Understanding FX liquidity

Nina Karnaukh, Angelo Ranaldo, Paul Söderlind

University of St.Gallen

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# Why measuring liquidity in the FX market is important?

- ► The FX market has unique characteristics
  - ► Do liquidity patterns documented for the stock market apply to the FX liquidity?
- ► Illiquidity erodes asset returns and liquidity risk demands a premium (e.g., Amihud and Mendelson 1986)
  - ► Evidence on liquidity premiums in FX literature (Christiansen, Ranaldo, and Söderlind 2011; Banti, Phylaktis, and Sarno 2012; Mancini, Ranaldo, and Wrampelmeyer 2013)
  - ► A clear understanding of why and how FX illiquidity materializes is still missing
- ► Important for policy and regulatory tools (open market operations, uncoventional measures, Basel III)

Change in the effective cost around events
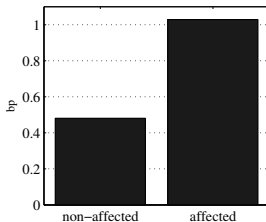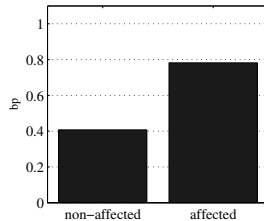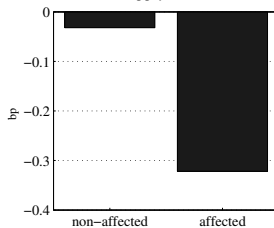
Contribution

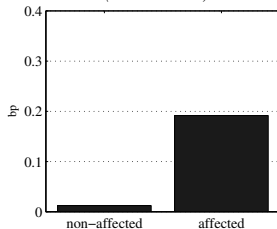- ► The first comprehensive study of FX liquidity and common patterns in FX liquidities ("commonality")
- ► Long sample (1991-) and many FX pairs (40)
- ► Study drivers of FX liquidity
  - ► Demand-side and supply-side explanations
  - ► Comoves with stock and bond liquidities
  - ► Some currencies are more exposed to liquidity drops
- ► Analyze commonality in FX liquidities
  - ► Demand-side explanations
  - ► Stronger commonality in distressed markets
- ► Methodological contribution
  - ► Show that it is possible to measure FX market liquidity from price data that are readily available at daily frequency

Literature survey on measuring liquidity

► Large literature on measuring liquidity on the stock, bond, and commodity markets over long periods (Lesmond, Ogden, and Trzcinka 1999; Amihud 2002; Pastor and Stambaugh 2003; Hasbrouck 2009; Corwin and Schultz 2012; Goyenko, Holden, and Trzcinka 2009; Marshall, Nguyen, and Visaltanachoti 2001)

► FX market
  ► order flow (e.g. Evans and Lyons 2002; Marsh and O'Rourke 2011; Breedom and Ranaldo 2012)
  ► indicative bid-ask spread (e.g. Bessembinder 1994)
  ► exception: Mancini, Ranaldo, and Wrampelmeyer (2013) on 9 FX pairs and over 3 years (2007–2009)

Our Empirical Strategy

► 2007–2012: Find low-frequency (LF) liquidity proxies that best mimic high-frequency (HF) benchmark
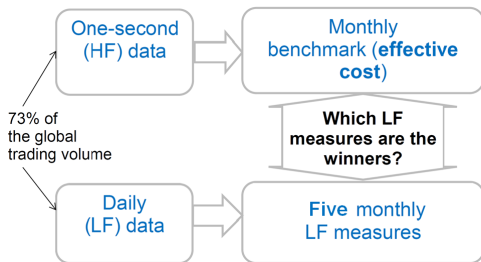
► 1991–2012: Study of FX liquidity for 40 and focus on floating FX pairs

Effective cost (HF) benchmark

Data: one-second mid, best bid/ask (*EBS*) over Jan 2007 – May 2012

$$EC = \begin{cases} (P^T - P)/P, & \text{for buyer-initiated trades,} \\ (P - P^T)/P, & \text{for seller-initiated trades,} \end{cases} \tag{1}$$

P^T is transaction price and P is mid price ($(P^A + P^B)/2$)
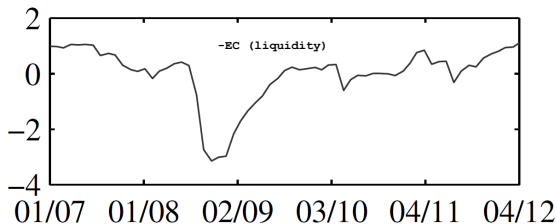
LF Liquidity Measures

