column (i), the expected liquidity coefficient - κ in column (ii), the time-series average of prices of risk in column (iii), the test statistics for a positive price of risk in column (iv), and the test statistics for a time-varying price of risk in column (v). t-ratios are in parentheses below the estimates of α and κ and p-values are in parentheses below the test statistics. Panel B presents model estimates for each market for the system of equations (7) used with the world market portfolio, the portfolio of non-investable stocks, and its diversification portfolio. Panel A reports on a restricted version used only for the world market portfolio. All time series end on January 24^{th}, 2018.

Table 4 Liquidity level and risk premium contributions to expected returns - Non-investable market portfolio

			World risk premium				*Local risk premium*			
Country	Premium for liquidity level $\kappa_{N^k} E[c]$ (i)	Jensen's term (ii)	r_N with c_W (iii)	c_N with r_W (iv)	c_N with c_W (v)	Total world liquidity risk premium (vi)	r_N with c_{N-DP} (vii)	c_N with r_{N-DP} (viii)	c_N with c_{N-DP} (ix)	Total local liquidity risk premium (x)
Argentina	6.01	-0.32	0.13	0.16	0.01	0.30	0.87	0.83	0.48	2.19
Brazil	0.01	-0.22	0.14	0.09	0.02	0.25	-0.09	0.07	0.03	0.02
Chile	29.89	-0.03	0.07	0.04	0.00	0.11	0.10	0.01	0.05	0.15
China	30.14	-0.13	0.11	0.06	0.01	0.17	-0.08	0.11	0.05	0.08
Colombia	1.72	-0.22	0.15	0.18	0.02	0.34	0.53	0.23	0.18	0.93
Egypt	0.14	-0.19	0.18	0.13	0.02	0.32	0.43	0.49	0.16	1.09
Greece	5.87	-0.17	0.12	0.11	0.01	0.25	0.09	0.05	0.06	0.20
Hungary	9.57	-0.18	0.08	0.18	0.01	0.26	0.74	0.18	0.51	1.43
India	17.10	-0.11	0.17	0.08	0.01	0.26	-0.11	0.04	0.07	0.01
Indonesia	0.01	-0.33	0.20	0.09	0.01	0.30	0.06	0.22	0.06	0.35
Israel	4.12	-0.11	0.18	0.13	0.02	0.33	0.02	-0.00	0.05	0.07
Malaysia	0.02	-0.06	0.11	0.06	0.01	0.18	-0.09	-0.02	0.03	-0.08
Mexico	0.50	-0.18	0.13	0.18	0.02	0.33	-0.05	-0.11	0.07	-0.09
Morocco	3.62	-0.06	0.09	0.01	0.00	0.10	0.18	0.17	0.15	0.50
Philippines	8.35	-0.09	0.16	0.06	0.01	0.22	-0.10	0.09	0.08	0.07
Poland	0.81	-0.09	0.11	0.09	0.01	0.21	-0.12	0.02	0.03	-0.06
Portugal	0.20	-0.07	0.12	0.06	0.01	0.19	-0.00	0.00	0.00	0.00
South Africa	0.12	-0.11	0.13	0.09	0.01	0.23	-0.14	0.04	0.03	-0.06
South Korea	10.41	-0.18	0.24	0.08	0.02	0.33	-0.01	0.00	0.00	-0.00
Sri Lanka	3.21	-0.08	0.06	-0.00	0.00	0.06	0.37	0.36	0.13	0.86
Taiwan	4.97	-0.05	0.14	0.02	0.01	0.17	-0.45	0.02	0.02	-0.40
Thailand	0.02	-0.02	0.13	-0.00	0.01	0.14	-0.02	0.01	0.02	0.01
Turkey	15.02	-0.23	0.19	0.06	0.01	0.26	-0.51	0.47	0.27	0.23
UAE	30.36	-0.07	0.06	0.03	0.00	0.10	0.29	0.24	0.16	0.70
Median	3.87	-0.11	0.13	0.08	0.01	0.24	-0.01	0.06	0.06	0.07

We report for each EM the time-series averages of each liquidity level and risk premia contribution in percentage annualized. Column (i) reports the premium coming from the liquidity level in Equation (12). Column (ii) shows the contribution from the Jensen inequality term in Equation (13). Columns (iii-v) report each of the three world covariance contribution in Equation (14) and column (vi) shows the total world liquidity risk premium. Columns (vii-x) report on the three unspanned local liquidity risk premium contributions in Equation (15) and their sum. The last line reports the median across all EMs. We obtain conditional covariances from the estimation of the system of equations (7)

