# Online Appendix to "International Illiquidity" Not for Publication

This online appendix contains three sections. We first study how our country-level illiquidity proxies are related to country-level illiquidity measures using the methodology in Amihud (2002). We then study how the country-level illiquidity proxies are related to measures of country-level VIX. In the last section, we compare our global illiquidity proxies to other common proxies of illiquidity extracted from bond markets.

## Appendix OA-1 Comparison with Amihud (2002) Illiquidity

In the following, we compare our illiquidity measures to the Amihud (2002) illiquidity measure as it is one of the most widely used proxies of market liquidity and has been shown to be a significant risk factor in the cross-section of international stock returns (see, e.g., Amihud, Hameed, Kang, and Zhang (2015) and Karolyi, Lee, and van Dijk (2017)).

Summary statistics are reported in Table OA-1 and value-weighted averages of the Amihud illiquidity measures are plotted in Figure OA-1 together with our illiquidity proxies. We note that overall correlations between the two measures vary a lot. For example, correlations range from as little as 10% for Germany to 43% for the US. We also find that the correlations seem to become stronger after 2008, when the two measures co-move more. The strong correlation between market and funding illiquidity is also the focus of Dudley (2016) who finds that during the 2008/2009 crisis, funding illiquidity, measured by volume of dealer-funded repos backed by US Treasuries, and market illiquidity, measured by bid-ask spreads on Treasury bond yields, comoved strongly. Pre- and post-crisis, however, market illiquidity did not display a lot of variation.

**Table OA-1**
**Average Market Illiquidity**

| CA | GE | UK | SW | US | JP |
|---|---|---|---|---|---|
| 0.26 | 0.38 | 0.12 | 0.15 | 0.06 | 0.34 |

## Appendix OA-2 Comparison with Country-Level VIX

There is an intimate link between margins and market volatility. Per a Congressional mandate, margins on stocks have been controlled by the Federal Reserve since 1934. The objective of this regulation includes curbing excessive leverage and reducing the stock price volatility. However, empirical evidence on the relationship between margins and stock market volatility is often ambiguous. On the one hand, Schwert (1989) and Hsieh and Miller (1990) find no effect from margin requirements as set by the Federal Reserve on prices but find that market volatility tends to increase together with margins. More recently, Hedegaard (2014) finds a large effect from margins onto volatility in the commodity market. Hardouvelis (1990) and Hardouvelis and Peristiani (1992), on the other hand, argue that more stringent margins lead to lower stock market volatility in the US and in Japan, respectively.

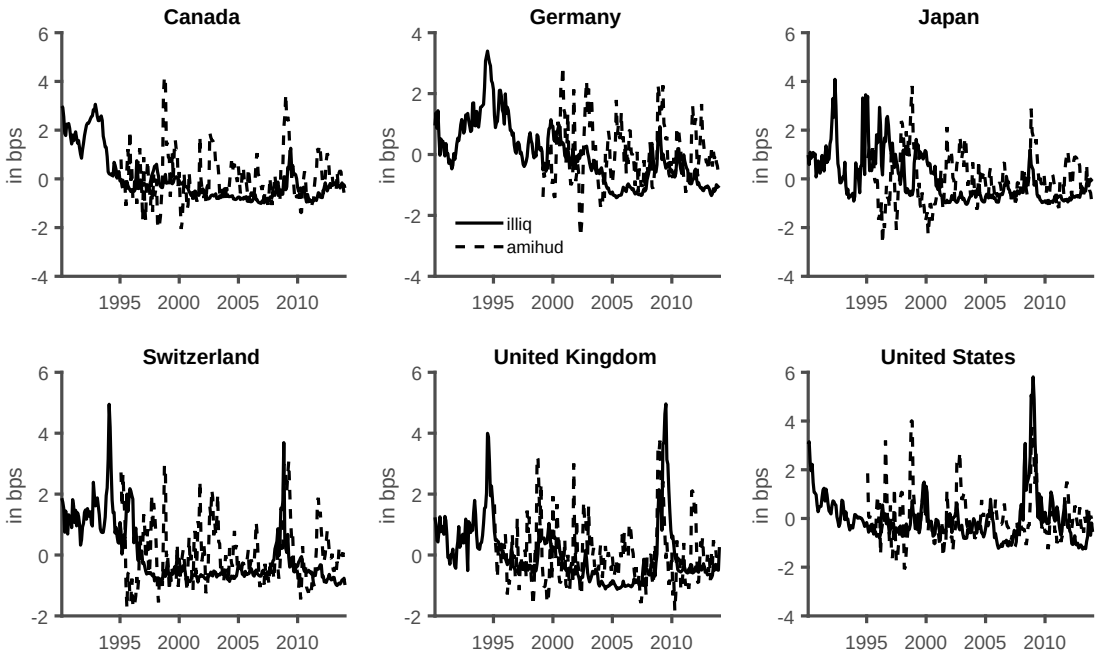


**Figure OA-1. Illiquidity Proxies and Amihud Measure**

This figure plots our illiquidity proxies together with country-level Amihud (2002) illiquidity measures. All variables are normalized, i.e., they are de-meaned and have a standard deviation of one.