Data: daily mid, bid/ask, high/low (*Thomson Reuters*) Jan 2007 – May 2012

1. Relative bid-ask (*BA*) spread

$$BA = (P^A - P^B)/P$$

2. *Roll* spread (Roll, 1984)

$$Roll = \sqrt{-\frac{1}{N-1}\sum_{t=1}^{N} \Delta\tilde{p}_t \cdot \Delta\tilde{p}_{t-1}},$$

skipping positive $\Delta\tilde{p}_t \cdot \Delta\tilde{p}_{t-1}$.

3. Bayesian approach (*Gibbs*) to the Roll model (Hasbrouck, 2009)

LF Liquidity Measures II

4. (Corwin and Schultz, 2012) *CS* uses high and low (H-L) over two days: vol increases proportionaly with the length of the trading interval, while bid-ask spreads does not

5. *Effective Tick* (Holden, 2009, Goyenko, Holden, and Trzcinka, 2009): estimates bid-ask spread from the clustering (relative frequency) of the last digits in transaction prices

► *FHT*, *LOT* and *Zeros* also considered but of little help
► Volume-based measures such as *Amihud* perform well but available only over short sample periods

Comparing FX rate LF liquidities and the EC

	BA	Roll	Gibbs	CS	EffTick
Panel A. Correlations of changes in liquidity measures of individual currencies					
AUD/USD	**0.353**	**0.782**	**0.649**	**0.593**	**0.024**
EUR/CHF	**0.180**	**0.580**	**0.548**	**0.699**	0.021
EUR/GBP	**0.226**	**0.304**	**0.257**	**0.484**	**-0.080**
EUR/JPY	**0.143**	**0.506**	**0.446**	**0.614**	**-0.024**
EUR/USD	**0.197**	**0.460**	**0.340**	**0.372**	**0.093**
GBP/USD	**0.253**	**0.413**	**0.213**	**0.630**	**0.025**
USD/CAD	**0.034**	**0.301**	**0.353**	**0.406**	0.029
USD/CHF	**0.231**	**0.154**	**0.374**	**0.528**	**-0.018**
USD/JPY	**0.349**	**0.462**	**0.399**	**0.411**	**-0.223**
Panel B. Average correlations					
Correlation, changes	0.219	0.440	0.398	0.526	-0.017
Correlation, levels	0.548	0.713	0.696	0.779	0.050

Result: CS, Roll, and Gibbs have the highest correlation with the EC

LF Liquidity vs EC

- ▶ average (standardized) *CS*, *Roll* and *Gibbs* to get one LF liquidity proxy (per exchange rate)
- ▶ average over exchange rates to get a *systematic* (global) *liquidity* proxy
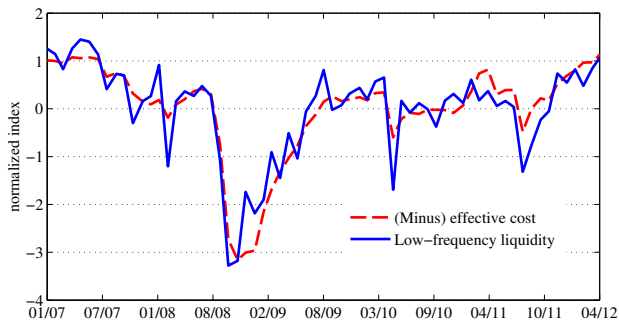
Result: our LF liquidity proxy works well (correlation of *0.91* with the benchmark)