Table 5 Summary statistics for U.S: illiquidity-sorted portfolios

Portfolio	*Return* Average (%) (i)	Volatility (%) (ii)	*Bid-ask spread* Average (%) (iii)	Volatility (%) (iv)	$100 \times \beta$ r_j with r_m (v)	r_j with c_m (vi)	c_j with r_m (vii)	c_j with c_m (viii)	Total liquidity (ix)
Panel A: Results from Acharya and Pedersen (2005) - Monthly returns and rescaled price impact measure - 1964-1999									
1	5.76	4.95	0.25	0.00	55.10	-0.80	-0.00	0.00	0.80
5	7.20	6.03	0.27	0.01	74.67	-1.24	-0.07	0.00	1.31
9	8.52	6.44	0.32	0.02	81.93	-1.37	-0.18	0.01	1.56
15	10.20	7.07	0.53	0.08	88.99	-1.61	-0.70	0.02	2.33
21	13.56	7.90	1.61	0.34	92.73	-1.69	-2.10	0.09	3.88
25	13.20	9.94	8.83	1.46	84.54	-1.69	-4.52	0.42	6.63
25-1 portfolio spread liquidity risk premia (%)						0.16	0.82	0.08	1.06
Panel B: United States of America - Monthly returns and AR bid-ask spread - 1994-2018									
1	9.18	9.91	0.46	0.16	27.40	-0.46	-0.92	0.07	1.44
5	8.57	14.96	0.69	0.27	57.75	-1.05	-1.15	0.10	2.30
9	10.80	18.88	0.88	0.34	78.80	-1.27	-1.35	0.12	2.74
15	11.17	28.60	1.27	0.50	124.48	-1.55	-1.89	0.14	3.58
21	12.50	39.81	1.96	0.73	175.12	-2.39	-1.71	0.19	4.29
25	11.63	35.25	4.74	1.54	123.35	-2.11	-3.52	0.26	5.89
25-1 portfolio spread liquidity risk premia (%) - $\lambda = 1.512\%$						0.30	0.47	0.03	0.81
Market portfolio liquidity risk premia (%) - $\lambda = 1.512\%$						0.29	0.29	0.05	0.63
25-1 portfolio spread liquidity risk premia (%) - $\lambda = 0.114\%$						0.02	0.04	0.00	0.06
Market portfolio liquidity risk premia (%) - $\lambda = 0.114\%$						0.02	0.02	0.00	0.05
Panel C: United States of America - Weekly returns and AR bid-ask spread - 1994-2018									
1	9.67	12.10	0.51	0.23	45.65	-1.38	-1.83	0.38	3.58
5	12.47	15.30	0.69	0.34	64.61	-1.79	-2.65	0.58	5.02
9	10.27	18.81	0.81	0.40	81.58	-1.99	-2.91	0.68	5.58
15	7.38	25.78	1.15	0.55	116.26	-2.68	-2.77	0.77	6.23
21	11.99	35.20	1.79	0.83	152.34	-3.57	-3.34	1.03	7.94
25	12.14	36.27	4.38	1.59	121.48	-3.07	-5.11	1.21	9.39
25-1 portfolio spread liquidity risk premia (%) - $\lambda = 1.512/4\%$						0.31	0.60	0.15	1.05
Market portfolio liquidity risk premia (%) - $\lambda = 1.512/4\%$						0.49	0.49	0.22	1.20
25-1 portfolio spread liquidity risk premia (%) - $\lambda = 0.005\%$						0.00	0.01	0.00	0.02
Market portfolio liquidity risk premia (%) - $\lambda = 0.005\%$						0.01	0.01	0.00	0.02

This table reports the summary statistics for the $P_1, P_5, P_9, P_{15}, P_{21}, P_{25}$ portfolios of 25 value-weighted illiquidity-sorted portfolios of U.S. stocks from May 1994 to January 2018. We report in Panel A the corresponding values from 1964 to 1999 from Table 1 in AP for comparison. We directly report the values in their Table 1, though we annualized the averages and volatilities of returns. We report in Panel B summary statistics of monthly returns using the Abdi and Ranaldo (2017) measure as proxy for the bid-ask spread. We report in Panel C summary statistics for weekly returns. Each month (week), we sort all available stocks using their average bid-ask spread over the past four months (weeks). We report in columns (i-iv) the annualized average return and volatility, the average of the bid-ask spreads and their volatility. We report the beta between portfolio returns and market returns (column v), between portfolio returns and market unexpected bid-ask spread shocks (column vi), between portfolio unexpected bid-ask spread shocks and market returns (column vii), and between portfolio and market unexpected bid-ask spread shocks (column viii). Column (ix) shows the sum of the liquidity betas i.e. column (viii) minus the sum of columns (vi-vii). The unexpected bid-ask spread shocks are the residuals from an AR(2) model for monthly returns and AR(6) model for weekly returns. We use the equal-weighted portfolio with all available stocks as the market portfolio. We express each covariance in its β form by dividing each covariance by the variance of net market returns and multiply by a factor of 100 such that figures are comparable to those in Acharya and Pedersen (2005). The volatilities of returns in Panel B and C are not directly comparable to those in Panel A; AP report the average of daily stock return volatilities whereas we report the volatility of portfolio returns.

