Treasury Bond Illiquidity and Global Equity Returns

Ruslan Goyenko and Sergei Sarkissian *

Abstract

In this study, using data from 46 markets and a 34-year time period, we examine the impact of the illiquidity of U.S. Treasuries on global asset valuation. We find that it predicts equity returns in both developed and emerging markets. This predictive relation remains intact after controlling for various world and country-level variables. Asset pricing tests further reveal that bond illiquidity is a priced factor even in the presence of other conventional risks. Since the illiquidity of Treasuries is known to reflect monetary and macroeconomic shocks, our results suggest that it can be considered as a proxy for aggregate worldwide risks.

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* The authors are from the Faculty of Management, McGill University, Montreal, QC H3A1G5, Canada. Goyenko may be reached at ruslan.goyenko@mcgill.ca or (514) 398-5692; Sarkissian may be reached at sergei.sarkissian@mcgill.ca or (514) 398-4976. We thank Yakov Amihud, Gurdip Bakshi, Hank Bessembinder (Editor), Kristin Forbes, Evan Gatev, David Goldreich, Denis Gromb, Andrew Karolyi, Michael Schill, Pedro Santa-Clara, Rudi Schadt, Akiko Watanabe, Guofu Zhou, and especially the anonymous referee for useful comments. The paper has also benefited from the feedback of participants at the Seventh Darden International Finance Conference, the 2008 European Finance Association Meeting, the 2008 World Bank Conference on Risk Analysis and Management, the 2009 Bank of Canada Conference on Financial Market Stability, the 2009 Northern Finance Association Meeting, the 2009 Conference of the Society of Quantitative Analysts, as well as workshops at the ISCTE Business School, Durham University, and Luxembourg School of Finance. We are thankful to Hugues Langlois-Bertrand for help with compiling stock illiquidity data. This paper was circulated earlier under "Flight to Liquidity and Global Equity Returns." Goyenko acknowledges financial support from SSHRC. Sarkissian acknowledges financial support from IFM2 and SSHRC.

I. Introduction

There is a well-documented relation between monetary policy on one side and stock and bond markets on the other. Fama and French (1989) find that dividend yield, default and term spreads are significant predictors of U.S. stock and bond returns. There is also substantial evidence on the impact of U.S. Treasury rates on expected returns in the U.S. and global equity markets.[1] Jensen, Mercer, and Johnson (1996) show that the main driving force behind the predictive power of these variables is the change in the monetary policy environment proxied by the Fed funds rate. Furthermore, such studies as Patelis (1997), Thorbecke (1997), Rigobon and Sack (2004), and Bernanke and Kuttner (2005) suggest not only predictive but also contemporaneous effect of U.S. monetary policy on stock returns.[2] They explain this finding by the persistent impact of U.S. monetary policy shifts on firm cash flows that lasts over several periods. Yet, Goyal and Welch (2008) cast doubts on the ability of interest rate and its various derivatives (e.g., term spread, default spread, etc.) to predict stock returns. In addition, a link between U.S. macroeconomic variables and foreign equity prices is not well established.[3]

In this paper, instead of analyzing the relation between Treasury rates or related U.S. interest-rate-based variables and stock markets around the world, we examine the relation between the *illiquidity* of Treasury bonds and international equity returns using market-level data from 46 countries over the 34 year period from 1977 to 2010. This wide cross-sectional and time-series sample provides an ideal ground for analyzing the connection between changes in the illiquidity of Treasuries and expected equity returns. If there is an illiquidity premium in asset returns associated with U.S. Treasuries, focusing on equities of both developed and emerging markets should result in particularly powerful tests and valuable cross-market evidence. Our

[1] Fama, and Schwert (1977), Breen, Glosten, and Jagannathan (1989), Ang and Bekaert (2007), and Campbell and Thompson (2008) find strong predictive power of the U.S. T-bill rate for U.S stock returns. Harvey (1991), Ferson and Harvey (1993) and many others use U.S. T-bills as predictors of returns in the U.S. and world equity markets.
[2] Empirical support for the contemporaneous link between interest rates to stock returns is also presented in Stone (1974), Sweeny and Warga (1986), and Ferson and Harvey (1993) among others.
[3] A few studies here are Bailey (1990) and Wongswan (2006, 2009) who document limited impact of the U.S. monetary policy proxy, the Federal Open Market Committee decisions, on equity markets in other countries.

main contribution is the finding of an economically and statistically significant illiquidity premium of U.S. Treasuries in global equity markets.

There is substantial evidence on the importance of stock market illiquidity for equity returns in the U.S. (see Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Amihud (2002), Pastor and Stambaugh (2003), Acharya and Pedersen (2005)) as well as around the world (Bekaert, Harvey, and Lundblad (2007), Lee (2011)). We expect the effect of Treasury bond illiquidity on stock returns to be no less important. Indeed, Chordia, Sarkar, and Subrahmanyam (2005) and Baele, Bekaert, and Inghelbrecht (2010) document certain similarities between stock and bond market illiquidity. There is also an extensive literature on the relation between macroeconomic news and illiquidity of Treasury bonds using intraday data (see Balduzzi, Elton, and Green (2001), Green (2004)). Furthermore, Goyenko and Ukhov (2009) observe that a distinctive feature of the illiquidity of Treasuries compared to that of stocks is that it reflects and transmits monetary policy shocks to equity markets. Finally, Goyenko, Subrahmanyam, and Ukhov (2011) show that the Fed fund rate is one of the main determinants of Treasury bond illiquidity.

The U.S. Treasuries are typically viewed as the safest and most liquid asset class which comprises significant portion of diversified foreign equity portfolios. Investors outside the U.S. hold large and increasing stakes in U.S Treasuries: in 1996 they held close to 28% of all marketable Treasury securities outstanding, but by 2010 their holdings reached almost 50%.[4] This suggests that both foreign and domestic investors move their funds in and out of Treasuries and affect Treasury market illiquidity (see Longstaff (2004), Chordia, Sarkar, and Subrahmanyam (2005). Therefore, while the illiquidity effect related to stock trading costs should generally be subsumed by stock illiquidity, the macroeconomic news component of Treasury illiquidity shocks should have an independent impact on global equity prices.

[4] Source: The Federal Reserve System, Treasury Bulletin, see http://www.ustreas.gov/tic/.

We proceed as follows. First, we show that the main determinants of Treasury bond illiquidity are the U.S. monetary policy and aggregate economic conditions. In particular, we show that an increase in the Fed funds rate increases bond illiquidity, even after controlling for other potential predictors such as stock market returns, volatility, and liquidity, as well as the term spread, changes in the amount of funds held in money market mutual funds, and changes in the consumer confidence index. We also reach similar conclusion using the Taylor rule (Taylor (1993)) after relating bond illiquidity to unexpected monetary policy shocks. These findings confirm the main message in Goyenko, Subrahmanyam, and Ukhov (2011) that Treasury bond illiquidity reflects changes in the U.S. monetary policy and changing macroeconomic conditions.

Second, the literature on monetary policy effects on stock returns documents negative predictive and contemporaneous effects of monetary policy tightening on changes in share prices in the U.S. (see, e.g., Jensen, Mercer, and Johnson (1996), Patelis (1997), Thorbecke (1997), Bernanke and Kuttner (2005)). If Treasury bond illiquidity reflects U.S. monetary policy and other macroeconomic shocks, then we expect it to have negative predictive and contemporaneous effects in international equity returns as well. We indeed find that bond illiquidity significantly negatively predicts stock returns in developed and emerging markets and in different sub-periods. This result is robust to the inclusion of other standard predictors of countries' equity returns such as local market returns, local dividend yields, the U.S. term spread, the Fed fund rate, the Eurodollar rate, as well as local and world stock market illiquidity.

Finally, we explore the importance of the Treasury bond illiquidity risk in the setting of global asset pricing models. We first test a benchmark specification – a full-integration international asset pricing model with two global risk factors: the world market portfolio return and Treasury bond illiquidity. We then consider global pricing models that include the foreign exchange rate as well as the local equity market's variance and illiquidity. Similar to Bekaert, Harvey, and Lundblad (2007), we conduct our estimation in two steps. In the first step, we use the multivariate GARCH (1,1) methodology and, for each country, compute the conditional return variance and the set of conditional covariances between local stock market returns and the model-specific risk factors. In the second step, we use GMM and estimate prices of risk for both the entire sample of countries and for developed and emerging market sub-samples. Since the contemporaneous covariance between bond illiquidity and stock returns is also negative, our asset pricing tests show, as expected, a negative and significant price of bond illiquidity risk, implying that it is associated with a positive premium in global equity markets. This result holds in the presence of other world and local risk factors.

The estimates of the price of bond illiquidity risk are usually larger in magnitude in emerging markets. This is natural as those markets are more exposed to negative worldwide risks than developed countries. Among developed markets, Greece and Portugal show the largest bond illiquidity risk, which is fully consistent with these markets suffering the most from the recent financial crisis. In our benchmark model, in economic terms, the average annual premium for the bond illiquidity risk is between 1.0% and 1.6%. This is comparable in magnitude to the stock illiquidity premium of 1.1% per annum reported by Acharya and Pedersen (2005) for the U.S. equity market. The only other consistently priced factor across all models, not surprisingly, is the world market portfolio return. Thus, our results suggest that the illiquidity of Treasuries can be considered an important global risk factor which proxies the impact of U.S. monetary policy shifts and other changes in a macroeconomic environment on global asset prices.

The rest of the paper is organized as follows. Section II describes the data. In Section III, we look at the determinants of bond illiquidity and examine predictive regressions of stock market returns on lagged values of bond illiquidity and other variables. In Section IV, we develop our conditional asset pricing methodology. Section V presents the results of asset pricing tests. In this section, we also relate our estimates of the bond illiquidity risk to various country-level macroeconomic and financial variables. Section VI concludes.