Systematic LF liquidity over 1991–2012

Data: daily mid, bid/ask, high/low prices on 30 currencies
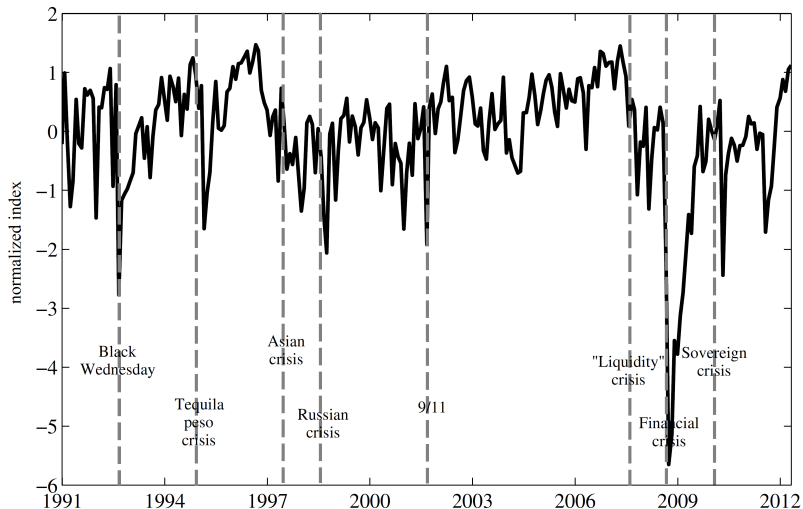
Drivers of FX liquidity

- ▶ How FX liquidity relates to broad market conditions?
    - ▶ *return* and *volatility* on the FX, stock and bond markets (Stoll 1978; Black 1976)
- ▶ What are demand- and supply-side factors explaining FX liquidity?
    - ▶ *demand-side*: traditional portfolio approach (Kouri 1976; Hau and Rey 2006), reserve currencies (Maggiori 2012), "rush to exit" (Pedersen 2009) and sentiment
    - ▶ *supply-side*: funding conditions (Brunnermeier and Pedersen 2009; Garleanu and Pedersen 2007; Gromb and Vayanos 2002; Kyle and Xiong 2001), monetary conditions (Lukas 1982), banking (Gabaix and Maggiori 2014)
- ▶ Is there a spillover effect from liquidity of stock and bond markets?
- ▶ Are some currencies more exposed to liquidity dry-ups?

Explaining FX liquidity

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Demand-side factors									
Δ U.S.Gross cap flow	-0.057				**-0.097**				-0.026
	[-1.814]				[-2.634]				[-0.756]
Δ VIX		-0.025				**-0.286**			-0.104
		[-0.490]				[-5.018]			[-1.654]
Supply-side factors									
Δ TED spread			**-0.060**				**-0.139**		**-0.072**
			[-2.224]				[-3.765]		[-2.760]
PF ret. top FX deal.				-0.066				0.069	
				[-1.710]				[1.643]	
Market conditions									
Δ FX impl. vol.	**-0.213**	**-0.201**	**-0.207**	**-0.225**					**-0.204**
	[-4.783]	[-4.040]	[-4.759]	[-4.818]					[-3.926]
Δ MSCI vol.	**-0.207**	**-0.212**	**-0.213**	**-0.242**					**-0.103**
	[-4.081]	[-4.036]	[-4.408]	[-5.047]					[-1.957]
Δ MOVE index	0.007	-0.003	0.012	-0.013					
	[0.213]	[-0.096]	[0.357]	[-0.397]					
Δ Stock liq.					0.092	-0.021	0.097	**0.103**	-0.066
					[1.769]	[-0.490]	[1.790]	[2.362]	[-1.743]
Δ Bond liq.					**0.245**	**0.141**	**0.226**	**0.217**	**0.103**
					[3.969]	[3.289]	[3.287]	[3.785]	[2.380]
Δ FX liq. lagged					**-0.158**	**-0.194**	**-0.180**	**-0.185**	**-0.130**
					[-3.542]	[-5.903]	[-4.791]	[-4.780]	[-3.676]
Ec. effect, % of EC	-8.4%	-3.6%	-8.8%	-9.7%	-14.2%	-41.8%	-20.4%	10.1%	
Ec. effect, % of Roll	-5.8%	-2.5%	-6.1%	-6.7%	-9.8%	-28.8%	-14.0%	7.0%	
R^2	**0.144**	**0.141**	**0.144**	**0.145**	**0.104**	**0.140**	**0.114**	**0.100**	**0.184**

Commonality Across Markets
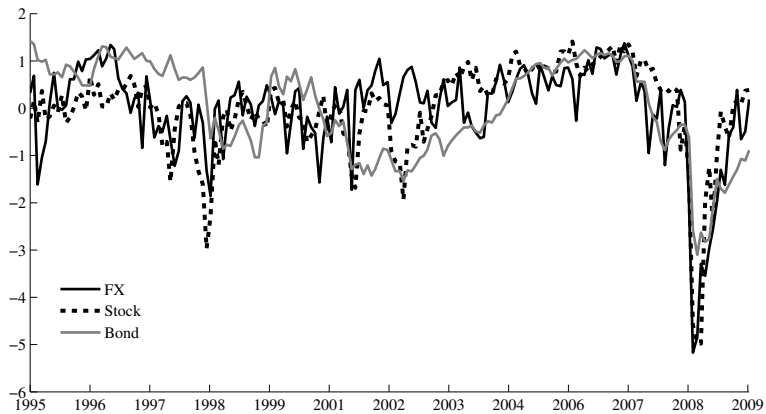
Explaining FX liquidity for developed and riskier currencies

