JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS Vol. 49, Nos. 5/6, Oct./Dec. 2014, pp. 1227–1253

doi:10.1017/S0022109014000362

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 a proxy for aggregate worldwide risks.

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 of the impact of U.S. Treasury rates on expected returns in U.S. and global equity markets.[1] Jensen, Mercer, and Johnson (1996) show that the main driving force behind the predictive power of

*Goyenko, ruslan.goyenko@mcgill.ca, Sarkissian, sergei.sarkissian@mcgill.ca, Faculty of Management, McGill University, Montreal, QC, H3A 1G5, Canada. We thank Yakov Amihud, Gurdip Bakshi, Hendrik Bessembinder (the editor), Kristin Forbes, Evan Gatev, David Goldreich, Denis Gromb, Andrew Karolyi, Christian Lundblad (the referee), Pedro Santa-Clara, Rudi Schadt, Michael Schill, Akiko Watanabe, and Guofu Zhou for useful comments. The paper has also benefited from the feedback of participants at the 2008 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, and the 2009 Conference of the Society of Quantitative Analysts, as well as workshops at the University Institute of Lisbon (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 as "Flight to Liquidity and Global Equity Returns." Goyenko acknowledges financial support from Social Sciences and Humanities Research Council (SSHRC). Sarkissian acknowledges financial support from Institut de Finance Mathématique de Montréal (IFM2) and SSHRC.

[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.

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 effects 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 doubt on the ability of interest rates and their 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 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 United States (see Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Amihud (2002), Pastor and Stambaugh (2003), and 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 funds rate is one of the main determinants of Treasury bond illiquidity.

U.S. Treasuries are typically viewed as the safest and most liquid asset class that comprises a significant portion of diversified foreign equity portfolios. Investors outside the United States hold large and increasing stakes in U.S. Treasuries: In 1996 they held close to 28% of all marketable Treasury securities

[2]Empirical support for the contemporaneous link between interest rates and stock returns is also presented in Stone (1974), Sweeney and Warga (1986), and Ferson and Harvey (1993), among others.

[3]A few studies here are Bailey (1990) and Wongswan (2006), (2009), who document the limited impact of the U.S. monetary policy proxy, the Federal Open Market Committee decisions, on equity markets in other countries.

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 et al. (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.

We proceed as follows: First, we show that the main determinants of Treasury bond illiquidity are 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 a similar conclusion using the Taylor (1993) rule after relating bond illiquidity to unexpected monetary policy shocks. These findings confirm the main message in Goyenko et al. (2011) that Treasury bond illiquidity reflects changes in U.S. monetary policy and in 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 United States (see, e.g., Jensen et al. (1996), Patelis (1997), Thorbecke (1997), and 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. Indeed, we find that bond illiquidity significantly negatively predicts stock returns in developed and emerging markets and in different subperiods. 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 funds rate, and the eurodollar rate, as well as local and world stock market illiquidity.

Finally, we explore the importance of 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 et al. (2007), we conduct our estimation in two steps. In the first step, we use the multivariate generalized autoregressive conditional heteroskedasticity (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 the generalized method of moments (GMM) and estimate prices of risk for both the entire sample of countries and for developed and emerging market subsamples. 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,

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

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 markets in 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 that 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 that 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, of which 23 are classified as developed and 23 as emerging. It covers the 34-year period from Jan. 1977 to Dec. 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 International Finance Corporation (IFC) Global Indices. We construct excess returns by subtracting the 1-month U.S. T-bill rate from gross returns. Following Bekaert et al. (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 equal-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 equal-weighted proportion of zero daily returns across all firms in a country during a month. The world stock market illiquidity is the equal-weighted average of country-level aggregate illiquidity series.

Goyenko et al. (2011) find that the illiquidity of off-the-run T-bills with maturities of up to 1 year captures the illiquidity of the Treasury market overall

[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.

better than that of 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 3-, 6-, and 12-month securities available from the Center for Research in Security Prices (CRSP) daily Treasury Quotes file to proxy for 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]

Table 1 presents the number of observations, means, volatilities, and first-order autocorrelations of monthly excess equity returns, dividend yields, and stock market 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 in developed markets (28% vs. 24%), as expected. Note, however, that while Zeros is highly correlated with transaction costs, it does not directly indicate the magnitude of illiquidity

TABLE 1

Summary Statistics

Table 1 presents the number of observations, means, volatilities (σ), and first-order autocorrelations (ρ) of monthly excess equity returns (in U.S. dollars), dividend yields, and stock market illiquidity for 23 developed and 23 emerging countries. The sample period is Jan. 1977–Dec. 2010. The data are from Datastream and IFC. The returns are in U.S. dollars in excess of the 1-month U.S. T-bill rate. Market illiquidity is the equal-weighted average proportion of zero daily returns in a month.