While from a policy perspective it is interesting to study how margins affect volatility, it is not a priori obvious whether margins affect volatility or vice versa. For options and futures, margin requirements are set based on volatility itself. For example, the Chicago Mercantile Exchange (CME) uses the so called SPAN (Standard Portfolio Analysis of Risk) method that calculates the maximum likely loss that could be suffered by a portfolio. The method consists of 16 different scenarios which are comprised of different market prices and volatility.* Similarly, on the London Stock Exchange, the initial margin is calculated based on the maximum loss according to volatility and investors' leverage.

One natural question that arises is obviously whether and how the illiquidity measures relate to proxies of conditional market volatility. In the following, we study the relationship between country-level implied volatility and our illiquidity measures. The reason why we look at the VIX rather than say conditional volatility measures using country-level returns, is because the VIX is often used as a proxy for funding illiquidity itself (see e.g., Brunnermeier and Pedersen (2009)).

Figure OA-2 plots the illiquidity proxies together with country-level VIX for the longest time-series available. We note that overall the correlation between the time-series is quite high ranging from 49% (Japan) to 66% (Germany and Switzerland).

*For more information see `http://www.cmegroup.com/clearing/files/span-methodology.pdf`.

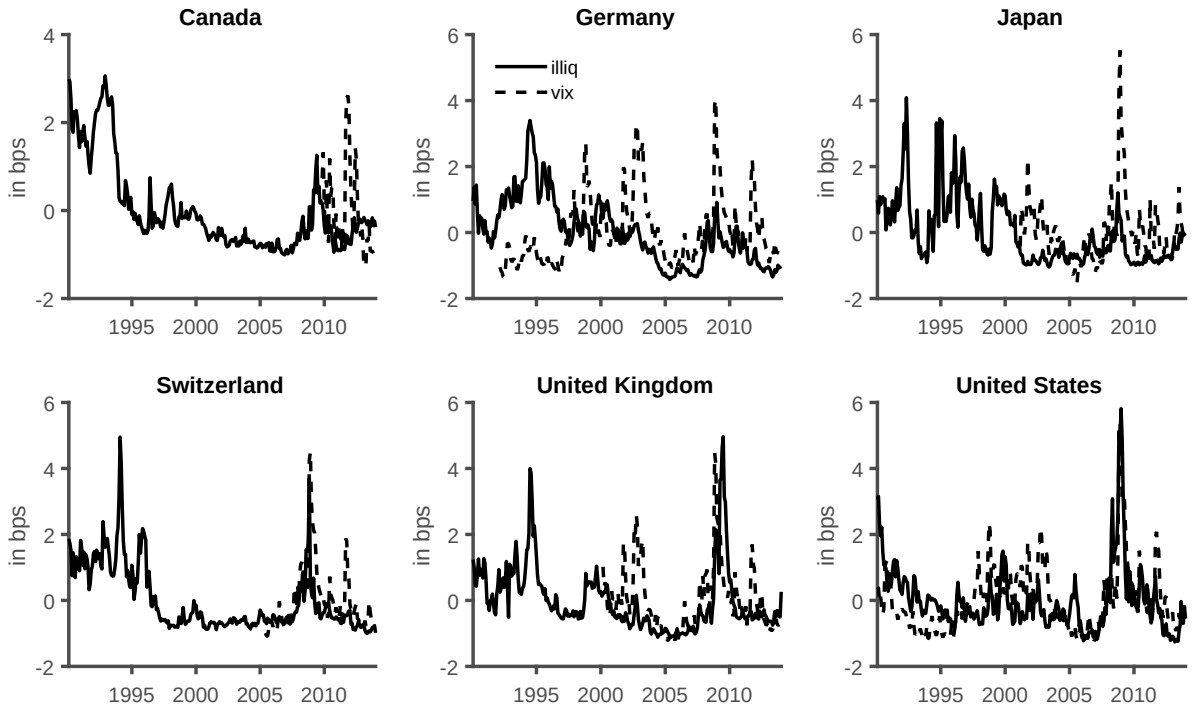


**Figure OA-2. Illiquidity Proxies and Country-Level VIX**

This figure plots monthly country-level implied volatility indices together with the illiquidity proxies. All measures are standardized. Data is monthly and implied volatility indices start in January 1990 (US), February 1992 (Germany), February 2000 (United Kingdom), February 2001 (Japan), May 2005 (Switzerland), October 2009 (Canada) and ends in December 2013.