				Dummy for:		
	[1]	[2]	[3]	Richer countries	High forward premium	High FX volatility
Demand-side						
Δ VIX	-0.071	-0.143	-0.063	-0.075	0.083	-0.095
	[-0.980]	[-1.851]	[-1.148]	[-1.503]	[1.074]	[-1.363]
Supply-side						
Δ TED spread	**-0.073**	**-0.110**	**-0.099**	-0.040	0.040	0.015
	[-2.260]	[-3.106]	[-3.983]	[-1.572]	[0.741]	[0.396]
Market conditions						
Δ FX implied volatility	**-0.171**	-0.135	-0.116	**-0.080**	-0.177	**-0.229**
	[-3.416]	[-1.590]	[-1.811]	[-2.353]	[-1.778]	[-3.447]
Δ MSCI volatility	**-0.135**	-0.026	**-0.110**	0.055	**-0.196**	0.010
	[-2.694]	[-0.410]	[-2.184]	[1.391]	[-3.248]	[0.183]
Δ MOVE index	0.034	0.047	0.038	0.027	-0.006	0.022
	[0.859]	[1.075]	[1.044]	[0.949]	[-0.107]	[0.545]
Δ Stock liquidity	-0.050	-0.053	-0.039	-0.020	-0.024	-0.044
	[-1.123]	[-1.200]	[-1.023]	[-0.487]	[-0.486]	[-1.144]
Δ Bond liquidity	0.082	**0.144**	0.077	0.039	-0.103	0.057
	[1.862]	[2.480]	[1.874]	[1.077]	[-1.769]	[1.340]
Δ FX liqudity lagged	**-0.119**	**-0.167**	**-0.086**	-0.042	0.070	**-0.104**
	[-3.410]	[-3.615]	[-2.037]	[-1.616]	[1.627]	[-2.478]
R^2				0.189	0.201	0.226

Result: liquidity of developed and riskier currencies is more (negatively) exposed to the worsening in market conditions

Commonality of FX Liquidity

R^2 from regression (Chordia, Roll, and Subrahmanyam 2005):

$$\triangle L_{j,t} = \alpha_j + \beta_j \triangle L_{M,t} + \varepsilon_{j,t}$$
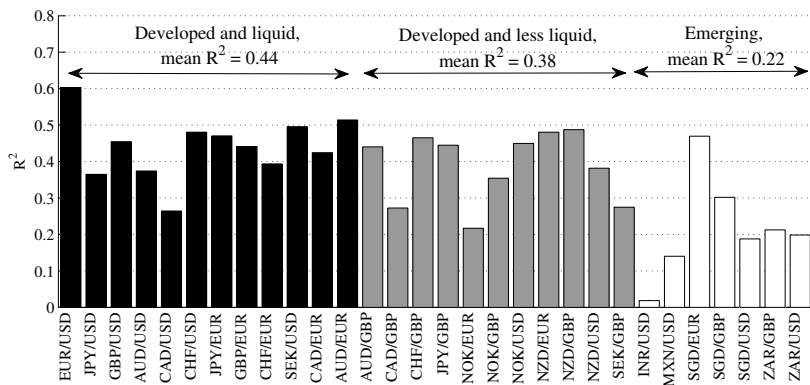
Result: higher commonality than on equity markets; stronger for developed currencies

Commonality in FX Liquidity in the Distressed Markets

Adding a dummy D_t for *distressed* markets (Hameed, Kang, and Viswanathan 2010):

$$\triangle L_{ij,t} = \alpha_{ij} + \beta_{ij}\Delta L_{M,t} + \gamma_{ij}\Delta L_{M,t} \cdot D_t + \varepsilon_{ij,t}$$