		Market Return			Dividend Yield			Market Illiquidity		
Country	No. of Obs.	Mean	σ	ρ	Mean	σ	ρ	Mean	σ	ρ
Developed Countries										
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

(continued on next page)

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

TABLE 1 (continued)

Summary Statistics

Country	No. of Obs.	Market Return Mean	Market Return σ	Market Return ρ	Dividend Yield Mean	Dividend Yield σ	Dividend Yield ρ	Market Illiquidity Mean	Market Illiquidity σ	Market Illiquidity ρ
Emerging Countries										
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 (all countries)	309	0.010	0.088	0.111	0.234	0.105	0.943	0.256	2.283	0.884

(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 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 second-order autoregressive (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 presented in Table 2. The first three columns of the table report the results for the whole 34-year sample period, while the last three are for the second 17-year subperiod. 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 (1987) standard errors corrected for six lags.

Our first specification, regressions (1) and (4), includes three predictors: the lagged world stock market illiquidity shock, $L_{w,t-1}$, and the lagged world excess equity return and volatility, $r_{w,t-1}$ and $\sigma_{w,t-1}$, respectively. The monthly

TABLE 2

Determinants of Treasury Bond Illiquidity

Table 2 shows the relation between U.S. Treasury bond illiquidity shocks and the lagged value of world market illiquidity shock, L_W, and other global predictors. The sample has 46 countries and covers a period from Jan. 1977 to Dec. 2010. Treasury bond illiquidity, L_B, is off-the-run illiquidity of T-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 equal-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 1-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. 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 (1987) standard errors with six lags correction. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, 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)
$\text{FED}_{W,t-1}$		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-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

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 a statistically significant impact on bond illiquidity, although its significance is present only in the later subperiod. 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 1-month T-bill. We find, similarly to Goyenko et al. (2011), that changes in the Fed funds rate have positive predictive power for bond illiquidity over the whole sample and, in statistical terms, are even stronger in the second subperiod. The presence of the Fed funds rate knocks out the negative predictive power of 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 the 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 shows any importance for the illiquidity of Treasuries, again leaving world market volatility to pick up the bulk of the predictive power in the absence of the Fed funds rate.

While Table 2 shows the linkage between bond illiquidity and 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 (1993) rule, augmented with the lagged rate to allow for interest-rate smoothing (see Bernanke and Boivin (2003)), namely:

$$\text{(1)} \qquad \text{FED}_t = \phi^0 + \phi^1 \text{FED}_{t-1} + \phi^{\pi}\left(\pi_t - \pi_t^*\right) + \phi^{y}\left(y_t - \bar{y}_t\right) + e_t^{\text{FED}},$$

where π_t is the inflation rate, π_t^* is the target inflation rate, y_t is the log of real gross domestic product (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 equation (1), $\hat{e}_{t-1}^{\text{FED}}$. In this simple framework, we find the coefficient on $\hat{e}_{t-1}^{\text{FED}}$ 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]

In sum, Treasury bond illiquidity is related to changes in U.S. monetary policy, which, in turn, reflects changes in the overall macroeconomic environment. A similar point is made by Balduzzi et al. (2001) and Green (2004), who find that macroeconomic news affects the illiquidity of Treasuries. To this, we add that Treasury bond illiquidity also captures changes in monetary policy not explained by the Taylor (1993) rule. Moreover, since the Treasury bond market is an

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

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 subsection, we test whether it has predictive power for global equity returns. Since a positive shock to bond illiquidity is associated with tightening of 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^2, 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 1-month eurodollar deposit rate, and the January dummy, the last being included in every regression. All regressions also include the year-fixed effects.

Panel A of Table 3 gives 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 (1987) 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 conduct our estimation on the full sample period (columns (1)–(4)) and the two 17-year subperiods, 1977–1993 and 1994–2010 (columns (5) and (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 predictive power at the standard 5% level (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 subperiods, with its magnitude increasing in the second half of the sample. The second subperiod 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 subperiods.

The predictive relation between Treasury bond illiquidity and world equity market excess returns is economically important as well. Since a 1 standard deviation of bond illiquidity is 0.002, a 1-standard-deviation positive shock to bond illiquidity, based, for instance, on the output of regression (4), implies a

[8]For example, Conway (2011) writes: "Investors staged a global flight from risk Thursday that sent U.S. stocks plummeting 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."