II. Data

Our sample consists of 46 countries, out of which 23 are classified as developed and 23 as emerging. It covers the 34-year period from January 1977 to December 2010, although the time-series data for many countries start significantly later than 1977. For each country, we collect monthly local equity market returns in U.S. dollars and dividend yields from Datastream and IFC Global Indices. We construct excess returns by subtracting the one-month U.S. Treasury bill rate from gross returns. Following Bekaert, Harvey, and Lundblad (2007) and Lee (2011), our proxy for stock market illiquidity in each country is the zero-return measure (Zeros) suggested by Lesmond, Ogden, and Trzcinka (1999). It is the equally-weighted average proportion of zero daily returns across all firms in a given country and month. This measure is motivated by data limitations, which are especially pronounced in emerging markets.[5] We follow Lee (2011) and use the equally-weighted proportion of zero daily returns across all firms in a country during a month. The world stock market illiquidity is the equally-weighted average of country-level aggregate illiquidity series.

Goyenko, Subrahmanyam, and Ukhov (2011) find that the illiquidity of off-the-run T-bills with maturities of up to one year captures the illiquidity of the Treasury market overall better than other government securities. Accordingly, we use the illiquidity of off-the-run T-bills as our proxy for the illiquidity of the U.S. Treasury bond market. More specifically, we use the average percentage quoted bid-ask spread of off-the-run U.S. T-bills of three-, six-, and 12-month securities available from CRSP's daily Treasury Quotes file to proxy for the U.S. Treasury bond market illiquidity. Under the standard definition, when a new security is issued, it is considered to be on-the-run, and the older issues are treated as off-the-run. For each month the average spread is first computed for each security as the average proportional daily spread for the month and then equally weighted across short-term assets.[6]

[5] Note, however, that Zeros is directly related to trading volume. More illiquid stocks have less frequent trading and, therefore, a higher incidence of zero returns. Fong, Holden, and Trzcinka (2011) find that Zeros efficiently captures the time-series patterns of stock market liquidity compared to effective spread-based benchmarks.

[6] Acharya, Amihud, and Bharath (2009) and Baele, Bekaert, and Inghelbrecht (2010) also used these data.

Table 1 shows the number of observations, means, volatilities, and first-order autocorrelations of monthly excess equity returns, dividend yields, and stock illiquidity for each country and across all markets. The number of observations corresponds to the available monthly equity market returns in each country. Not surprisingly, the average monthly returns and volatilities in emerging markets are higher than those in developed markets. The autocorrelation of dividend yields is very high, in excess of 0.90 in all but seven countries. Stock market illiquidity is also higher on average in emerging markets than developed (28% versus 24%), as expected. Note, however, that while Zeros is highly correlated with transaction costs, it does not directly indicate the magnitude of illiquidity (see Hasbrouck (2009), Goyenko, Holden, and Trzcinka (2009)). Rather, this measure gives us only a relative sense of the magnitude of illiquidity. The zero-return measure also shows very high autocorrelation.

III. Preliminary Analysis

A. Determinants of Treasury Bond Illiquidity

We first investigate the relation between U.S. Treasury bond illiquidity and the set of potential predictors, including the world stock market illiquidity. Note that both bond illiquidity and stock market illiquidity are persistent. Therefore, to preclude concerns with spurious regression biases (see Ferson, Sarkissian, and Simin (2003)), in the subsequent analysis we follow Pastor and Stambaugh (2003) and Acharya and Pedersen (2005) and use the AR(2) residuals as our illiquidity measures of both the Treasury bond and global stock markets. To reduce the impact of outliers on our estimation results we winsorize bond and stock market illiquidity shocks at the 1st and 99th percentiles.

The test results are shown in Table 2. The first three columns of the table report the results for the whole 34-year sample period, while the last three – for the second 17-year sub-period. The dependent variable is the U.S. Treasury bond illiquidity shock, L_B. All regressions include the first lag of L_B and year fixed effects, but their coefficients are not reported. The t-statistics are based on the Newey-West standard errors corrected for six lags.

Our first specification, Regressions 1 and 4, includes three predictors: the lagged world stock market illiquidity shock, $L_{w,t-1}$, as well as the lagged world excess equity return and volatility, $r_{w,t-1}$ and $\sigma_{w,t-1}$, respectively. The monthly world stock market volatility is computed as the standard deviation of daily world market returns in that month. The daily return data are from Datastream. An increase in stock market illiquidity may result in increased flows of funds into Treasuries (flight to liquidity), reducing the illiquidity of Treasury bonds. Stock illiquidity may thus have a negative impact on the next-period bond illiquidity. Other variables may also have predictive power for Treasury bond illiquidity. For instance, global market uncertainty and increased volatility may again prompt investors to turn their attention to Treasuries and, therefore, reduce their illiquidity. The test results show that, among these three variables, the worldwide equity market volatility is the only predictor that has statistically significant impact on bond illiquidity, although its significance is present only in the later sub-period. The coefficient on σ_w is negative, confirming the intuition that in turbulent times more money flows into Treasuries reducing their illiquidity.

In Regressions 2 and 5, we consider two monetary policy controls, the lagged change in the Fed funds rate, Fed_{t-1}, and the lagged term spread, $Term_{t-1}$. The term spread is the difference in yields between the 10-year U.S. Treasury note and the one-month T-bill. We find, similar to Goyenko, Subrahmanyam, and Ukhov (2011), that changes in the Fed funds rate have positive predictive power for bond illiquidity over the whole sample and, in statistical terms, even stronger in the second sub-period. The presence of the Fed funds rate knocks out the negative predictive power of the world stock market volatility on bond illiquidity. This implies that during times of high stock market uncertainty and shifts in monetary policy regimes, changes in bond illiquidity are primarily related to monetary policy shifts.

Finally, in Regressions 3 and 6, instead of the two monetary policy variables, we use two controls from Longstaff (2004): the lagged percentage change in the amount of funds held in money market mutual funds, MMF_{t-1}, and the lagged change in the consumer confidence index, CCI_{t-1}. The data on the amount of funds held in money market mutual funds are from the Federal Reserve Board, and data on the consumer confidence index are from the Conference Board. We do not include them with the Fed funds rate and term spread because of substantial cross-correlation between MMF and term spread. Nevertheless, neither MMF nor CCI show any importance for the illiquidity of Treasuries leaving again the world market volatility to pick up the bulk of the predictive power in the absence of the Fed fund rate.

While Table 2 shows the linkage between bond illiquidity and the U.S. monetary policy via changes in the Fed funds rate, we also want to see whether bond illiquidity is related to the direct measure of unexpected monetary shocks. To do this, we first compute the unexpected shocks to the Fed funds rate using the basic Taylor rule (Taylor, 1993) augmented with the lagged rate to allow for interest-rate smoothing (see Bernanke and Boivin (2003)), namely:

(1) $$Fed_t = \phi^0 + \phi^1 Fed_{t-1} + \phi^\pi \left(\pi_t - \pi_t^*\right) + \phi^y \left(y_t - \bar{y}_t\right) + e_t^{Fed},$$

where π_t is the inflation rate, π_t^* is the target inflation rate, y_t is the log of real GDP, and $\bar{y}_t$ is the log of potential output. We construct $\bar{y}_t$ based on a linear trend model. Similarly, we use a simple downward trending inflation rate target because inflation is much higher in the beginning of our sample than at the end. Since GDP's frequency is quarterly, we convert the monthly Fed funds rate to quarterly frequency, so that each quarterly rate is the average of corresponding monthly rates for a given quarter. Then, we regress Treasury bond illiquidity converted similarly to the quarterly frequency on the lagged estimated residuals from Eq. (1), $\hat{e}_{t-1}^{Fed}$. In this simple framework, we find the coefficient on $\hat{e}_{t-1}^{Fed}$ to be positive and marginally significant over the whole sample period, and it becomes significant at the 1% level in the second half of the sample.[7]

[7] The details of these estimations are available on request. The results are also similar if we use an alternative representation of the inflation rate target fixed at an annual rate of 2%.

In sum, Treasury bond illiquidity is related to changes in the U.S. monetary policy, which, in turn, reflects changes in the overall macroeconomic environment. Similar point is made in Balduzzi, Elton, and Green (2001) and Green (2004) who find that macroeconomic news affect the illiquidity of Treasuries. To this, we add that Treasury bond illiquidity also captures changes in monetary policy not explained by the Tailor rule. Moreover, since the Treasury bond market is an important source of immediate liquidity provision, bond illiquidity is likely to impact any asset around the world that is not immune from the flight to liquidity.[8]

B. Predictive Regressions of Equity Returns

Given the evidence that Treasury bond illiquidity reflects changes in the U.S. monetary and economic environment, in this sub-section, we test whether it has predictive power for global equity returns. Since a positive shock to bond illiquidity is associated with tightening of the U.S. monetary policy, and the effect of the latter on expected stock returns is negative (see Patelis, (1997), Thorbecke (1997), and Bernanke and Kuttner (2005)), we also expect a *negative* relation between bond illiquidity and expected equity returns.

Table 3 presents test results of predictive regressions, including the adjusted R-squared, for global and local excess market returns. The control variables included in all panels are the lagged values of the Fed funds rate change, the U.S. term spread, the one-month Eurodollar deposit rate, and the January dummy; the latter being included in every regression. All regressions also include the year fixed effects.