	Demand-side	**Supply-side**	**Market conditions**		
	US Gross capital flow/ GDP	TED spread	Implied FX volatility	MSCI volatility	Losses on carry trade portfolio
	[1]	[2]	[3]	[4]	[5]
Panel A. Cut-off 1.5 std above the mean					
Mean(β_{ij})	**0.537**	**0.541**	**0.551**	**0.541**	**0.544**
Mean(γ_{ij})	**0.089**	**0.103**	**0.074**	**0.071**	**0.070**
t-stat of mean(γ_{ij})	[3.390]	[4.351]	[2.207]	[2.589]	[2.208]
Mean R^2, calm	0.294	0.311	0.328	0.311	0.308
Mean R^2, distressed	0.500	0.491	0.427	0.426	0.429
Sum(D_t)	25	18	10	18	20
Number of obs.	255	255	241	255	255

Result: higher commonality in distressed markets

Determinants of Cross-sectional Differences in Commonality

Cross-sectional regressions:

$$\ln[R_{ij}^2/(1 - R_{ij}^2)] = a + bz_{ij} + u_{ij}$$

Two groups of factors z_{ij}:

▶ *Demand-side explanations*: capital and trade flows, portfolio positions (Pavlova and Rigobon 2007; Hau and Hey 2004; Froot and Ramodai 2005; Hau, Massa, and Peress 2010), investor protection and transparency (Morck, Yeung, and Wu 2000)

▶ *Supply-side explanations*: funding and monetary conditions, banking (Brunnermeier and Pedersen 2009; Kyle and Xiong 2001; Cespa and Fouclault 2014)

Explaining Commonality in FX liquidity

	[1]	[2]	[3]	[3]b	[4]	[5]
Demand-side factors						
Export BC to QC / GDP BC	-0.130					
	[-1.902]					
Good government index		**0.229**				**0.236**
		[2.225]				[2.626]
Supply-side factors						
Inflation			-0.124			
			[-1.242]			
Local money market interest rate				-0.010		
				[-0.079]		
Bank deposits / GDP					0.081	
					[1.270]	
Controls						
ln (GDP pro capita)	**0.715**	**0.471**	**0.565**	**0.647**	**0.634**	**0.471**
	[4.805]	[3.164]	[3.111]	[3.396]	[4.379]	[3.194]
Stock market cap / GDP	0.036	0.026	0.029	0.043	0.023	
	[0.540]	[0.377]	[0.405]	[0.523]	[0.327]	
Economic effect I	-0.029	0.053	-0.028	-0.002	0.018	
Economic effect II	-0.216	0.402	-0.207	-0.018	0.139	
R^2	**0.663**	**0.669**	**0.653**	**0.644**	**0.652**	**0.668**

Result: good governance (high investor protection and transparency) and high GDP per capita are associated with stronger commonality

Concluding remarks

- ▶ FX liquidity can be accurately measured on the basis of readily available daily data and fairly simple methods
- ▶ Construct FX liquidities for 30 currency pairs over 1991–2012 and an index of systematic FX liquidity
- ▶ Study *drivers of FX liquidities*
  - ▶ is driven by *supply-side* factors (tighter funding condition) and *demand-side* factors (capital flows)
  - ▶ decreases together with an increase of *volatility in stock and bond* markets, suggesting a novel channel of contagion
  - ▶ subject to *liquidity spillovers* (moves together with the stock and bond market liquidities)
  - ▶ currency liquidity of richer countries is more exposed to risk

Concluding remarks

- ► Analyze *commonality in FX liquidities*
  - ► *over time:* stronger in *distressed markets* (characterized by extreme values of both demand-side and supply-side factors as well as contagion)
  - ► *in the cross-section:* stronger in countries with better quality of institutions and higher development (demand-side)
- ► Implications for investors
  - ► FX transaction cost and liquidity risk relevant for asset pricing, portfolio and risk management
- ► Implications for policy-makers
  - ► FX illiquidity as an additional dimension of financial instability

Thank you very much for your attention

Correlations between HF benchmarks

...alternative HF benchmarks are very similar

	EC	BA	PI	RR	PD
Effective cost	**1**				
Bid-ask	**0.985**	**1**			
Price impact	**0.963**	**0.946**	**1**		
Return reversal	**-0.939**	**-0.951**	**-0.917**	**1**	
Price dispersion	**0.940**	**0.947**	**0.898**	**-0.937**	**1**

Table 1: Jan 2007 – May 2012.