TABLE 3

Predictive Regressions of Country Equity Returns

Table 3 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 1-month eurodollar deposit rate, and JAN_D is the January dummy. Regressions include year-fixed effects (Panels A–C) and country-fixed effects (Panels B and C), 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 (1987) standard errors with six lags, while those in Panels B and C are based on standard errors clustered by time. The *t*-statistics are shown in parentheses. The full sample period is 1977–2010 (1987–2010 for emerging markets). Adj. R^2 is the adjusted *R*-squared. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Full Sample Period				Subperiods	
	(1)	(2)	(3)	(4)	1977–1993	1994–2010
Panel A. Dependent Variable: World Stock Market Returns						
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)
JAN_D	−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-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.065	0.059	0.103	0.118	0.211	0.118
Panel B. Dependent Variable: Local Stock Market Returns						
$L_{B,t-1}$	−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)
JAN_D	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-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.042	0.050	0.053	0.073	0.055	0.094

(continued on next page)

TABLE 3 (continued)

Predictive Regressions of Country Equity Returns

	Developed Markets			Emerging Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C. Developed and Emerging Market Subsamples						
$L_{B,t-1}$	−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)
JAN_D	−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-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.084	0.087	0.086	0.062	0.071	0.078

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) and (6) correspond to subperiod tests. The first four regressions show that over the entire sample period, bond illiquidity retains its negative and statistically and highly significant predictive power for local stock returns. Moreover, this relation again mostly survives the subperiod 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) are for emerging markets. As in 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 et al. (2003)). Finally, the lagged local market illiquidity is essentially 0 for all markets.

Thus, the Treasury bond illiquidity predicts global stock returns at the world and individual country levels, over different subperiods, 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 U.S. monetary policy and its macroeconomic environment affect not only stock prices in the United States 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 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,

$$\text{(2)} \qquad \mathrm{E}_{t-1}\left(r_{i,t}\right) \quad = \quad \lambda_w \mathrm{cov}_{t-1}\left(r_{i,t}, r_{w,t}\right) + \lambda_{\mathrm{LB}} \mathrm{cov}_{t-1}\left(r_{i,t}, L_{B,t}\right),$$

where λ_w is the price of the world market risk and λ_{LB} is the price of the Treasury bond illiquidity risk. Equation (2) represents our benchmark 2-factor model.[10] Economically and statistically significant λ_{LB} values would suggest that the risk associated with changes in 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). In the absence of stock illiquidity, due to 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), Bernanke and Kuttner (2005)). Therefore, as we expected a negative *predictive* relation, we also expect a negative *contemporaneous* relation between bond illiquidity and global

[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) intertemporal capital asset pricing model (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: the world market return and the change in a variable that describes the state of investment opportunities in that country's economy (bond illiquidity, in our case).

stock returns. This effect is also similar to that between stock illiquidity and equity returns (see Amihud (2002)), implying a $\text{cov}_{t-1}(r_{i,t}, L_{B,t})$ term that is, on average, negative. Therefore, if bond illiquidity is a systematic risk factor in international equity markets, λ_{LB} must have a negative sign as well. This is our main testable hypothesis.

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 et al. (1989), Fama and Schwert (1977), and 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 using 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, which ultimately influence 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:

$$\text{(3)} \qquad \text{E}_{t-1}\left(r_{i,t}\right) = \lambda_w \text{cov}_{t-1}\left(r_{i,t}, r_{w,t}\right) + \lambda_{\text{LB}} \text{cov}_{t-1}\left(r_{i,t}, L_{B,t}\right) + \lambda_c \text{cov}_{t-1}\left(r_{i,t}, r_{c,t}\right),$$

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 equal-weighted average change in exchange rates between the U.S. dollar and four global currencies: the British pound, the euro, the Japanese yen, and the 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 a 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 (i.e., $\text{E}_{t-1}(r_{i,t}) = \lambda_i \text{var}_{t-1}(r_{i,t})$), where λ_i is the price of country i's 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, that is:

$$\text{(4)} \qquad \text{E}_{t-1}\left(r_{i,t}\right) = \lambda_w \text{cov}_{t-1}\left(r_{i,t}, r_{w,t}\right) + \lambda_{\text{LB}} \text{cov}_{t-1}\left(r_{i,t}, L_{B,t}\right) + \lambda_i \text{var}_{t-1}\left(r_{i,t}\right).$$

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

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), and Acharya and Pedersen (2005)). There is some evidence that stock market illiquidity is also important in global markets (see Bekaert et al. (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:

$$\text{(5)} \quad \mathrm{E}_{t-1}(r_{i,t}) = \lambda_w \mathrm{cov}_{t-1}(r_{i,t}, r_{w,t}) + \lambda_{\mathrm{LB}} \mathrm{cov}_{t-1}(r_{i,t}, L_{B,t}) + \lambda_i \mathrm{var}_{t-1}(r_{i,t}) + \lambda_{Li} \mathrm{cov}_{t-1}(r_{i,t}, L_{i,t}),$$

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 5-factor model. Also, following Acharya and Pedersen (2005), one could consider other stock market illiquidity–based covariance risks (e.g., $\mathrm{cov}_{t-1}(r_{w,t}, L_{i,t})$, $\mathrm{cov}_{t-1}(L_{B,t}, L_{i,t})$, or $\mathrm{cov}_{t-1}(L_{w,t}, L_{i,t})$). However, these model specifications will render our estimation impractical.