Panel A of Table 3 shows the results for the world equity market return as the dependent variable. It reports the point estimates and robust t-statistics based on standard errors with the Newey-West correction for six lags. The regressions also include, as global stock market controls, the lagged values of the world market return, illiquidity, and dividend yield. We

[8] For example, on September 22, 2011, The Wall Street Journal writes: "Investors staged a flight from risk in global markets that sent U.S. stocks falling to fresh session lows in afternoon trading and 10-year Treasury yields to 1940s levels, after a gloomy outlook by the Federal Reserve renewed fears of a global economic slowdown. …Investors also piled into the safety of Treasury bonds, pushing down the benchmark 10-year note's yield to the lowest since the 1940s." Source: The Wall Street Journal, September 22, 2011, "U.S. Stocks Plunge."

conduct our estimation on the full sample period (columns 1-4) and the two 17-year sub-periods, 1977-1993 and 1994-2010 (columns 5-6). The first four columns show that the slope on bond illiquidity is consistently negative and significant at the 1% level, supporting our expectations. Among all other variables, only the world dividend yield and the Eurodollar rate also seem to exercise significant at the standard 5% level predictive power (with expected signs) for global stock returns. The other two global predictors – the term spread and the Fed funds rate – are only marginally significant. The last two columns of the table show that the negative relation observed between the lagged bond illiquidity and stock returns is present in each of the two sub-periods, with its magnitude increasing in the second half of the sample. The second sub-period also shows a drastic reduction in the predictive power of the dividend yield in terms of both economic and statistical significance, consistent with Goyal and Welch (2003). The term spread barely reaches marginal significance, while the Fed funds rate is no longer significant in the later years of the sample. The Eurodollar rate is the only variable showing significant impact on world stock market returns in both sub-periods.

The predictive relation between Treasury bond illiquidity and world equity market excess returns is economically important as well. Since one standard deviation of bond illiquidity is 0.002, a one-standard deviation positive shock to bond illiquidity, based, for instance, on Regression 4 output implies a decrease in the next-period world market excess return by about 60 basis points (-0.03 times 100 times 0.002). This makes a yearly return decline of about 7%.

Panel B of Table 3 reports panel regression results for local stock market returns. Our country-specific controls include the lagged values of equity market returns, illiquidity, and dividend yields. To account for cross-market correlations and average country-specific characteristics, all regressions include both the year and country fixed effects, and we cluster standard errors by month. Again, columns 1-4 correspond to full sample tests, while columns 5-6 – to sub-period tests. The first four regressions show that over the entire sample period, bond illiquidity retains its negative and statistically highly significant predictive power for local stock returns. Moreover, this relation again mostly survives the sub-period tests. Across all regression specifications, the coefficients on L_B are comparable in magnitude to those in Panel A. The only other significant variable in these predictive tests is the local dividend yield.

In Panel C of Table 3, we split the sample countries into 23 developed and 23 emerging markets and repeat the first, third, and fourth tests from Panel B. Columns 1-3 report the estimation results for developed markets, while columns 4-6 – for emerging markets. Similar to previous panels, the slope on the lagged bond illiquidity is negative and significant at least at the 5% level across five out of six specifications. However, its magnitude for emerging markets is more than four times larger than that for developed ones. Thus, emerging markets, which tend to be less liquid, experience stronger illiquidity effects. This is consistent with the U.S. evidence that monetary policy effects are stronger for smaller, more illiquid stocks. Dividend yield again appears to predict stock returns across both market groups. However, the true predictability of dividend yield, based on standard statistical inferences is doubtful (see, e.g., Ferson, Sarkissian, and Simin (2003)). Finally, the lagged local market illiquidity is essentially zero for all markets.

Thus, the Treasury bond illiquidity predicts global stock returns at the world and individual country levels, over different sub-periods, and across developed and emerging markets. This result, which is statistically and economically significant even after controlling for common predictors of equity returns and stock market illiquidity, points out that changes in the U.S. monetary policy and its macroeconomic environment affect not only stock prices in the U.S. but also overseas equities. In the next section, we investigate the main pricing implications of bond illiquidity for global equity returns.

IV. Conditional Methodology

A. General Framework

In this section, we test four asset pricing models of global equity returns under full and partial market integration. All models use Treasury bond illiquidity as a proxy for changes in the

U.S. monetary policy and its overall economic conditions.[9] We assume constant prices of all risk factors.

Model I. If country i is integrated with the world and purchasing power parity holds across countries, then country i's expected return at time t, given the information available at time t-1, is determined by its conditional covariances with the return on the world market portfolio and with Treasury bond illiquidity, that is,

$$E_{t-1}(r_{i,t}) = \lambda_w \,\mathrm{Cov}_{t-1}(r_{i,t}, r_{w,t}) + \lambda_{LB} \,\mathrm{Cov}_{t-1}(r_{i,t}, L_{B,t}), \qquad (2)$$

where λ_w is the price of the world market risk and λ_{LB} is the price of the Treasury bond illiquidity risk. Eq. (2) represents our benchmark two-factor model.[10] Economically and statistically significant λ_{LB} would suggest that the risk associated with changes in the U.S. monetary policy is priced in global markets. Strictly speaking though, significant λ_{LB} will be associated with U.S. monetary shifts only in the presence of stock illiquidity risk in the asset pricing model (see Model IV below). In the absence of stock illiquidity, due so certain commonality between bond illiquidity and stock illiquidity, bond illiquidity may also capture risks embedded in the trading costs of equities.

Note that the contemporaneous effect of monetary policy tightening on equity returns is generally negative (see Thorbecke (1997) and Bernanke and Kuttner (2005)). Therefore, similar to a negative predictive relation, we also expect a *negative* contemporaneous relation between bond illiquidity and global stock returns. This effect is also similar to that between stock illiquidity and equity returns (see Amihud, 2002), implying a negative on average $Cov_{t-1}(r_{i,t}, L_{B,t})$ term. Therefore, if bond illiquidity is a systematic risk factor in international equity markets, λ_{LB} must have negative sign as well. This is our main testable hypothesis.

[9] Since the Treasury bond illiquidity risk is a global factor it cannot be present in fully segmented markets.
[10] Under conditions of market integration and no exchange rate risk, we could also relate Model I to the global version of Merton's (1973) ICAPM. In this version of the ICAPM, a country's risk premium is a function of two conditional covariance terms of its equity market return: with the world market return and with the change in a variable that describes the state of investment opportunities in that country's economy (bond illiquidity in our case).

The empirical literature documents that another financial variable closely related to monetary policy, the short-term interest rate, also has negative predictive and contemporaneous effects on stock prices (see, e.g., Breen, Glosten, and Jagannathan (1989), Fama and Schwert (1977), Campbell (1987)). However, Bernanke and Kuttner (2005) point out that the reaction of equity prices to monetary policy is not directly related to the policy's impact on the real interest rate.

Thus, using bond illiquidity in asset pricing tests has clear advantages over other competing economic and financial measures. First, it is closely related to U.S. monetary and macroeconomic shocks as well as equity returns. Second, unlike such low frequency variables as GDP growth and changes in inflation that ultimately influence the U.S. monetary policy, it is a high frequency financial data based measure that is well suited to capture those components of shocks that matter the most for U.S. and international capital markets.

Model II. If there are deviations in purchasing power parity across countries, then exchange rate risk may also be priced (see Dumas and Solnik, 1995). Model II extends Model I to accommodate this factor as follows:

(3) $$E_{t-1}(r_{i,t}) = \lambda_w \operatorname{Cov}_{t-1}(r_{i,t}, r_{w,t}) + \lambda_{LB} \operatorname{Cov}_{t-1}(r_{i,t}, L_{B,t}) + \lambda_c \operatorname{Cov}_{t-1}(r_{i,t}, r_{c,t}),$$

where $r_{c,t}$ is the return on the currency basket deposit at time t and λ_c is the price of currency risk. In our estimations, the return on the currency basket deposit is calculated as the equally-weighted average change in exchange rates between the U.S. dollar and four global currencies: the British Pound, Euro, Japanese Yen, and Swiss Franc.[11]

Model III. A country may not be fully integrated with the world. Errunza and Losq (1985) develop a model where expected return on a risky security in such country is determined by a global risk premium and an additional risk premium proportional to the country's conditional market risk. If country i is fully segmented, its expected return at time t, given the information available at time t-1, is based only on its conditional variance with the market return,

[11] Replacing our currency basket with individual exchange rates does not materially impact our test results.

i.e., $E_{t-1}(r_{i,t}) = \lambda_i \mathrm{Var}_{t-1}(r_{i,t})$, where λ_i is the price of country *i* variance risk. We combine this term with Model I, following similar econometric specifications of Chan, Karolyi, and Stulz (1992), Bekaert and Harvey (1995), De Santis and Gerard (1997), and many others and obtain an asset pricing model of partial world market integration, i.e.:

(4) $$E_{t-1}(r_{i,t}) = \lambda_w \mathrm{Cov}_{t-1}(r_{i,t}, r_{w,t}) + \lambda_{LB} \mathrm{Cov}_{t-1}(r_{i,t}, L_{B,t}) + \lambda_i \mathrm{Var}_{t-1}(r_{i,t}).$$

In this model, the expected return in country *i* is determined based on its conditional covariances with two global risk factors as well as its own country risk.

Model IV. Recent research shows that stock market illiquidity is an important factor for U.S. stock returns (e.g., see Amihud (2002), Pastor and Stambaugh (2003), Acharya and Pedersen (2005)). There is some evidence that stock market illiquidity is also important in global markets (see Bekaert, Harvey, and Lundblad (2007), Lee (2011)). To control for stock market illiquidity, we extend further the partial integration model (Model III) to include the second country-specific factor. This yields the following model:

(5) $$E_{t-1}(r_{i,t}) = \lambda_w Cov_{t-1}(r_{i,t}, r_{w,t}) + \lambda_{LB} Cov_{t-1}(r_{i,t}, L_{B,t}) + \lambda_i Var_{t-1}(r_{i,t}) + \lambda_{Li} Cov_{t-1}(r_{i,t}, L_{i,t}),$$

where λ_{Li} is the price of equity market illiquidity risk in country *i*.

It is possible to combine Models II and IV, which would result in a five-factor model. Also, following Acharya and Pedersen (2005), one could consider other stock market illiquidity based covariance risks, such as $Cov_{t-1}(r_{w,t}, L_{i,t})$, $Cov_{t-1}(L_{B,t}, L_{i,t})$, or $Cov_{t-1}(L_{w,t}, L_{i,t})$. However, these model specifications will render our estimation impractical.