LF measures vs across-currencies EC

Panel A. Across-currencies					Panel B. Systematic			
BA	Roll	Gibbs	CS	EffTick	[1]	[2]	[3]	[4]
Whole sample (Jan 2007 - May 2012)								
0.376	0.653	0.605	0.760	-0.035	0.718	0.719	0.768	0.725
Pre-crisis (Jan 2007 - Jun 2008)								
0.597	0.809	0.819	0.851	-0.159	0.852	0.855	0.874	0.846
Financial crisis (Jul 2008 - Dec 2009)								
0.630	0.685	0.495	0.842	0.032	0.740	0.742	0.842	0.776
European sovereign-debt crisis (Jan 2010 - May 2012)								
-0.034	0.638	0.800	0.735	-0.133	0.771	0.756	0.802	0.714

Panel B. Systematic LF liquidity:

[1] simple mean over FX rate *CS*, *Roll*, and *Gibbs*

[2] first principal component across FX rate *CS*, *Roll*, and *Gibbs*

[3] weighted mean over across-currencies *CS*, *Roll*, and *Gibbs*, using coefficients from regressing across-currencies EC on the across-currencies *CS*, *Roll*, and *Gibbs* as weights

[4] simple mean over *CS* and *Roll*

From Months to Weeks and Days...
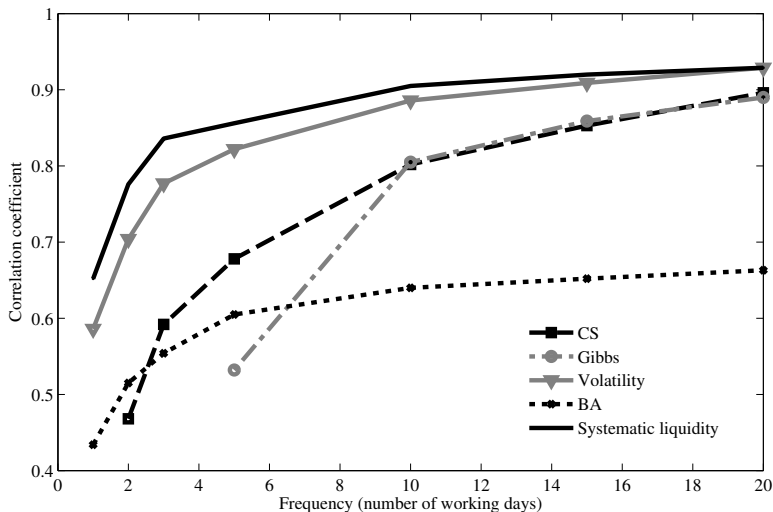
...could construct weekly LF liquidity proxy

Commonality over time
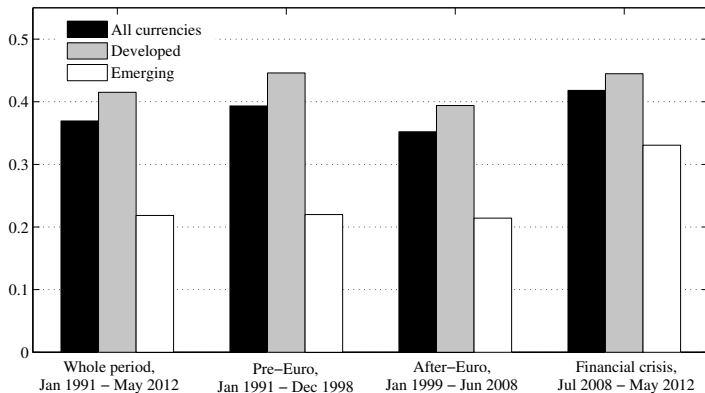
Quote-based liquidity measures

	Amihud	Amivest	Pastor-Stambaugh
AUD/USD	**0.892**	**-0.321**	0.028
EUR/CHF	**0.537**	**-0.481**	**0.046**
EUR/GBP	**0.540**	**-0.193**	**-0.070**
EUR/JPY	**0.458**	0.012	**-0.114**
EUR/USD	**0.866**	**-0.457**	**-0.075**
GBP/USD	**0.906**	**-0.351**	**-0.186**
USD/CAD	**0.748**	**-0.503**	**-0.164**
USD/CHF	**0.340**	**-0.186**	**0.087**
USD/JPY	**0.765**	**-0.399**	**-0.227**
Average	0.673	-0.320	-0.075

Table 2: **Correlations between FX rate quote-based (LF) and effective cost (HF) liquidity.** The sample is January 2007 - May 2012, 65 months.