B. Estimation Details

Evaluating Models I–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 multicountry or multiasset 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 et al. (2007), respectively. Including the lagged stock market return is a common practice in conditional asset pricing, although it

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

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 et al. (2011). Third, the change in the exchange rate is predicted by the lagged world market return and the 1-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 et al. (2005)).

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:

$$\text{(6a)} \quad r_{i,t} = \delta_{10} + \delta_{11} L_{B,t-1} + \delta_{12} r_{i,t-1} + \delta_{13} L_{i,t-1} + \delta_{14} \text{DY}_{i,t-1} + \delta_{15} \text{TERM}_{t-1} + e_{i,t},$$

$$\text{(6b)} \quad r_{w,t} = \delta_{20} + \delta_{21} L_{B,t-1} + \delta_{22} r_{w,t-1} + \delta_{23} L_{w,t-1} + \delta_{24} \text{DY}_{w,t-1} + \delta_{25} \text{TERM}_{t-1} + e_{w,t},$$

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

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

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

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

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

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

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

In the full system of equations (6a)–(6f), the error term is $e_t = [e_{i,t}, e_{w,t}, e_{\text{LB},t}, e_{c,t}, e_{Li,t}, e_{Lw,t}]$. It is assumed to be a multivariate normal distribution with conditional variance-covariance matrix H_t. The matrix H_t has the Baba, Engle, Kraft, and Kroner (BEKK) (1991) 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 $(M \times M)$ upper triangular matrix and A and B are $(M \times M)$ 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

$$\text{(7)} \quad \begin{aligned} \zeta_{i,t} &= r_{i,t} - \lambda_w \widehat{\text{cov}}_{t-1}(r_{i,t}, r_{w,t}) - \lambda_{\text{LB}} \widehat{\text{cov}}_{t-1}(r_{i,t}, L_{B,t}) \\ &\quad - \lambda_i \widehat{\text{var}}_{t-1}(r_{i,t}) - \lambda_{Li} \widehat{\text{cov}}_{t-1}(r_{i,t}, L_{i,t}), \\ \zeta_{w,t} &= r_{w,t} - \lambda_w \widehat{\text{var}}_{t-1}(r_{w,t}) - \lambda_{\text{LB}} \widehat{\text{cov}}_{t-1}(r_{w,t}, L_{B,t}) \\ &\quad - \lambda_{Lw} \widehat{\text{cov}}_{t-1}(r_{w,t}, L_{w,t}), \end{aligned}$$

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; $i = 1, \ldots, N$; and N is the number of countries (46 for the whole sample or 23 for the subsamples 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, where $i = 1, \ldots, N$;

Model IV: λ_w, λ_{LB}, λ_{Lw}, λ_i, λ_{Li}, where $i = 1, \ldots, N$.

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 the 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, $Z_{t-1} = [1, L_{B,t-1}, r_{w,t-1}, \mathrm{TERM}_{t-1}]$. This gives $4N+4$ orthogonality conditions in the GMM estimation. In smaller GMM systems (Model I), we also use a shorter instrument vector, which we obtain 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 the 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 prewhitening 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 equations (6a)–(6c). In particular, given the estimates of the conditional variance of Treasury bond illiquidity, $\widehat{\mathrm{var}}_{t-1}(L_{B,t})$, and the conditional covariance of country returns with bond illiquidity, $\widehat{\mathrm{cov}}_{t-1}(r_{i,t}, L_{B,t})$, we can construct for each country i its conditional bond illiquidity beta as

$$\text{(8)} \qquad \mathrm{BETA}_{i,t-1}(L_{B,t}) = \frac{\widehat{\mathrm{cov}}_{t-1}(r_{i,t}, L_{B,t})}{\widehat{\mathrm{var}}_{t-1}(L_{B,t})}.$$

In Graph A of Figure 1, we show the average 36-month conditional bond illiquidity betas for developed and emerging markets. Three things are notable in this graph. First, the average bond illiquidity beta is lower in emerging markets than in developed markets. This is consistent with the intuition that the effect of