B. Estimation Details

Evaluating Models I through IV jointly across 46 countries in a conditional framework with unknown conditional variances and covariances is practically impossible. We therefore estimate our asset pricing models in two steps. While the two-step estimation framework is usually associated with an errors-in-variables problem, it is often the only technique for testing multi-country or multi-asset conditional asset pricing models.[12]

In the first step, we estimate conditional variances of equity market returns and their covariances with all risk factors depending on model specification. We obtain these estimates separately for each country in a multivariate GARCH (1,1) setting that includes return and risk factor dynamics. We follow Harvey (1991), Ferson and Harvey (1993), and others and model country equity returns and risk factors as linear functions of global and local information variables.

The choice of our information variables is determined by previous literature and our results in Tables 2 and 3. First, for the local (world) market return, we use the first lags of the local (world) market return, Treasury bond illiquidity, and, following Fama and French (1989), local (world) dividend yield and the U.S. term spread, as well as local (world) stock market illiquidity. We include the lagged values of bond illiquidity and stock market illiquidity based on our Table 3 and evidence in Bekaert, Harvey, and Lundblad (2007), respectively. Including the lagged stock market return is a common practice in conditional asset pricing, although it is often insignificant. Second, for bond illiquidity, the instruments are the lagged stock market volatility and the change in the Fed funds rate, which come from our Table 2 and Goyenko, Subrahmanyam, and Ukhov (2011). Third, the change in the exchange rate is predicted by the lagged world market return and the one-month Eurodollar deposit rate, following Dumas and Solnik (1995). Finally, stock market illiquidity is predicted by the lagged values of bond illiquidity, stock market return, and volatility. This choice is based on our results in Table 2 as well as extant studies (see, e.g., Benston and Hagerman (1974), Chordia, Sarkar, and Subrahmanyam (2005)).

[12] For example, Bekaert, Harvey, and Lundblad (2007) model stock market liquidity in emerging countries using a two-step estimation procedure, where the first step is based on the VAR(1) framework and the second on GMM. Engle (2002) examines conditional correlations across multiple assets using a two-step approach with multivariate GARCH models.

Based upon the discussion above, for our Model I and Model III we initially estimate the following trivariate GARCH (1,1) system for each country:

(6a) $$r_{i,t} = \delta_{10} + \delta_{11} L_{B,t-1} + \delta_{12} r_{i,t-1} + \delta_{13} L_{i,t-1} + \delta_{14} DY_{i,t-1} + \delta_{15} Term_{t-1} + e_{i,t} ,$$

(6b) $$r_{w,t} = \delta_{20} + \delta_{21} L_{B,t-1} + \delta_{22} r_{w,t-1} + \delta_{23} L_{w,t-1} + \delta_{24} DY_{w,t-1} + \delta_{25} Term_{t-1} + e_{w,t} ,$$

(6c) $$L_{B,t} = \delta_{30} + \delta_{31} \sigma_{w,t-1} + \delta_{32} Fed_{t-1} + e_{LB,t} .$$

For Model II we add the relation that governs the dynamics of currency returns,

(6d) $$r_{c,t} = \delta_{40} + \delta_{41} r_{w,t-1} + \delta_{42} Euro\$_{t-1} + e_{c,t} ,$$

while for Model IV we add instead the predictive relation for local stock market illiquidity,

(6e) $$L_{i,t} = \delta_{50} + \delta_{51} L_{B,t-1} + \delta_{52} r_{i,t-1} + \delta_{53} \sigma_{i,t-1} + e_{Li,t} .$$

We also estimate system (6) for the world market portfolio. In this case, Eq. (6a) is dropped, and, for Model IV, all local market variables in Eq. (6e) are replaced with their corresponding world market counterparts, that is,

(6f) $$L_{w,t} = \delta_{50} + \delta_{51} L_{B,t-1} + \delta_{52} r_{w,t-1} + \delta_{53} \sigma_{w,t-1} + e_{Lw,t} .$$

In the full system of Eqs. (6a-f), the error term is $e_t = [e_{i,t}, e_{w,t}, e_{c,t}, e_{LB,t}, e_{Li,t}, e_{Lw,t}]$. It is assumed to be a multivariate normal distribution with conditional variance-covariance matrix H_t. The matrix H_t has the BEKK structure (Engle and Kroner (1995)) ensuring that it is parsimonious and positive definite, that is, $H_t = C'C + A'e_{t-1}e'_{t-1}A + B'H_{t-1}B$, where C is an (MxM) upper triangular matrix and A and B are (MxM) diagonal matrices, where M is the number of equations being estimated under different model specifications. Similar specifications are used in Bekaert and Harvey (1995), De Santis and Gerard (1997), and others.

In the second step, we use panel GMM and estimate pricing moment conditions across all countries (or country groups) and the world market. For example, the moment conditions for Model IV are:

$$
(7) \quad \begin{aligned} \zeta_{i,t} &= r_{i,t} - \lambda_w \hat{\mathrm{C}}\mathrm{ov}_{t-1}(r_{i,t}, r_{w,t}) - \lambda_{LB} \hat{\mathrm{C}}\mathrm{ov}_{t-1}(r_{i,t}, L_{B,t}) - \lambda_i \hat{V}ar_{t-1}(r_{i,t}) - \lambda_{Li} \hat{\mathrm{C}}\mathrm{ov}_{t-1}(r_{i,t}, L_{i,t}) \\ \zeta_{w,t} &= r_{w,t} - \lambda_w \hat{V}ar_{t-1}(r_{w,t}) - \lambda_{LB} \hat{\mathrm{C}}\mathrm{ov}_{t-1}(r_{w,t}, L_{B,t}) - \lambda_{Lw} \hat{\mathrm{C}}\mathrm{ov}_{t-1}(r_{w,t}, L_{w,t}) \end{aligned},
$$

where $\zeta_{i,t}$ and $\zeta_{w,t}$ are the error terms of country *i* and world market excess return equations at time *t*, respectively, *i=1,…N*, and *N* is the number of countries (46 for the whole sample or 23 for the sub-samples of developed and emerging markets). The “hat” denotes the estimates from the multivariate GARCH (1,1) estimation. At this stage, we compute the following prices of risk:

Model I: λ_w, λ_{LB};

Model II: λ_w, λ_{LB}, λ_c;

Model III: λ_w, λ_{LB}, λ_i, *i=1,…N*;

Model IV: λ_w, λ_{LB}, λ_{Lw}, λ_i, λ_{Li}, *i=1,…N*.

To create orthogonality conditions in an overidentified yet parsimonious system, we use instruments that can be implemented with various asset pricing models. This approach facilitates comparison of test results across models. Our most commonly used instrument vector *Z*, which is largely motivated by the predictive regression results in Table 3, includes a constant and three global information variables, namely, the lagged values of Treasury bond illiquidity, the world market portfolio return, and the U.S. term spread, that is, $Z_{t-1} = [1, L_{B,t-1}, r_{w,t-1}, Term_{t-1}]$. This gives 4*N*+4 orthogonality conditions in the GMM estimation. In smaller GMM systems (Model I), we also use a shorter instrument vector by dropping the term spread from *Z*. These variations allow us to examine the sensitivity of our results to the instrument choice.

Following the studies on GMM performance in small samples (Andersen and Sørensen (1996), Ferson and Foerster (1994)), we use Bartlett kernel, Andrews’ bandwidth, and iterative updating of both the weighting matrix and the coefficients in all our GMM estimations. Furthermore, to facilitate convergence, we apply the pre-whitening of the weighting matrix as suggested by Andrews and Monahan (1992).

V. Empirical Tests

A. Conditional Treasury Bond Illiquidity Betas

We start by examining the outcome of our multivariate GARCH (1,1) model based on Eqs. (6a-c). In particular, given the estimates of the conditional variance of Treasury bond illiquidity, $\hat{\mathrm{V}}\mathrm{ar}_{t-1}(L_{B,t})$, and the conditional covariance of country returns with bond illiquidity, $\hat{\mathrm{C}}\mathrm{ov}_{t-1}(r_{i,t}, L_{B,t})$, we can construct for each country *i* its conditional bond illiquidity beta as:

(8) $$Beta_{i,t-1}(L_{B,t}) = \hat{C}ov_{t-1}(r_{i,t}, L_{B,t}) / \hat{V}ar_{t-1}(L_{B,t}).$$

In Figure 1 (Plot A), we show the average 36-month conditional bond illiquidity betas for developed and emerging markets. First, the average bond illiquidity beta is lower in emerging markets than in developed. This is consistent with the intuition that the effect of the U.S. monetary policy tightening should be more pronounced in emerging markets. Indeed, firms in these countries are subject to more capital constraints from shrinking global credit supply than in developed countries. Second, the impact of the recent financial crisis is clearly visible. The exposure of all countries to the Treasury bond illiquidity risk, i.e., bond illiquidity betas, is the highest (more negative) over the latest sample period, consistent with reality and reflecting more globalized nature of the world economy and capital markets. Third, supporting the fact that the 2008 crisis has affected more developed markets than many emerging ones, we observe the largest ever change in the average value of bond illiquidity beta among developed markets just before 2008. Their average conditional beta dropped from almost zero around 2005 to the level similar to that of emerging countries in the mid-2000s.

In Plot B of Figure 1, we present the time-series of conditional bond illiquidity betas for two developed counties – Greece and Portugal, – countries that suffered the most from the recent financial crisis. The three important takeaways from this picture are: (i) the bond illiquidity beta for Greece is more volatile than that of Portugal, (ii) the change (increase in magnitude) in Greece's bond illiquidity beta during the period preceding the recent crisis is the largest in the history of that market, and (iii) the levels reached by bond illiquidity betas of those two countries approached (for Portugal) or surpassed (for Greece) that of the average of emerging markets.