Explaining FX liquidity with single factors

	beta	t-stat	R^2	N
Demand-side factors				
a) Current account				
Δ U.S. (Export+Import)/GDP	0.047	[0.887]	0.002	255
Δ U.S. Export/GDP	0.070	[1.378]	0.005	255
b) Portfolio balances				
Δ U.S. CB reserves / GDP	0.006	[0.195]	0.000	255
Δ U.S. Gross capital flow / GDP	**-0.151**	[-4.349]	0.023	255
Δ Gross foreigners purchases of the U.S. treasuries / GDP	**-0.129**	[-3.300]	0.017	255
Δ Gross U.S. citizens purchases of the foreign stocks and bonds / GDP	**-0.092**	[-3.049]	0.008	255
Losses on the 3 best investment currencies	**-0.165**	[-2.725]	0.027	255
Losses on the 3 best funding currencies	-0.008	[-0.164]	0.000	255
Δ Carry trade return	**0.161**	[3.713]	0.026	255
c) Sentiments				
Δ U.S. investor sentiment index	0.001	[0.030]	0.000	238
Δ Global country fund discounts	0.008	[0.169]	0.000	179
Δ VIX	**-0.278**	[-6.191]	0.077	255

Explaining FX liquidity with single factors

	beta	t-stat	R^2	N
Supply-side factors				
a) Funding conditions				
Δ TED spread	**-0.140**	[-3.908]	0.020	255
Δ U.S. commercial paper spread	0.065	[1.066]	0.004	255
Δ U.S. default spread	-0.108	[-1.448]	0.012	255
PF return of the 10 biggest FX dealers	**0.115**	[2.031]	0.013	255
b) Monetary conditions				
Δ Monetary aggregates in the U.S.	-0.017	[-0.236]	0.000	255
Inflation in the U.S.	-0.020	[-0.352]	0.000	255
c) Banking				
Δ Bank deposits / GDP in the U.S.	0.033	[0.828]	0.001	255
Δ Financial commercial paper rate	-0.045	[-0.838]	0.002	184
Market conditions				
Mean FX return	**-0.122**	[-2.059]	0.015	255
MSCI return	**0.153**	[2.514]	0.023	255
$\Delta i_{AAA\ bonds}$	-0.081	[-1.106]	0.007	255
Δ FX implied volatility	**-0.319**	[-8.294]	0.102	241
Δ MSCI volatility	**-0.313**	[-6.433]	0.098	255
Δ MOVE index	**-0.135**	[-3.163]	0.018	255
Δ Stock liquidity	0.167	[1.933]	0.028	179
Δ Bond liquidity	**0.194**	[3.435]	0.038	255
Δ FX liqudity lagged	**-0.174**	[-3.332]	0.030	255

Explaining commonality in FX liquidity with single factors

	beta	tstat	R^2
Demand-side factors			
a) Current account			
(Export + Import)/GDP	-0.029	[-0.252]	0.001
Export QC to BC / GDP QC	-0.161	[-1.329]	0.038
Export BC to QC / GDP BC	**0.198**	[4.052]	0.057
Trade flow (gravity model)	0.003	[0.030]	0.000
b) Portfolio balances			
International debt issues / GDP	**0.367**	[2.182]	0.196
CB reserves / GDP	-0.057	[-0.556]	0.005
Net foreign assets / GDP	-0.099	[-0.981]	0.014
Gross capital flow / GDP	0.101	[0.678]	0.015
c) Institutional setting			
Good government index	**0.620**	[3.659]	0.560
Financial disclosure	0.069	[0.299]	0.007

Explaining commonality in FX liquidity with single factors

	beta	tstat	R^2
Supply-side factors			
a) Funding conditions			
Volatility of the FX rate return	0.413	[1.815]	0.248
Local money market interest rate	**-0.470**	[-3.095]	0.321
Local money market interest rate volatility	**-0.444**	[-2.061]	0.287
b) Monetary conditions			
Money supply/GDP	**0.257**	[2.703]	0.096
Inflation	**-0.552**	[-3.096]	0.444
c) Banking			
Bank deposits / GDP	**0.280**	[2.827]	0.114
Controls			
ln (GDP pro capita)	**0.663**	[4.839]	0.641
GDP growth volatility	-0.167	[-1.418]	0.041
ln GEO size	0.004	[0.037]	0.000
Stock market cap / GDP	**0.193**	[1.964]	0.054