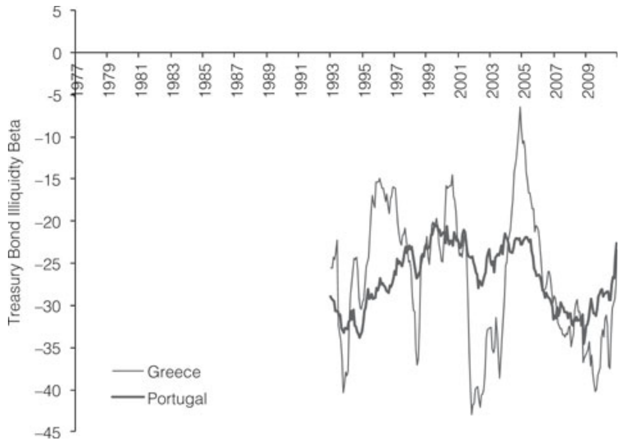
FIGURE 1

Average Conditional Treasury Bond Illiquidity Betas

Figure 1 shows the 36-month average of conditional Treasury bond illiquidity betas for 23 developed markets and 23 emerging markets (Graph A) and for two individual countries, Greece and Portugal (Graph B). The sample period is Jan. 1977 (Jan. 1987)–Dec. 2010 for developed (emerging) markets. The sample period for Greece and Portugal is Mar. 1990–Dec. 2010. The conditional beta in each market is the ratio of the conditional covariance of the country's excess returns with bond illiquidity risk over the conditional variance of bond illiquidity.

Graph A. Treasury Bond Illiquidity Betas for Developed and Emerging Markets

Graph B. Treasury Bond Illiquidity Betas for Greece and Portugal



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 those in developed countries. Second, the impact of the recent financial crisis is clearly visible. The exposure of all countries to Treasury bond illiquidity risk (i.e., bond illiquidity beta) is the highest (most negative) over the latest sample period, consistent with reality and reflecting the 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 0 around 2005 to a level similar to that of emerging countries in the mid-2000s.

In Graph B of Figure 1, we present the time series of conditional bond illiquidity betas for two developed countries, Greece and Portugal, which 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 for 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 the bond illiquidity betas of those two countries approached (for Portugal) or surpassed (for Greece) the average level of emerging markets, as shown in Graph A.

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 illiquidity betas. The plot differentiates between developed and emerging markets. First, most bond illiquidity betas are negative, and there is a downward trend between these betas and mean excess stock returns. This implies that the lower in absolute terms the country's stock market exposure to the illiquidity of U.S. Treasuries is, the lower its expected return is. Second, illiquidity betas are much more negative on average for emerging markets than for developed markets. The only two emerging markets with bond illiquidity betas close to 0 are Malaysia and the 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 the beta's cross-sectional differences. Table 4 reports results for country-level variables that we believe may affect bond illiquidity betas, that is, impact the exposure of countries'

FIGURE 2

Country Equity Returns and Treasury Bond Illiquidity Betas

Figure 2 shows the relation between the average monthly stock market excess returns and the 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 Jan. 1977 (Jan. 1987)–Dec. 2010 for developed (emerging) markets. The conditional beta in each market is the ratio of conditional covariance of the country's excess returns with bond illiquidity risk to 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.

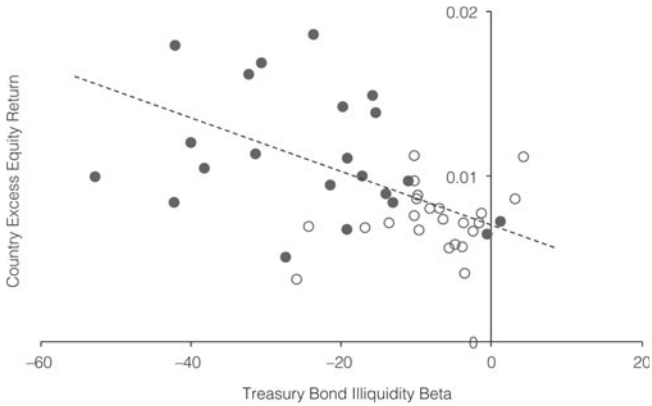


TABLE 4

Summary of Macroeconomic and Financial Variables

Table 4 presents 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-earnings ratio and that of the world market. The monthly price-to-earnings 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).

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

equity market returns to U.S. monetary policy shifts. CORW is the country 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, La Porta, Lopez-de-Silanes, and Shleifer (2008). XLIST is the number of all foreign listings from a given country placed on foreign exchanges at 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 its exposure to U.S. monetary and macroeconomic shocks is, and hence the lower in absolute terms its bond illiquidity betas are. SEG is a market segmentation proxy computed, in the spirit of Bekaert, Harvey, Lundblad, and Siegel (2011), as the average absolute difference between a country's inverse price-to-earnings ratio and that of the world market.[13] RATE is the short-term interest rate. The monthly price-to-earnings 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 the level of its nominal interest rates is, the higher the probability is for a negative reaction of its equity market to U.S. monetary policy tightening and, hence, the higher (more negative) its bond illiquidity beta is. 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, from Djankov et al. (2008). These two variables can be thought of as "investor environment" proxies. Countries 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 interest rate are taken with logs. Regression (1) includes only CORW, which produces a positive and significant slope coefficient. This implies that the higher the correlation between the local stock market and the world market is, the lower its sensitivity, in absolute terms, to bond illiquidity shocks is. Since a 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 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 in the United States. After using all proxies in regression (5), we find that the only variable that retains its sign and significance at the 5% level is CORW. Since the sample size of our tests in this subsection 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, CORW and SEG. In this estimation, both

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

TABLE 5

Relation between Treasury Bond Illiquidity Betas and Macroeconomic and Financial Factors

Table 5 presents 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. 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-earnings ratio and that of the world market. The monthly price-to-earnings 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-term interest rate are taken with logs. The table also reports the adjusted R^2 for each regression. The t-statistics, shown in parentheses, are based on robust standard errors. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Regression					
	(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

of them are significant, with positive (CORW) and negative (SEG) signs. Note that this regression attains the highest adjusted R^2 among all specifications.