Table 6 Model estimates - All local stocks are non-investable

Country	Start date	Intercept α_{N^k} (i)	Liquidity level κ_{N^k} (ii)	Average price π_t (iii)	Test for $\pi_t > 0$ (iv)	Test for time-varying π_t (v)
Argentina	August 95	0.24	0.01	2.79	6.33	0.01
		(1.05)	(0.02)		(0.04)	(0.94)
Brazil	August 95	0.48	0.00	1.10	6.02	0.33
		(2.31)	(0.00)		(0.05)	(0.57)
Chile	January 10	-0.45	0.88	13.95	22.32	1.94
		(1.06)	(2.96)		(0.00)	(0.16)
China	December 96	-0.04	0.17	1.18	36.36	8.99
		(0.19)	(0.54)		(0.00)	(0.00)
Colombia	June 05	0.17	0.27	2.97	6.97	0.00
		(0.77)	(0.87)		(0.03)	(0.97)
Egypt	March 04	0.12	0.12	4.12	24.07	0.93
		(0.31)	(0.21)		(0.00)	(0.33)
Greece	August 95	0.29	0.10	0.43	4.76	4.52
		(1.50)	(0.35)		(0.09)	(0.03)
Hungary	May 02	0.50	0.06	0.01	0.00	0.00
		(1.81)	(0.10)		(1.00)	(0.99)
India	February 96	0.50	0.00	0.24	0.30	0.12
		(2.74)	(0.00)		(0.86)	(0.73)
Indonesia	May 94	0.24	0.02	1.99	25.19	4.03
		(1.23)	(0.03)		(0.00)	(0.04)
Israel	June 07	0.16	0.00	4.81	17.56	16.61
		(0.81)	(0.00)		(0.00)	(0.00)
Malaysia	May 94	0.15	0.09	1.06	3.31	0.25
		(1.07)	(0.32)		(0.19)	(0.62)
Mexico	June 97	0.32	0.00	2.77	20.66	1.82
		(1.81)	(0.00)		(0.00)	(0.18)
Morocco	March 05	-0.08	0.01	7.86	35.32	0.32
		(0.33)	(0.01)		(0.00)	(0.57)
Philippines	May 94	0.26	0.00	0.68	3.48	0.45
		(0.97)	(0.00)		(0.18)	(0.50)
Poland	August 02	0.32	0.00	2.31	5.17	0.25
		(1.11)	(0.00)		(0.08)	(0.62)
Portugal	February 97	0.30	0.00	0.36	0.09	0.01
		(1.75)	(0.00)		(0.96)	(0.92)
South Africa	May 94	0.21	0.02	2.70	8.06	0.74
		(1.00)	(0.02)		(0.02)	(0.39)
South Korea	December 96	0.25	0.04	1.62	21.40	5.97
		(1.06)	(0.09)		(0.00)	(0.01)
Sri Lanka	December 04	-0.22	0.20	3.65	11.98	0.05
		(0.64)	(0.47)		(0.00)	(0.82)
Taiwan	May 94	0.17	0.03	1.84	10.43	2.43
		(1.12)	(0.07)		(0.01)	(0.12)
Thailand	May 94	-1.49	0.88	7.12	3,153.84	34.15
		(7.35)	(7.64)		(0.00)	(0.00)
Turkey	November 02	0.00	0.63	2.91	41.63	1.93
		(0.01)	(3.32)		(0.00)	(0.16)
United Arab Emirates	December 09	0.10	0.03	2.81	12.85	0.94
		(0.34)	(0.04)		(0.00)	(0.33)

We report estimation results for the asset pricing model for 24 emerging markets. We assume that all local stocks are non-investable. For each country, we report the estimation start date, the intercept in % per week in column (i), the expected liquidity coefficient - κ in column (ii), the time-series average of prices of risk in column (iii), the test statistics for a positive price of risk in column (iv), and the test statistics for a time-varying price of risk in column (v). t-ratios are in parentheses below the estimates of α and κ and p-values are in parentheses below the test statistics. The table presents model estimates for each market for the system of equations (7) used with the world market portfolio, the portfolio of local market stocks, and its diversification portfolio. All time series end on January 24^{th}, 2018.