## Appendix OA-3 Comparison Funding Proxies Others

In the following, we compare different proxies of illiquidity from fixed income markets used in the literature with our global illiquidity measure.

- Goyenko, Subrahmanyam, and Ukhov (2011), Goyenko (2013), and Goyenko and Sarkissian (2014) calculate the illiquidity of off-the-run T-Bills with maturities between 6 and 12 months. Illiquidity is the average spread between ask and bid prices scaled by the midpoint. The monthly average spread is then computed for each security and then equal weighted across different assets for each month.

- Based on theory in Vayanos (2004), Fontaine and Garcia (2012) extract a latent liquidity premium from estimating a term structure model from a panel of pairs of US Treasury securities where each pair has similar cash flows but different ages. The intuition is that older bonds are less liquid.

- The US VIX (the implied volatility from options on the S&P500) is often used as a proxy of funding illiquidity (see e.g., Brunnermeier and Pedersen (2009)). We look at Treasury implied

volatility (TIV) constructed in Choi, Mueller, and Vedolin (2017). The TIV is akin to the VIX and represents a model-free implied volatility measure from one-month options written on 10-year Treasury futures.

- The TED spread is the difference between the three-month Eurodollar deposit yield (LIBOR) and three-month US T-Bills.

The different time-series are plotted in Figure OA-3. We note that all proxies tend to increase during crisis periods such as the 2008 financial crisis. The unconditional correlation between the different proxies and our global illiquidity measure can be as big as 53% (Goyenko, Subrahmanyam, and Ukhov (2011) proxy) and as low as 14% (Fontaine and Garcia (2012) measure).

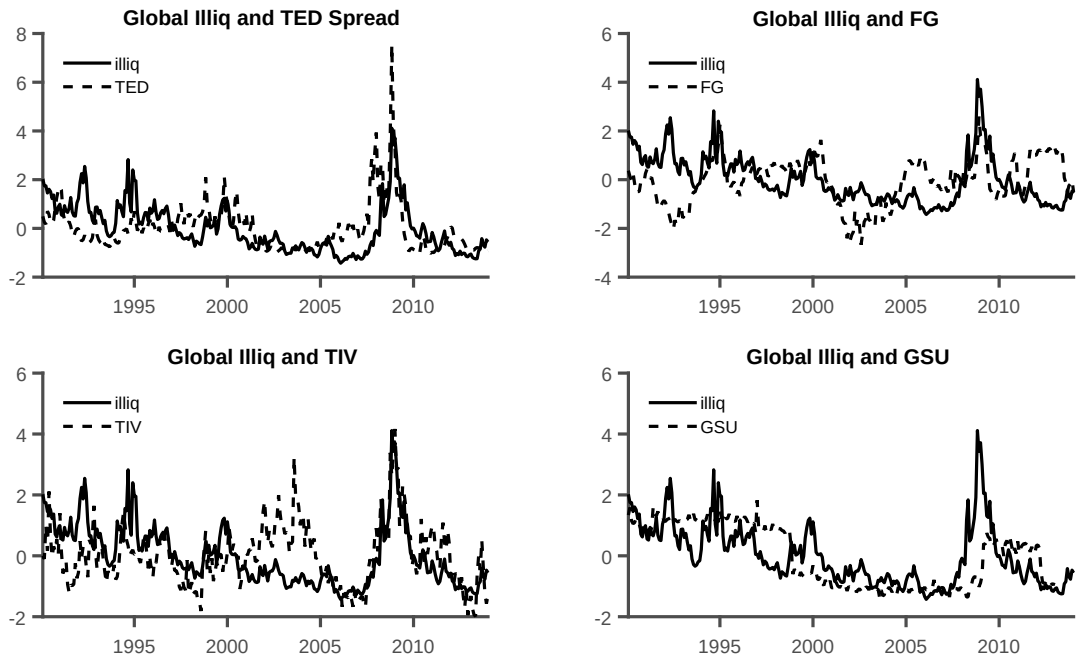


**Figure OA-3. Global Illiquidity Proxy and Other Illiquidity Measures**

This figure plots monthly global illiquidity together with different proxies of illiquidity such as the TED spread (upper left panel), the Fontaine and Garcia (2012) funding measure (upper right panel), Treasury implied volatility (lower left panel), and the Goyenko, Subrahmanyam, and Ukhov (2011) illiquidity proxy (lower right panel). All variables are normalized, i.e., they are de-meaned and have a standard deviation of one. Data is running from January 1990 to December 2013.