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

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 2-factor model (Model I). Table 6 presents 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 we use its full version. The conditional variances and covariances are obtained from the multivariate GARCH$(1, 1)$ using equations (6a)–(6c).

TABLE 6

Tests of the Benchmark 2-Factor Global Asset Pricing Model

Table 6 presents 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 Jan. 1977 (Jan. 1987)–Dec. 2010 for developed (emerging) markets. Here, 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 equations (6a)–(6c). 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 parentheses. The table also presents the degrees of freedom (df) and the goodness-of-fit *J*-statistic with its corresponding *p*-value (in square brackets). *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Parameter	All Countries	Developed	Emerging
Panel A. Instruments: C, L_B, r_W			
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-statistic	108.11	61.70	61.19
p-value	[0.975]	[0.749]	[0.764]
Panel B. Instruments: C, L_B, r_W, TERM			
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-statistic	149.39	93.01	75.67
p-value	[0.977]	[0.509]	[0.916]

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 et al. (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, $\mathrm{cov}_{t-1}(r_{i,t}, r_{w,t})$, which is 0.002, we can compute the average expected equity market return for a typical country attributed to the world market risk factor, $\lambda_w \mathrm{cov}_{t-1}(r_{i,t}, r_{w,t})$. We find that $\lambda_w \mathrm{cov}_{t-1}(r_{i,t}, r_{w,t})$ is about 10.8% 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 subsamples 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 $\mathrm{cov}_{t-1}(r_{i,t}, L_{B,t})$ from the first-stage estimation to compute the average annual equity market premium attributed to bond illiquidity risk, $\lambda_{\mathrm{LB}} \mathrm{cov}_{t-1}(r_{i,t}, L_{B,t})$. 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 10.8%. Note that the magnitude of the bond illiquidity premium is comparable to that of the 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 those in developed markets (on average, 4.4 vs. 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 arise 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, and 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.

TABLE 7

Tests of Alternative Global Asset Pricing Models

Table 7 gives the estimation results of three global asset pricing models. The sample period is Jan. 1977 (Jan. 1987)–Dec. 2010 for developed (emerging) markets. Here, 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. Avg λ_i and Avg 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 equal-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 parentheses. The table also gives the degrees of freedom (df) and the goodness-of-fit *J*-statistic with its corresponding *p*-value (in square brackets). *, **, and *** indicate significance at the 10%, 5%, and 1% levels, 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)
Avg λ_i		0.715	2.973
		(1.33)	(1.02)
Avg λ_{Li}			−2.642
			(−1.16)
df	185	140	93
J-statistic	149.40	124.90	62.42
p-value	[0.974]	[0.815]	[0.993]

The price of the world exchange risk, λ_c, is negative but insignificant. The second column of Table 7 gives 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. As in 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 the 3rd column of Table 7, we test the performance of Model IV, a 4-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 1% level. Neither 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 degrees of 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 3-factor model of full market integration, one similar to our Model II, but in which 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 from the authors.

VI. Conclusion

In this paper, we show that the illiquidity of U.S. Treasuries has a 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 the sensitivity of an asset is to an increase in the illiquidity of U.S. Treasuries due to monetary contraction or other negative macroeconomic shocks, the larger the asset's expected return is.

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 the one 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 the one 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.

References

Acharya, V.; Y. Amihud; and S. Bharath. "Liquidity Risk of Corporate Bond Returns." Working Paper, New York University (2009).

Acharya, V., and L. Pedersen. "Asset Pricing with Liquidity Risk." *Journal of Financial Economics*, 77 (2005), 375–410.

Amihud, Y. "Illiquidity and Stock Returns: Cross-Section and Time-Series Effects." *Journal of Financial Markets*, 5 (2002), 31–56.

Amihud, Y., and H. Mendelson. "Asset Pricing and the Bid-Ask Spread." *Journal of Financial Economics*, 17 (1986), 223–249.

Andersen, T., and B. Sørensen. "GMM Estimation of a Stochastic Volatility Model: A Monte Carlo Study." *Journal of Business and Economic Statistics*, 14 (1996), 328–352.

