Internet Appendix for "Liquidity in the Foreign Exchange Market: Measurement, Commonality, and Risk Premiums"

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ABSTRACT

This supplemental appendix presents additional analyses and robustness checks, describes the cleaning procedure of EBS data, compares EBS to other datasets, and discusses the robust estimation of the price impact model.

*Citation format: Mancini, Ranaldo, and Wrampelmeyer, 2012, Internet Appendix for "Liquidity in the Foreign Exchange Market: Measurement, Commonality, and Risk Premiums," *Journal of Finance* [vol #], [pages], http://www.afajof.org/IA/[year].asp. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the authors of the article.

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Appendix A. Cleaning procedure of EBS data

We run the algorithm proposed by Brownlees and Gallo (2006) to clean the EBS data. This filtering procedure removed only very few and obvious outliers. For instance on March 30, 2007, one bid quote for AUD/USD is 0.803 instead of 0.8073, and on June 15 two bid quotes for EUR/JPY are 100.11 instead of 165.1.

The observation at time t_i is removed from the sample if both the bid and ask price are zero or if the price p_{t_i} is such that

$$|p_{t_i} - \bar{p}_i(\alpha, k)| > 3s_i(\alpha, k) + \nu$$

where $\bar{p}_i(\alpha, k)$ and $s_i(\alpha, k)$ denote the α-trimmed sample mean and standard deviation based on k observations in the neighborhood of t_i, respectively. To avoid zero variance for a sequence of equal prices, ν is added on the right hand side of the inequality. As the purpose of the filtering is to remove only the most obvious outliers, we choose ν equal to five pips (for JPY the smallest price change or pip is 0.01, for all other currencies is 0.0001). We set $\alpha = 5\%$ and $k = 100$. Hence the 100 prices closest to p_{t_i} are chosen as the neighborhood, and the largest and smallest 2.5% of these prices are discarded for the computation of mean and standard deviation.

Appendix B. Comparison of EBS with other Datasets

Table IA.I compares EBS characteristics with other commonly used datasets, namely Reuters, Datastream, Carry trade exchange traded funds (ETFs), and customer order flow data from custodian banks. Various differences between EBS and the other datasets emerge from the comparison. For example, EBS covers the largest market share of interdealer trading (60%), provides the most accurate information about volumes, and reports executable (thus reliable) quotes. Together with EBS, Reuters D2000-2 is the only other data source to provide intraday data at one-second frequency. Unfortunately, Reuters does not provide historical data and the researcher would need to record and organize data on her own. Moreover, Reuters official platform does not provide data in a continuous or consistent way, making the use of this data rather involved. Furthermore, no volume information is provided by Reuters. Thus, EBS is effectively the only current data source for intraday data.

To highlight the importance of executable quotes in EBS, we contrast bid-ask spreads from EBS with indicative quotes from Reuters/Datastream. During our sample period, January 2007–December 2009, the correlation between intraday average bid-ask spreads from EBS and daily indicative snapshots from Reuters is 0.255, 0.341, 0.350, 0.495, 0.635 for USD/CHF, AUD/USD, GBP/USD, EUR/USD, USD/JPY, respectively. Such correlations are well below one and can be as low as 0.255 for a rather liquid FX rate like USD/CHF. The main reason for such low correlations appears to be various "jumps" in daily Reuters bid-ask spreads (by a multiple of pips), whereas average bid-ask spreads from EBS are much smoother over time.

Appendix C. Robust Estimation of Model (1)

The classic choice to estimate Model (1) in the paper (or Model (IA.6) in the separate appendix) is ordinary least squares (OLS) regression. However, high frequency data are likely to contain outliers. Unfortunately, classic OLS estimates are adversely affected by these atypical observations which are separated from the majority of the data. In line with this reasoning, Pástor and Stambaugh (2003) warn that their reversal measure can be very noisy for individual securities.

Removing outliers from the sample is not a meaningful solution since subjective outlier deletion or algorithms as described by Brownlees and Gallo (2006) have the drawback of risking to delete legitimate observations which diminishes the value of the statistical analysis. The approach adopted in this paper is to rely on robust regression techniques. The aim of robust statistics is to obtain parameter estimates which are not adversely affected by the presence of potential outliers (Hampel et al., 2005).

In shorthand notation Model (1) is

$$r_{t_i} = \boldsymbol{\theta}_t \mathbf{x}_{t_i} + \varepsilon_{t_i}, \tag{IA.1}$$

where $\mathbf{x}_{t_i} = [1 \quad (v_{b,t_i} - v_{s,t_i}) \quad (v_{b,t_{i-1}} - v_{s,t_{i-1}}) \ldots (v_{b,t_{i-K}} - v_{s,t_{i-K}})]^\top$ includes the intercept, contemporaneous and lagged order flows, and ε_{t_i} is an error term. Robust parameter esti-

mates $\boldsymbol{\theta}_t$ for day t are the solutions to:

$$\min_{\boldsymbol{\theta}_t} \sum_{i=1}^{I} \rho\left(\frac{\varepsilon_{t_i}(\boldsymbol{\theta}_t)}{\sigma_t}\right), \tag{IA.2}$$

where I denotes the number of intraday observations, σ_t is the scale of the error term, and $\rho(\cdot)$ is a bisquare function:

$$\rho(y) = \begin{cases} 1 - \left[1 - (y/k)^2\right]^3 & \text{if} \quad |y| \leq k \\ 1 & \text{if} \quad |y| > k. \end{cases} \tag{IA.3}$$