We also analyze the cross-sectional properties of bond illiquidity betas. Figure 2 shows the relation between average country excess equity returns and average conditional betas. The plot differentiates between developed and emerging markets. First, most bond illiquidity betas are negative and that there is a downward trend between these betas and mean excess stock returns. This implies that the lower in absolute terms is the country's stock market exposure to the illiquidity of U.S. Treasuries the lower is its expected return. Second, illiquidity betas are much more negative on average for emerging markets than developed. The only two emerging markets with bond illiquidity betas close to zero are Malaysia and Philippines, while the most negative bond illiquidity betas among developed markets belong to Greece and Portugal.

Given a wide dispersion of Treasury bond illiquidity betas across countries, we explore whether any country characteristics can explain their cross-sectional differences. Table 4 reports results for country-level variables that we believe may affect bond illiquidity betas, i.e., impact the exposure of countries' equity market returns to U.S. monetary policy shifts. CORR is the average country's equity market correlation with the world market portfolio over the entire sample period. SIZE is the average stock market capitalization to GDP ratio from Djankov et al. (2008). XLIST is the number of all foreign listings from a given country placed on foreign exchanges the end of 1998 from Sarkissian and Schill (2004). We can think of these three variables as "market development" proxies. The more developed a country's financial market is, the lower is its exposure to U.S. monetary and macroeconomic shocks, and hence the lower are in absolute terms their bond illiquidity betas. SEG is a market segmentation proxy computed, in the spirit of Bekaert et al. (2011), as the average absolute difference between a country's inverse price-to-earning ratio and that of the world market.[13] RATE is the short-term interest rate. The monthly price-to-earning ratios and interest rates are taken from Datastream. These two variables can be regarded as "dynamic indicators," and are easily observable over time at any sampling frequency. The more partially segmented a country is, or the higher is the level of its nominal

[13] In Bekaert et al. (2011), SEG is the weighted sum of local-global industry valuation differentials.

interest rates, the higher is the probability for a negative reaction of its equity market to the U.S. monetary policy tightening, and hence the higher is (more negative) its bond illiquidity beta. Finally, FREEDOM is the average index of economic freedom in 1995-2006 from the Heritage Foundation,[14] and LAW is the anti-self-dealing index again from Djankov, et al. (2008). These two variables can be thought of as "investor environment" proxies. Counties with better investor protection should be associated with more developed and liquid stock markets with lower exposure to U.S. monetary contractions, and thus should have smaller bond illiquidity betas.

Table 5 reports the results of the regression of average conditional Treasury bond illiquidity betas across countries (46 data points) on various sets of country characteristics from Table 4. In all estimations, the number of foreign listings and the short-term rate are taken with logs. Regression (1) includes only CORR, which produces a positive and significant slope coefficient. This implies that the higher is the correlation between the local stock market and the world market the lower is its sensitivity, in absolute terms, to bond illiquidity shocks. Since country's higher equity market correlation with the world market does not directly imply its higher integration and/or development level, in Regression (2) we also use the other two "market development" variables, SIZE and XLIST. The slopes on these two measures are positive and significant, indicating once again that more developed markets are more immune from bond illiquidity shocks. Regression (3) presents the test results for the "dynamic indicators." The coefficients on SEG and RATE are both negative, as expected, but only the market segmentation proxy is marginally significant. This implies that less integrated but open countries are generally more prone to the bond illiquidity risk. Regression (4) presents the results for the "investor environment" proxies. Consistent with our expectations, we find a positive and significant relation between FREEDOM and the bond illiquidity beta. This implies that economically, financially, and politically more sound countries have more liquid markets overall as well as easier access to credit. Thus, these types of countries are less exposed to monetary policy shocks

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[14] Source: http://www.heritage.org/research/features/index/.

in the U.S. After using all proxies in Regression (5), we find that the only variable that retains its sign and significance at the 5% level is CORR. Since the sample size of our tests in this sub-section is small (only 46 observations) and many variables in a multivariate setting of Regression (5) show very low statistical power, in Regression (6) we drop all but two variables, CORR and SEG. In this estimation, both of them are significant with positive (CORR) and negative (SEG) signs. Note that this regression attains the highest adjusted R-squared among all specifications.

Thus, when a country is more developed and integrated with the world market its financial markets are more liquid and have an open access to other liquid assets around the world. Therefore, the U.S. Treasuries would not be the only source of liquidity provision for this country, and it will have lower in absolute terms bond illiquidity beta.

B. Asset Pricing Tests

To further examine the cross-sectional importance of Treasury bond illiquidity for international equity market returns, we turn our attention to the results of GMM-based asset pricing tests. We first examine the performance of our base two-factor model (Model I). Table 6 shows the test results for two different instrument sets across all countries as well as separately for developed and emerging markets. Besides the point estimates of the prices of risk and their t-statistics, for each test the table also reports the degrees of freedom and the GMM J-statistic with its corresponding p-value. The estimation period is 1977-2010 (1987-2010) for developed (emerging) markets. In Panel A, we use the short version of our instrument set, while in Panel B its full version. The conditional variances and covariances are obtained from the multivariate GARCH (1,1) using Eqs. (6a-c).

Across both panels of Table 6, we observe a positive and significant price of the world market portfolio risk, λ_w. Its average magnitude between the two panels is around 4.5 for the full sample of countries, and it is in line with similar estimates in prior studies on world market integration (see, e.g., De Santis and Gerard (1997), Bekaert, Harvey, and Lundblad (2007)). Using the estimates of λ_w and, from the first-stage estimation, the average estimate (across all countries) of the conditional covariance between each country's equity return and the world market return, $Cov_{t-1}(r_{i,t}, r_{w,t})$, which is 0.002, we can compute the average expected equity market return for a typical country attributed to the world market risk factor, $\lambda_w Cov_{t-1}(r_{i,t}, r_{w,t})$. We find that $\lambda_w Cov_{t-1}(r_{i,t}, r_{w,t})$ is about 11.2% per annum (4.5 times 0.002 times 12).

More importantly, our parameter of primary interest, the price of bond illiquidity risk, λ_{LB}, is negative, as expected, and significant at the 5% level or better in every estimation, both for the entire sample of countries and for the sub-samples of developed and emerging countries. The point estimates of λ_{LB} are between 1.19 and 1.91, in absolute terms, for the whole sample of 46 countries. We can use the values of λ_{LB} and the average conditional covariance $Cov_{t-1}(r_{i,t}, L_{B,t})$ from the first-stage estimation to compute the average annual equity market premium attributed to bond illiquidity risk, $\lambda_{LB} Cov_{t-1}(r_{i,t}, L_{B,t})$. Our evaluation produces a range of annual values between 1.0% and 1.6%. This is economically meaningful given that the average annual stock market excess return across 46 countries in our sample is 12.2% (1.02% times 12) and the estimated market premium is 11.2%. Note that the magnitude of bond illiquidity premium is comparable to that of U.S. stock illiquidity premium of 1.1% per annum reported in Acharya and Pedersen (2005).

We can also observe in Table 6 that the point estimates of λ_{LB} in emerging markets are higher than in developed markets (on average 4.4 versus 1.5 across both panels). This evidence corroborates well with our results based on predictive regressions in Table 3, where bond illiquidity is found to have a higher predictive impact on stock returns in emerging markets. In economic terms, the average price of risk in emerging markets (across both panels) implies that in these countries about 3.8% of annual stock market returns arises from their exposure to the Treasury bond illiquidity risk. Finally, the J-statistics indicate that we cannot reject our model in which the prices of the world market and bond illiquidity risks are set constant.

While Table 6 shows that the negative and significant price of bond illiquidity risk is a consistent outcome across different estimation settings, one cannot exclude the possibility that this result is not due to other world or country-specific risk factors that are omitted from the analysis. In Table 7, we address this issue by estimating three alternative global asset pricing models: Model II, which includes an additional global factor, namely, foreign exchange rate risk, as well as Models III and IV, which consider partial market integration. Our instrument set is as in Panel B of Table 6. Due to the large number of parameters being estimated, we focus only on the full-sample results across all 46 countries.

The first column of Table 7 presents the estimation results for Model II. We again see that λ_w is significantly positive and λ_{LB} is significantly negative. Their magnitudes are also similar to the corresponding estimates in Panel B of Table 6. The price of the world exchange risk, λ_c, is negative but insignificant. The second column of Table 7 shows the output for Model III, a partial integration model that consists of two global factors (the world market return and bond illiquidity), as well as the country-specific variance risk. This model thus has 48 parameters to be estimated. Similar to the earlier results, both λ_w and λ_{LB} are significant with positive and negative signs, respectively. The average λ_i is 0.72 across all 46 countries, but it is insignificant. This implies that there is no premium associated with the local market variance risk. Finally, in column 3 of Table 7, we test the performance of Model IV, a four-factor partial integration model. Relative to Model III, it also includes the second country-specific factor, local stock market illiquidity, and, at the world level, world market illiquidity. This model contains 95 parameters and is computationally the most intensive of the four models we consider. The results show that the price of the world market portfolio risk remains positive but its significance drops to the 10% level. The bond illiquidity risk retains its economic significance and statistical power at the 10% level. None of the two local risks (variance and stock market illiquidity) is significant. Likewise, the price of the world stock market illiquidity risk, λ_{Lw}, is insignificant. The reported J-statistics show no misspecification among all models in the table. In sum, Table 7 shows that the Treasury bond illiquidity risk is important even in the presence of other global factors that have been shown in the past, albeit with various success, to have an impact on global equity returns.

We also conduct two robustness tests to examine whether our finding of the existence of Treasury bond illiquidity risk in global stock markets is immune to alternative data series and model specifications. First, one concern with our tests is that they do not include other interest rate related risk factors besides Treasury bond illiquidity. This concern seems relevant if one recalls that Chen, Roll, and Ross (1986) find that term spread is one of the risk factors for U.S. stock returns. We therefore test another three-factor model of full market integration, similar to our Model II, but where the currency factor is replaced with the term spread. In this test, bond illiquidity still receives negative and significant pricing.