Andrews, D., and J. Monahan. "An Improved Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimator." *Econometrica*, 60 (1992), 953–966.

Ang, A., and G. Bekaert. "Stock Return Predictability: Is It There?" *Review of Financial Studies*, 20 (2007), 651–707.

Baba, Y.; R. Engle; D. Kraft; and K. Kroner. "Multivariate Simultaneous Generalized ARCH." Working Paper, University of California at San Diego (1991).

Baele, L.; G. Bekaert; and K. Inghelbrecht. "The Determinants of Stock and Bond Return Comovements." *Review of Financial Studies*, 23 (2010), 2374–2428.

Bailey, W. "U.S. Money Supply Announcements and Pacific Rim Stock Markets: Evidence and Implications." *Journal of International Money and Finance*, 9 (1990), 344–356.

Balduzzi, P.; E. Elton; and T. Green. "Economic News and Bond Prices: Evidence from U.S. Treasury Market." *Journal of Financial and Quantitative Analysis*, 36 (2001), 523–543.

Bekaert, G., and C. Harvey. "Time-Varying World Market Integration." *Journal of Finance*, 50 (1995), 403–444.

Bekaert, G.; C. Harvey; and C. Lundblad. "Liquidity and Expected Returns: Lessons from Emerging Markets." *Review of Financial Studies*, 20 (2007), 1783–1832.

Bekaert, G.; C. Harvey; C. Lundblad; and S. Siegel. "What Segments Equity Markets?" *Review of Financial Studies*, 24 (2011), 3841–3890.

Benston, G., and R. Hagerman. "Determinants of Bid-Ask Spreads in the Over-the-Counter Market." *Journal of Financial Economics*, 1 (1974), 353–364.

Bernanke, B., and A. Blinder. "Credit, Money, and Aggregate Demand." *American Economic Review*, 78 (1988), 435–439.

Bernanke, B., and A. Blinder. "The Federal Funds Rate and the Channels of Monetary Transmission." *American Economic Review*, 82 (1992), 901–921.

Bernanke, B., and J. Boivin. "Monetary Policy in a Data-Rich Environment." *Journal of Monetary Economics*, 50 (2003), 525–546.

Bernanke, B., and M. Gertler. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *Journal of Economic Perspectives*, 9 (1995), 27–48.

Bernanke, B., and K. Kuttner. "What Explains the Stock Market's Reaction to Federal Reserve Policy?" *Journal of Finance*, 60 (2005), 1221–1257.

Breen, W.; L. Glosten; and R. Jagannathan. "Economic Significance of Predictable Variations in Stock Index Returns." *Journal of Finance*, 44 (1989), 1177–1190.

Brennan, M., and A. Subrahmanyam. "Market Microstructure and Asset Pricing: On the Compensation for Illiquidity in Stock Returns." *Journal of Financial Economics*, 41 (1996), 441–464.

Campbell, J. "Stock Returns and the Term Structure." *Journal of Financial Economics*, 18 (1987), 373–399.

Campbell, J., and S. Thompson. "Predicting Excess Stock Returns Out of Sample: Can Anything Beat the Historical Average?" *Review of Financial Studies*, 21 (2008), 1509–1531.

Chan, K. C.; G. A. Karolyi; and R. Stulz. "Global Financial Markets and the Risk Premium on U.S. Equity." *Journal of Financial Economics*, 32 (1992), 137–167.

Chen, N.-F.; R. Roll; and S. Ross. "Economic Forces and the Stock Market." *Journal of Business*, 59 (1986), 383–403.

Chordia, T.; A. Sarkar; and A. Subrahmanyam. "An Empirical Analysis of Stock and Bond Market Liquidity." *Review of Financial Studies*, 18 (2005), 85–129.

Conway, B. "Stock Investors Head for Exits." *The Wall Street Journal* (Sept. 22, 2011).

De Santis, G., and B. Gerard. "International Asset Pricing and Portfolio Diversification with Time-Varying Risk." *Journal of Finance*, 52 (1997), 1881–1912.

Diamond, D., and P. Dybvig. "Bank Runs, Deposit Insurance, and Liquidity." *Journal of Political Economy*, 91 (1983), 401–419.

Djankov, S.; R. La Porta; F. Lopez-de-Silanes; and A. Shleifer. "The Law and Economics of Self-Dealing." *Journal of Financial Economics*, 88 (2008), 430–465.

Dumas, B., and B. Solnik. "The World Price of Foreign Exchange Risk." *Journal of Finance*, 50 (1995), 445–479.

Engle, R. "Dynamic Conditional Correlation: A Simple Class of Multivariate GARCH Models." *Journal of Business and Economic Statistics*, 20 (2002), 339–350.

Engle, R., and K. Kroner. "Multivariate Simultaneous Generalized ARCH." *Econometric Theory*, 11 (1995), 122–150.