Table 7 Liquidity level and risk premium contributions to expected returns - All local stocks are non-investable

			World risk premium				*Local risk premium*			
Country	Premium for liquidity level $\kappa_{N^k} E[c]$ (i)	Jensen's term (ii)	r_N with c_W (iii)	c_N with r_W (iv)	c_N with c_W (v)	Total world liquidity risk premium (vi)	r_N with c_{N-DP} (vii)	c_N with r_{N-DP} (viii)	c_N with c_{N-DP} (ix)	Total local liquidity risk premium (x)
Argentina	0.73	-0.23	0.15	0.16	0.01	0.32	0.23	0.05	0.16	0.45
Brazil	0.28	-0.22	0.17	0.12	0.02	0.30	-0.06	0.08	0.03	0.05
Chile	28.31	-0.04	0.08	0.04	0.00	0.13	-0.05	0.04	0.06	0.05
China	8.27	-0.12	0.11	0.05	0.01	0.17	0.03	0.11	0.05	0.19
Colombia	10.12	-0.19	0.16	0.21	0.01	0.39	0.17	0.10	0.10	0.37
Egypt	4.89	-0.15	0.18	0.11	0.01	0.31	0.13	0.19	0.08	0.40
Greece	6.04	-0.17	0.12	0.10	0.01	0.24	0.03	0.02	0.03	0.08
Hungary	2.85	-0.12	0.08	0.12	0.02	0.22	-0.00	0.00	0.00	0.00
India	0.19	-0.11	0.18	0.07	0.01	0.26	-0.01	0.00	0.01	-0.00
Indonesia	1.52	-0.30	0.19	0.11	0.01	0.30	0.15	0.30	0.08	0.53
Israel	0.00	-0.09	0.16	0.13	0.02	0.31	-0.14	0.06	0.13	0.05
Malaysia	4.57	-0.05	0.11	0.06	0.01	0.18	-0.11	-0.04	0.03	-0.12
Mexico	0.05	-0.16	0.12	0.16	0.02	0.30	0.01	-0.07	0.03	-0.03
Morocco	0.60	-0.04	0.06	0.01	0.00	0.08	0.01	0.08	0.16	0.25
Philippines	0.01	-0.10	0.16	0.06	0.01	0.22	-0.02	0.03	0.02	0.03
Poland	0.02	-0.09	0.11	0.09	0.01	0.21	-0.11	0.03	0.03	-0.05
Portugal	0.19	-0.07	0.11	0.07	0.01	0.20	0.00	0.00	0.00	0.01
South Africa	0.88	-0.10	0.13	0.09	0.01	0.23	-0.12	0.07	0.04	-0.01
South Korea	2.76	-0.14	0.22	0.09	0.02	0.33	-0.33	0.05	0.11	-0.18
Sri Lanka	11.02	-0.05	0.06	-0.02	0.00	0.05	0.12	0.13	0.09	0.34
Taiwan	1.69	-0.06	0.15	0.01	0.01	0.16	-0.46	0.05	0.03	-0.38
Thailand	50.59	-0.06	0.18	-0.01	0.01	0.18	-0.56	-0.04	0.22	-0.39
Turkey	30.78	-0.22	0.17	0.07	0.01	0.26	-0.32	0.28	0.12	0.07
UAE	1.41	-0.08	0.06	0.03	0.00	0.10	0.16	0.15	0.07	0.38
Median	1.60	-0.10	0.14	0.08	0.01	0.23	-0.01	0.05	0.06	0.05

We report for each EM the time-series averages of each liquidity level and risk premia contribution in percentage annualized. Column (i) reports the premium coming from the liquidity level in Equation (12). Column (ii) shows the contribution from the Jensen's inequality term in Equation (13). Columns (iii-v) report each of the three world covariance contribution in Equation (14) and column (vi) shows the total world liquidity risk premium. Columns (vii-x) report on the three unspanned local liquidity risk premium contributions in Equation (15) and their sum. The last line reports the median across all EMs. We obtain conditional covariances from the estimation of the system of equations (7) assuming all local stocks are non-investable.

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