Second, in 1996, CRSP switched its data source from the Federal Reserve Bank of New York to GovPX indicative quotes. To determine the implications of this switch on our analysis, we also estimate bond illiquidity using GovPX quotes. The sample starts in 1992 – the first full year with available GovPX data. The estimation of our pricing models leads to the same outcome for bond illiquidity as before. The details of these test results are available on request.

VI. Conclusion

In this paper, we show that the illiquidity of U.S. Treasuries has predictive and contemporaneous relation to stock market returns around the world. The Treasury bond illiquidity risk is priced in global equity markets, and it commands an economically and statistically significant premium even after controlling for other conventional factors, such as the world market return, foreign exchange rate, local stock market variance, and stock market illiquidity. Our findings show that, *ceteris paribus*, the higher is the sensitivity of an asset to an increase in the illiquidity of U.S. Treasuries due to monetary contraction or other negative macroeconomic shocks, the larger is the asset's expected return.

Our evidence indicates that Treasury bond illiquidity reflects U.S. monetary and macroeconomic shocks and transmits these effects into global stock returns. What needs to be understood is the exact nature of two propagation channels. The first channel is through which

U.S. macroeconomic shocks spread into Treasury bond illiquidity. This analysis could be related to the literature on the "credit channel" of monetary policy transmission (see Bernanke and Blinder (1988, 1992), Kashyap and Stein (2000)). The second channel is through which Treasury bond illiquidity affects stock market returns around the world. Besides better understanding of the impact of U.S. macroeconomic shocks on global equities, this analysis may also be related to studies on flight to liquidity and flight to quality (see Diamond and Dybvig (1983), Bernanke and Gertler (1995)). These issues are left for future research.

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TABLE 1
Summary statistics

This table shows means, volatilities, and autocorrelations of monthly excess equity returns (in U.S. dollars), dividend yields, and stock market illiquidity for 24 developed and 24 emerging countries. The sample period is 1977:01-2010:12. The data are from Datastream and IFC. The returns are in U.S. dollars in excess of the one-month U.S. T-bill rate. Market illiquidity is the equally-weighted average proportion of zero daily returns in a month.

		Market return			Dividend yield			Market illiquidity		
Country	Obs	Mean	σ	ρ	Mean	σ	ρ	Mean	σ	ρ
Australia	408	0.008	0.069	0.075	0.329	0.068	0.957	0.223	0.104	0.975
Austria	408	0.007	0.069	0.243	0.159	0.056	0.968	0.224	0.098	0.950
Belgium	408	0.007	0.057	0.154	0.322	0.152	0.976	0.233	0.106	0.975
Canada	408	0.007	0.055	0.095	0.242	0.084	0.988	0.348	0.053	0.925
Denmark	408	0.008	0.056	0.076	0.160	0.068	0.983	0.269	0.169	0.984
Finland	273	0.009	0.086	0.194	0.228	0.103	0.973	0.285	0.090	0.901
France	408	0.008	0.065	0.057	0.309	0.116	0.980	0.177	0.073	0.902
Germany	408	0.006	0.059	0.024	0.206	0.068	0.983	0.207	0101	0.981
Greece	251	0.007	0.101	0.122	0.239	0.099	0.963	0.202	0.112	0.955
Hong Kong	408	0.011	0.086	0.077	0.300	0.095	0.948	0.215	0.117	0.966
Ireland	408	0.009	0.068	0.104	0.318	0.181	0.988	0.145	0.083	0.944
Italy	408	0.007	0.074	0.101	0.240	0.104	0.972	0.107	0.047	0.820
Japan	408	0.004	0.062	0.118	0.095	0.045	0.992	0.173	0.091	0.981
Netherlands	408	0.007	0.054	0.071	0.338	0.121	0.983	0.180	0.075	0.951
New Zealand	275	0.006	0.064	-0.007	0.396	0.074	0.927	0.413	0.048	0.788
Norway	371	0.008	0.080	0.117	0.214	0.074	0.938	0.275	0.101	0.956
Portugal	251	0.004	0.060	0.171	0.255	0.103	0.791	0.304	0.100	0.901
Singapore	408	0.008	0.073	0.095	0.212	0.064	0.960	0.240	0.127	0.955
Spain	285	0.007	0.065	0.075	0.270	0.099	0.979	0.177	0.061	0.924
Sweden	347	0.010	0.073	0.112	0.217	0.073	0.954	0.254	0.071	0.926
Switzerland	408	0.007	0.050	0.098	0.173	0.053	0.986	0.234	0.106	0.980
United Kingdom	408	0.008	0.054	0.050	0.342	0.085	0.974	0.308	0.176	0.993
United States	408	0.005	0.044	0.070	0.250	0.122	0.995	0.215	0.124	0.995
Argentina	288	0.023	0.185	-0.034	0.181	0.141	0.844	0.285	0.075	0.833
Brazil	288	0.021	0.150	-0.007	0.312	0.221	0.872	0.286	0.109	0.933
Chile	288	0.015	0.073	0.226	0.341	0.172	0.962	0.350	0.067	0.837
China	206	0.010	0.111	0.018	0.131	0.059	0.930	0.061	0.049	0.722
Colombia	288	0.017	0.090	0.323	0.330	0.162	0.977	0.404	0.130	0.874
Czech Republic	204	0.008	0.088	0.221	0.301	0.201	0.908	0.280	0.135	0.795
Egypt	167	0.010	0.092	0.272	0.363	0.205	0.941	0.162	0.072	0.880
Hungary	204	0.013	0.111	0.087	0.150	0.100	0.893	0.254	0.073	0.690
India	288	0.010	0.092	0.145	0.138	0.059	0.942	0.231	0.117	0.963
Indonesia	252	0.009	0.128	0.222	0.173	0.091	0.947	0.449	0.070	0.852
Israel	167	0.008	0.065	0.025	0.178	0.063	0.936	0.328	0.058	0.876
Korea	288	0.010	0.113	0.036	0.135	0.054	0.924	0.122	0.042	0.825
Malaysia	288	0.007	0.089	0.118	0.224	0.093	0.941	0.263	0.080	0.847
Mexico	288	0.017	0.106	0.265	0.156	0.053	0.900	0.202	0.088	0.932
Peru	207	0.018	0.086	0.046	0.230	0.114	0.921	0.253	0.134	0.927
Philippines	288	0.008	0.095	0.240	0.143	0.089	0.975	0.447	0.065	0.680
Poland	204	0.008	0.116	-0.007	0.169	0.120	0.900	0.200	0.075	0.795
Russia	167	0.022	0.153	0.195	0.094	0.061	0.893	0.296	0.107	0.848
South Africa	203	0.011	0.082	0.071	0.262	0.073	0.923	0.384	0.097	0.961
Sri Lanka	207	0.010	0.102	0.124	0.292	0.180	0.958	0.488	0.097	0.869
Taiwan	288	0.012	0.120	0.069	0.132	0.113	0.979	0.111	0.030	0.676
Thailand	288	0.010	0.112	0.111	0.246	0.128	0.877	0.287	0.054	0.602
Turkey	288	0.024	0.178	0.067	0.264	0.168	0.875	0.203	0.070	0.798
Average	309	0.010	0.088	0.111	0.234	0.105	0.943	0.256	2.283	0.884

TABLE 2
Determinants of Treasury bond illiquidity

This table shows the relation between U.S. Treasury bond illiquidity shocks and on the lagged value of world market illiquidity shock, L_w, and other global predictors. The sample has 46 countries and covers a period from 1977:01 to 2010:12. Treasury bond illiquidity, L_B, is off-the-run illiquidity of Treasury bills computed from the quoted spreads available at CRSP daily Treasury files. The variables r_w and σ_w denote the world measures of excess equity return and volatility, respectively. For each market and month, stock market illiquidity is based on the equally-weighted average proportion of zero returns of all firms in a given market and month. World stock market illiquidity is the value-weighted average of countries' illiquidity. All illiquidity shocks are the AR(2) residuals of the corresponding level series. Monthly world stock market volatility is computed as the standard deviation of daily world market returns in that month. Daily return data are from Datastream. The variables Fed, Term, MMF, and CCI denote the U.S.-based measures: change in the Federal funds rate, term spread, percentage change in the amount of funds held in money market mutual funds, and change in the consumer confidence index, respectively. The term spread is the difference in yields between the 10-year U.S. Treasury note and the one-month T-bill. The data on the amount of funds held in money market mutual funds are from the Federal Reserve Board. The consumer confidence index, which is divided by 100, is from the Conference Board. Treasury bond illiquidity is multiplied by 100 in Panel B. The constant and the first lag of the dependent variable are included in each regression, but their coefficients are not reported. The t-statistics shown in parentheses are based on Newey-West standard errors with six lags correction. Significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	Full sample period			1994-2010		
	(1)	(2)	(3)	(4)	(5)	(6)
$L_{w,t-1}$	-1.098	-1.286	-1.335	0.252	0.189	0.260
	(-1.08)	(-1.31)	(-1.33)	(1.25)	(0.94)	(1.33)
$r_{w,t-1}$	0.030	0.129	0.049	-0.102	-0.057	0.117
	(0.14)	(0.59)	(0.23)	(-1.14)	(-0.64)	(-1.17)
$\sigma_{w,t-1}$	-5.329	-4.543	-3.775	-1.899**	-1.071	-1.754**
	(-1.57)	(-1.31)	(-1.17)	(-1.97)	(-1.21)	(-2.02)
$Fed_{w,t-1}$		6.947*			5.300**	
		(1.89)			(2.18)	
$Term_{t-1}$		0.406			-0.077	
		(1.16)			(-1.02)	
MMF_{t-1}			-0.697			0.049
			(-0.62)			(0.22)
CCI_{t-1}			0.331			0.063
			(1.48)			(1.38)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes

TABLE 3
Predictive regressions of country equity returns

This table presents the output of predictive regressions of country excess equity returns (r_i) on the lagged Treasury bond illiquidity shocks, L_B, as well as other lagged instruments. L_w and L_i are the world and country-level stock market illiquidity shocks, respectively. For each market and month, illiquidity is based on the value-weighted average proportion of zero returns of all firms in a given market and month. World stock market illiquidity is the value-weighted average of countries' illiquidity. All illiquidity shocks are the AR(2) residuals of the corresponding level series. DY_w and DY_i are the world market and local country dividend yields, respectively, Term is the U.S. term spread, Fed is the change in the Federal funds rate, Euro$ is the one-month Eurodollar deposit rate, and JanD is the January dummy. Regressions in Panels A, B, and C include year and country (for Panels B and C) fixed effects but their coefficients are not reported. Stock market illiquidity and bond illiquidity shocks are winsorized at 1% and 99%. U.S. Treasury bond illiquidity is multiplied by 100. The t-statistics in Panel A are based on the Newey-West standard errors with six lags, while in Panels B and C on standard errors clustered by time. The whole sample period is 1977-2010 (1987-2010 for emerging markets). R^2 is the adjusted R-squared. Significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Panel A: Dependent variable: World stock market returns

	Full sample period				Sub-periods	
	(1)	(2)	(3)	(4)	1977-1993	1994-2010
Constant	0.004	0.006**	-0.188***	-0.144**	-0.321***	-0.017
	(1.59)	(2.26)	(-3.04)	(-2.01)	(-5.43)	(-0.36)
$L_{B,t-1}$	-0.036***	-0.037***	-0.035***	-0.030***	-0.025***	-0.183*
	(-4.14)	(-4.10)	(-3.50)	(-2.92)	(-2.58)	(-1.79)
$r_{w,t-1}$		-0.011	0.063	0.039	-0.031	0.052
		(-0.20)	(1.05)	(0.70)	(-0.48)	(0.70)
$L_{w,t-1}$		0.043	0.014	0.054	-0.389	-0.183
		(0.15)	(0.05)	(0.20)	(0.89)	(-0.55)
$DY_{w,t-1}$			0.047***	0.052***	0.100***	0.027*
			(3.09)	(3.25)	(5.69)	(1.89)
$Term_{t-1}$			-0.014	-0.091*	-0.125*	-0.135*
			(-0.39)	(-1.75)	(-1.93)	(-1.66)
Fed_{t-1}				0.546*	-0.599*	2.090
				(1.86)	(1.91)	(0.78)
$Euro\$_{t-1}$				-0.008***	-0.010***	-0.017**
				(-2.69)	(-3.03)	(-2.02)
JanD	-0.005	-0.005	-0.008	-0.008	-0.009	-0.007
	(-0.71)	(-0.65)	(-0.98)	(-1.07)	(-0.96)	(-0.61)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.065	0.059	0.103	0.118	0.211	0.118

TABLE 3 (continued)

Panel B: Dependent variable: Local stock market returns

	Full sample period				Sub-periods	
	(1)	(2)	(3)	(4)	1977-1993	1994-2010
$L_{B,t-1}$	-0.047***	-0.042***	-0.043***	-0.032**	-0.027*	-0.166*
	(-3.18)	(-2.86)	(-3.03)	(-2.00)	(-1.89)	(-1.73)
$r_{i,t-1}$		0.036	0.040	0.033	-0.027	0.053*
		(1.29)	(1.41)	(1.21)	(-0.56)	(1.82)
$L_{i,t-1}$		0.004	0.001	0.002	0.058	-0.018
		(0.11)	(0.01)	(0.06)	(0.78)	(-0.39)
$DY_{i,t-1}$			0.359***	0.352***	0.365**	0.413**
			(2.68)	(2.62)	(2.13)	(2.19)
$Term_{t-1}$			-0.048	-0.130	-0.098	-0.170
			(-0.89)	(-1.59)	(-1.46)	(-1.43)
Fed_{t-1}				-0.002	-0.271	1.163
				(-0.01)	(-0.84)	(-0.47)
$Euro\$_{t-1}$				-0.008	-0.004	0.017
				(-1.41)	(-1.23)	(-1.50)
JanD	0.003	-0.001	-0.001	-0.001	0.007	-0.003
	(0.41)	(-0.13)	(-0.14)	(-0.20)	(1.07)	(-0.32)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.042	0.050	0.053	0.073	0.055	0.094

TABLE 3 (continued)

Panel C: Developed and Emerging markets sub-samples

	Developed markets			Emerging markets		
	(1)	(2)	(3)	(4)	(5)	(6)
$L_{B,t-1}$	-0.039***	-0.038***	-0.029*	-0.146***	-0.140**	-0.140**
	(-2.68)	(-2.79)	(-1.94)	(-2.74)	(-1.96)	(-1.97)
$r_{i,t-1}$		0.031	0.018		0.033	0.025
		(0.95)	(0.62)		(0.96)	(0.76)
$L_{i,t-1}$		0.026	0.029		-0.011	-0.008
		(0.50)	(0.56)		(-0.26)	(-0.18)
$DY_{i,t-1}$		0.352**	0.351**		0.389**	0.356**
		(2.07)	(2.06)		(2.38)	(2.25)
$Term_{t-1}$		-0.033	-0.106		-0.084	-0.198
		(-0.71)	(-1.51)		(-0.87)	(-1.63)
Fed_{t-1}			-0.001			-1.993
			(0.01)			(-0.89)
$Euro\$_{t-1}$			-0.007			-0.017
			(-1.47)			(-1.50)
JanD	-0.004	0.006	-0.005	0.015	0.006	0.006
	(-0.58)	(-0.81)	(-0.80)	(1.14)	(0.50)	(0.49)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.084	0.087	0.086	0.062	0.071	0.078

TABLE 4
Summary of macroeconomic and financial variables

This table shows the averages of several country-level financial and macroeconomic variables. CORW is the country's equity market correlation with the world market portfolio. SIZE is the average ratio of market capitalization to GDP. XLIST is the number of all cross-listings from a given country placed on foreign exchanges at the end of 1998 from Sarkissian and Schill (2004). SEG and RATE are the market segmentation proxy and short-term interest rate, respectively. SEG is computed, following Bekaert et al. (2011), as the average absolute difference between the country's inverse price-to-earning ratio and that of the world market. The monthly price-to-earning ratios and interest rates are from Datastream. FREEDOM is the average index of economic freedom in 1995-2006 from the Heritage Foundation. LAW is the anti-self-dealing index from Djankov et al. (2008).

TABLE 4 (continued)

Country	CORW	SIZE	XLIST	SEG	RATE	FREEDOM	LAW
Argentina	0.21	0.58	19	8.73	16.5	66.3	0.34
Australia	0.65	1.02	96	1.45	7.9	76.7	0.76
Austria	0.51	0.16	12	1.84	4.2	70.0	0.21
Belgium	0.68	0.67	27	2.26	4.9	69.3	0.54
Brazil	0.42	0.38	27	6.29	24.4	55.8	0.27
Canada	0.76	1.06	266	1.52	7.2	73.2	0.64
Chile	0.43	0.89	22	5.08	0.7	76.0	0.63
China	0.12	0.43	15	1.41	6.1	52.6	0.76
Colombia	0.31	0.14	4	4.69	7.1	62.2	0.57
Czech Republic	0.55	0.20	5	3.93	7.5	69.6	0.33
Denmark	0.60	0.58	9	2.01	5.9	71.6	0.46
Egypt	0.46	0.30	2	5.16	9.3	52.7	0.20
Finland	0.67	1.77	12	3.33	4.2	70.8	0.46
France	0.72	0.89	69	2.16	5.5	63.1	0.38
Germany	0.71	0.54	112	1.36	4.4	68.6	0.28
Greece	0.46	0.91	9	2.48	8.2	57.9	0.22
Hong Kong	0.52	3.61	19	2.65	5.1	90.1	0.96
Hungary	0.35	0.24	11	2.30	13.6	62.4	0.58
India	0.34	0.33	65	1.80	6.8	49.1	0.58
Indonesia	0.46	0.24	7	5.05	15.4	54.8	0.65
Ireland	0.67	0.67	72	3.51	7.1	76.6	0.79
Israel	0.55	0.53	65	2.69	9.2	63.9	0.73
Italy	0.56	0.52	27	1.06	5.2	64.6	0.42
Japan	0.71	0.69	206	3.27	2.2	70.6	0.50
Korea	0.53	0.54	29	1.84	9.2	69.5	0.47
Malaysia	0.49	1.48	7	1.83	4.6	64.3	0.95
Mexico	0.55	0.21	30	4.09	26.2	61.4	0.17
Netherlands	0.82	1.31	105	3.09	3.2	73.3	0.20
New Zealand	0.62	0.40	22	2.31	9.9	81.0	0.95
Norway	0.66	0.39	19	4.42	7.6	67.4	0.42
Peru	0.22	0.23	3	1.77	8.8	64.3	0.45
Philippines	0.45	0.48	7	2.33	12.2	58.7	0.22
Poland	0.33	0.16	8	4.15	16.0	60.3	0.29
Portugal	0.66	0.46	7	1.77	4.4	65.0	0.44
Russia	0.59	0.33	6	7.45	31.0	49.9	0.44
Singapore	0.63	1.64	5	2.09	3.0	88.4	1.00
South Africa	0.71	1.55	88	2.91	13.0	62.8	0.81
Spain	0.78	0.79	24	2.34	5.6	66.4	0.37
Sri Lanka	0.29	0.10	0	4.33	13.6	61.9	0.39
Sweden	0.74	1.12	47	1.57	4.7	69.0	0.33
Switzerland	0.72	2.49	28	1.79	3.4	77.8	0.27
Taiwan	0.44	1.01	27	1.58	4.4	72.5	0.56
Thailand	0.51	0.44	3	6.28	7.4	67.8	0.81
Turkey	0.36	0.35	7	4.02	64.9	58.8	0.43
United Kingdom	0.73	1.57	176	2.30	8.9	78.4	0.95
United States	0.85	1.42	436	1.10	5.9	78.3	0.65
Average	0.55	0.78	49	3.07	9.9	67.1	0.52