Errunza, V., and E. Losq. "International Asset Pricing under Mild Segmentation: Theory and Test." *Journal of Finance*, 40 (1985), 105–124.

Fama, E., and K. French. "Business Conditions and Expected Returns on Stocks and Bonds." *Journal of Financial Economics*, 25 (1989), 23–49.

Fama, E., and G. Schwert. "Asset Returns and Inflation." *Journal of Financial Economics*, 5 (1977), 115–146.

Ferson, W., and S. Foerster. "Finite Sample Properties of the Generalized Method of Moments in Tests of Conditional Asset Pricing Models." *Journal of Financial Economics*, 36 (1994), 29–55.

Ferson, W., and C. Harvey. "The Risk and Predictability of International Equity Returns." *Review of Financial Studies*, 6 (1993), 527–566.

Ferson, W.; S. Sarkissian; and T. Simin. "Spurious Regressions in Financial Economics?" *Journal of Finance*, 58 (2003), 1393–1413.

Fong, K.; C. Holden; and C. Trzcinka. "What Are the Best Liquidity Proxies for Global Research?" Working Paper, University of New South Wales (2011).

Goyal, A., and I. Welch. "Predicting the Equity Premium with Dividend Ratios." *Management Science*, 49 (2003), 639–654.

Goyal, A., and I. Welch. "A Comprehensive Look at the Empirical Performance of Equity Premium Prediction." *Review of Financial Studies*, 21 (2008), 1455–1508.

Goyenko, R.; C. Holden; and C. Trzcinka. "Do Liquidity Measures Measure Liquidity?" *Journal of Financial Economics*, 92 (2009), 153–181.

Goyenko, R.; A. Subrahmanyam; and A. Ukhov. "The Term Structure of Bond Market Liquidity." *Journal of Financial and Quantitative Analysis*, 46 (2011), 111–139.

Goyenko, R., and A. Ukhov. "Stock and Bond Market Liquidity: A Long-Run Empirical Analysis." *Journal of Financial and Quantitative Analysis*, 44 (2009), 189–212.

Green, C. "Economic News and the Impact of Trading on Bond Prices." *Journal of Finance*, 59 (2004), 1201–1234.

Harvey, C. "The World Price of Covariance Risk." *Journal of Finance*, 46 (1991), 111–157.

Hasbrouck, J. "Trading Costs and Returns for US Equities: Estimating Effective Costs from Daily Data." *Journal of Finance*, 64 (2009), 1445–1477.

Jensen, G.; J. Mercer; and R. Johnson. "Business Conditions, Monetary Policy and Expected Security Returns." *Journal of Financial Economics*, 40 (1996), 213–238.

Kashyap, A., and J. Stein. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review*, 90 (2000), 407–428.

Lee, K.-H. "The World Price of Liquidity Risk." *Journal of Financial Economics*, 99 (2011), 136–161.

Lesmond, D.; J. Ogden; and C. Trzcinka. "A New Estimate of Transactions Costs." *Review of Financial Studies*, 12 (1999), 1113–1141.

Longstaff, F. "The Flight-to-Liquidity Premium in U.S. Treasury Bond Prices." *Journal of Business*, 77 (2004), 511–526.

Merton, R. "An Intertemporal Capital Asset Pricing Model." *Econometrica*, 41 (1973), 867–887.

Newey, W., and K. West. "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica*, 55 (1987), 703–708.

Pastor, L., and R. Stambaugh. "Liquidity Risk and Expected Stock Returns." *Journal of Political Economy*, 111 (2003), 642–685.

Patelis, A. "Stock Return Predictability and the Role of Monetary Policy." *Journal of Finance*, 52 (1997), 1951–1972.

Rigobon, R., and B. Sack. "The Impact of Monetary Policy on Asset Prices." *Journal of Monetary Economics*, 51 (2004), 1553–1575.

Sarkissian, S., and M. Schill. "The Overseas Listing Decision: New Evidence of Proximity Preference." *Review of Financial Studies*, 17 (2004), 769–809.

Stone, B. "Systematic Interest-Rate Risk in a Two-Index Model of Returns." *Journal of Financial and Quantitative Analysis*, 9 (1974), 709–721.

Sweeney, R., and A. Warga. "The Pricing of Interest Rate Risk: Evidence from the Stock Market." *Journal of Finance*, 41 (1986), 393–410.

Taylor, J. "Discretion versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy*, 39 (1993), 195–214.

Thorbecke, W. "On Stock Market Returns and Monetary Policy." *Journal of Finance*, 52 (1997), 635–654.

Wongswan, J. "Transmission of Information across International Equity Markets." *Review of Financial Studies*, 19 (2006), 1157–1189.

Wongswan, J. "The Response of Global Equity Indexes to U.S. Monetary Policy Announcements." *Journal of International Money and Finance*, 28 (2009), 344–365.