TABLE 5

Relation between Treasury bond illiquidity betas and macroeconomic and financial factors

This table shows the results of regression of countries' average conditional Treasury bond illiquidity betas on the set of country-level macroeconomic and financial variables. CORW is the country's equity market correlation with the world market portfolio multiplied by 100. SIZE is the average ratio of market capitalization to GDP. XLIST is the number of all listings from a given country placed on foreign exchanges at the end of 1998 from Sarkissian and Schill (2004). SEG and RATE are the market segmentation proxy and short-term interest rate, respectively. SEG is computed, following Bekaert et al. (2011), as the average absolute difference between the country's inverse price-to-earning ratio and that of the world market. The monthly price-to-earning ratios and interest rates are from Datastream. FREEDOM is the average index of economic freedom in 1995-2006 from the Heritage Foundation. LAW is the anti-self-dealing index from Djankov et al. (2008). The number of foreign listings and the short rate are taken with logs. The table also reports the adjusted R-squared for each regression. The t-statistics shown in parenthesis are based on robust standard errors. Significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
CORW	0.412***				0.298**	0.333**
	(4.86)				(2.27)	(2.27)
SIZE		5.705**			2.208	
		(1.99)			(0.71)	
XLIST		3.306**			0.444	
		(2.51)			(0.24)	
SEG			-2.697*		-2.062	-2.395**
			(-1.90)		(-1.53)	(-2.06)
RATE			-4.459		-0.107	
			(-1.59)		(-0.58)	
FREEDOM				0.524***	-0.101	
				(2.84)	(0.35)	
LAW				-3.369	-0.945	
				(-0.36)	(-0.09)	
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.268	0.174	0.197	0.071	0.263	0.337

TABLE 6

Tests of the benchmark two-factor global asset pricing model

This table shows the estimation results of the global asset pricing model with the world market portfolios return and Treasury bond illiquidity factors (Model I) for two instrument sets. The sample period is 1977:01(1987:01)-2010:12 for developed (emerging) markets. λ_w is the price of world market risk and λ_{LB} is the price of bond illiquidity risk. The estimates of conditional variances and covariances are from the multivariate GARCH (1,1) model based on Eqs. (6a-c). The instrument set consists of a constant, C, and the lagged values of the AR(2) residual of bond illiquidity, L_B, the world market return, r_w, and the U.S. term spread, Term. The robust t-statistics are shown in parenthesis. The table also shows the degrees of freedom (df) and the goodness-of-fit J-statistic with its corresponding p-value (in squared brackets). Significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Panel A: Instruments: {C, L_B, r_w}

Parameter	All countries	Developed	Emerging
λ_w	3.604***	3.331***	2.656***
	(3.57)	(2.80)	(2.74)
λ_{LB}	-1.914***	-1.868***	-4.696**
	(-3.50)	(-3.09)	(-2.06)
df	139	70	70
J-stat	108.11	61.70	61.19
p-value	[0.975]	[0.749]	[0.764]

Panel B: Instruments: {C, L_B, r_w, Term}

Parameter	All countries	Developed	Emerging
λ_w	5.408***	4.578***	3.471***
	(6.23)	(4.44)	(3.77)
λ_{LB}	-1.187***	-1.106**	-4.053**
	(-2.85)	(-2.38)	(-1.97)
df	186	94	94
J-stat	149.39	93.01	75.67
p-value	[0.977]	[0.509]	[0.916]

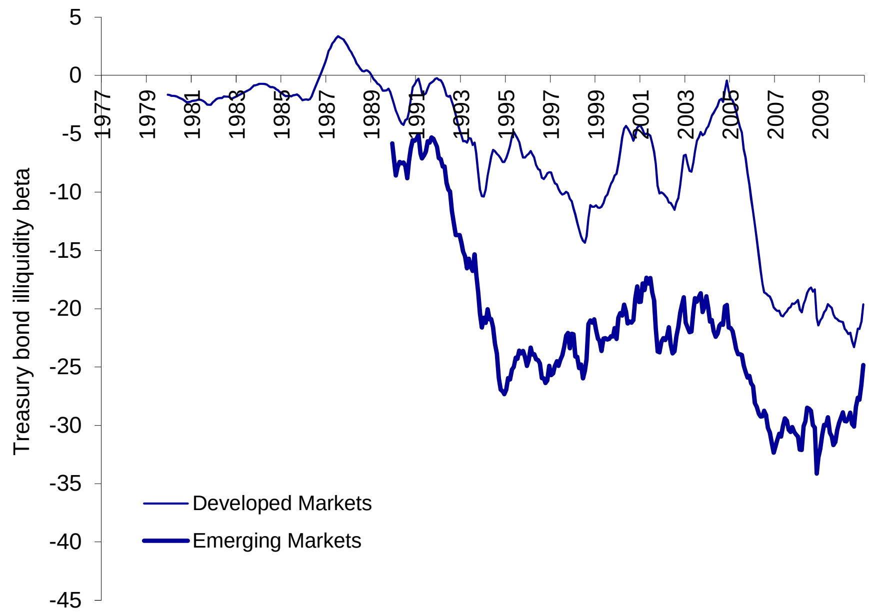
TABLE 7
Tests of alternative global asset pricing models

This table shows the estimation results of three global asset pricing models. The sample period is 1977:01(1987:01)-2010:12 for developed (emerging) markets. λ_w, λ_{Lw}, λ_{LB}, and λ_c are the prices of world market risk, world market illiquidity risk, Treasury bond illiquidity risk, and currency risk, respectively. Ave λ_i and Ave λ_{Li} are the average prices of local market variance risk and local market illiquidity risk, respectively, both across 46 countries. The return on the currency basket deposit is calculated as the equally weighted average change in exchange rates between the U.S. dollar and four global currencies: British Pound, Euro, Japanese Yen, and Swiss Franc. The instrument set consists of a constant, C, and the lagged values of AR(2) residual of bond illiquidity, L_B, world market return, r_w, and the U.S. term spread, Term. The robust t-statistics are shown in parenthesis. The table also shows the degrees of freedom and the goodness-of-fit J-statistic with its corresponding p-value (in squared brackets). Significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

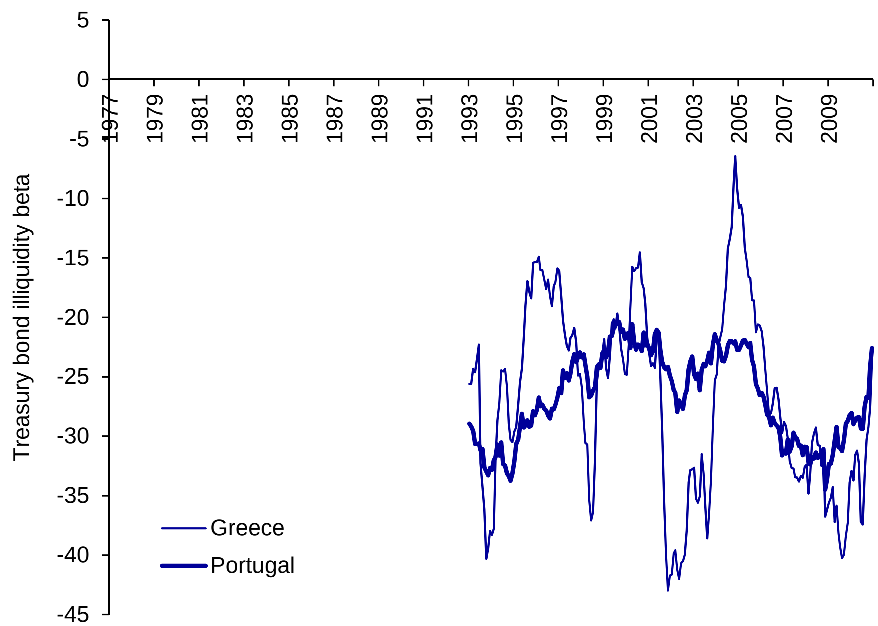
Parameter	Model II	Model III	Model IV
λ_w	5.497***	3.862***	6.180*
	(5.91)	(3.52)	(1.74)
λ_{LB}	-1.132***	-1.658***	-2.360***
	(-2.68)	(-2.63)	(-3.00)
λ_c	-1.672		
	(-0.55)		
λ_{Lw}			-1.351
			(-0.94)
Ave λ_i		0.715	2.973
		(1.33)	(1.02)
Ave λ_{Li}			-2.642
			(-1.16)
df	185	140	93
J-stat	149.40	124.90	62.42
p-value	[0.974]	[0.815]	[0.993]

FIGURE 1
Average conditional Treasury bond illiquidity beta

The figure shows the 36-month average of conditional Treasury bond illiquidity betas for 23 developed markets and 23 emerging markets (Plot A) and for two individual countries, Greece and Portugal (Plot B). The sample period is 1977:01(1987:01)-2010:12 for developed (emerging) markets. The sample period for Greece and Portugal is 1990:03-2010:12. The conditional beta in each market is the ratio of the conditional covariance of country's excess returns with bond illiquidity risk over the conditional variance of bond illiquidity.



Plot A



Plot B

FIGURE 2

Country equity returns and Treasury bond illiquidity betas

The figure shows the relation between the average monthly stock market excess returns and average conditional Treasury bond illiquidity betas for 23 developed (shown with empty circles) and 23 emerging (shown with solid circles) countries. The sample period is 1977:01(1987:01)-2010:12 for developed (emerging) markets. The conditional beta in each market is the ratio of conditional covariance of country's excess returns with bond illiquidity risk over conditional variance of bond illiquidity. Each conditional beta is averaged over the respective sample period. The regression line is shown with dashes. It is significant at the 1% level.