The first order condition for the optimization problem in Equation (IA.2) is:

$$\sum_{i=1}^{I} \rho'\left(\frac{\varepsilon_{t_i}\left(\widehat{\boldsymbol{\theta}}_t\right)}{\widehat{\sigma}_t}\right) \mathbf{x}_{t_i} = \mathbf{0}, \tag{IA.4}$$

where

$$\rho'(y) = \begin{cases} 6y/k^2 \left[1 - (y/k)^2\right]^2 & \text{if} \quad |y| \leq k \\ 0 & \text{if} \quad |y| > k. \end{cases} \tag{IA.5}$$

In the bisquare function the constant $k = 4.685$ ensures 95% efficiency of $\widehat{\boldsymbol{\theta}}_t$ when ε_{t_i} is normally distributed. Computationally, the parameters are found using iteratively reweighed least squares with a weighting function corresponding to the bisquare function (IA.3) and an initial estimate for the residual scale of $\widehat{\sigma} = \text{median}\,(|\varepsilon_{t_i}|,\ i = 1, \ldots, I$, such that $\varepsilon_{t_i} \neq 0)/0.675$. Compared to standard OLS, by construction, robust regression estimates are less influenced by potential contamination in the data (Maronna, Martin, and Yohai, 2006).

Appendix D. JP Morgan Implied Volatility Index for G7 Currencies VXY

The VXY index is calculated by JP Morgan continuously using JP Morgan's prices, with intraday updates reported on Bloomberg. It was launched in December 2006. Daily data from Datastream are available from April 12, 2007. The VXY index tracks aggregate volatility in currencies through a turnover-weighted index of G7 currencies. Weights are defined on the basis of BIS Triennial Central Bank Survey of FX and derivatives markets. The implied volatility is recovered from three-months at-the-money forward options.

It has been constructed for institutional investors such as real money managers and medium-term macro investors and is designed to follow aggregate FX volatility. It is often used to calibrate trading strategies and to express views on volatility as an asset class.

Appendix E. Additional Figures and Tables

We recall various definitions and model specifications to ease the reading of tables and figures in the supplemental appendix (SA).

For each currency, r_{t_i}, v_{b,t_i}, and v_{s,t_i} denote the log exchange rate return between t_{i-1} and t_i, the volume of buyer initiated trades and the volume of seller initiated trades at time t_i during day t, respectively. The price impact and return reversal are estimated based on the following equation:

$$r_{t_i} = \vartheta_t + \varphi_t(v_{b,t_i} - v_{s,t_i}) + \sum_{k=1}^{K} \gamma_{t,k}(v_{b,t_{i-k}} - v_{s,t_{i-k}}) + \varepsilon_{t_i}. \tag{IA.6}$$

By estimating the parameter vector $\boldsymbol{\theta}_t = [\vartheta_t \quad \varphi_t \quad \gamma_{t,1} \dots \gamma_{t,K}]$ on each day, we are able to directly compute the liquidity dimensions of price impact and return reversal on a daily basis. It is expected that the price impact of a trade $L^{(pi)} = \varphi_t$ is positive due to the supply and demand effect of net buying pressure. The overall return reversal is measured by $L^{(rr)} = \gamma_t = \sum_{k=1}^{K} \gamma_{t,k}$, which is expected to be negative.

Given a measure of liquidity, daily market-wide liquidity $L_{M,t}^{(\cdot)}$ can be estimated as:

$$L_{M,t}^{(\cdot)} = \frac{1}{N} \sum_{j=1}^{N} L_{j,t}^{(\cdot)}, \tag{IA.7}$$

where N is the number of exchange rates and $L_{j,t}^{(\cdot)}$ the liquidity of exchange rate j on day t. In order for market-wide liquidity to be less influenced by extreme values, a common practice is to rely on a trimmed mean. Therefore, we exclude the currency pairs with the highest and lowest value for $L_{j,t}^{(\cdot)}$ in the computation of $L_{M,t}^{(\cdot)}$.

Unobserved market-wide liquidity is extracted by assuming a latent factor model for the vector of standardized liquidity measures, which is estimated using PCA:

$$\widetilde{\mathbf{L}}_t = \boldsymbol{\beta} L_{M,t}^{(pca)} + \boldsymbol{\xi}_t, \tag{IA.8}$$

where $\widetilde{\mathbf{L}}_t = \left[\widetilde{\mathbf{L}}_t^{(pi)}, \widetilde{\mathbf{L}}_t^{(rr)}, \widetilde{\mathbf{L}}_t^{(ba)}, \widetilde{\mathbf{L}}_t^{(ec)}, \widetilde{\mathbf{L}}_t^{(pd)}\right]'$ denotes the vector which stacks all five liquidity measures for all exchange rates and $\widetilde{\mathbf{L}}_t^{(\cdot)} = \left[\widetilde{L}_{1,t}^{(\cdot)}, \dots, \widetilde{L}_{N,t}^{(\cdot)}\right]'$. $\boldsymbol{\beta}$ is the matrix of factor loadings and $\boldsymbol{\xi}_t$ represents FX rate and liquidity measure specific shocks on day t.

To analyze the sensitivity of the liquidity of exchange rate j to a change in market-wide

liquidity, we run a time-series regression of individual liquidity, $L_{j,t}^{(\cdot)}$, on common liquidity $L_{M,t}^{(\cdot)}$:

$$L_{j,t}^{(\cdot)} = a_j + b_j L_{M,t}^{(\cdot)} + L_{I,j,t}^{(\cdot)}, \tag{IA.9}$$

where $L_{I,j,t}^{(\cdot)}$ represents an idiosyncratic liquidity shock. The sensitivity is captured by the slope coefficient b_j. For the sake of interpretability, we rely on effective cost as measure of liquidity.

Finally, in the analysis of carry trade returns the variable of interest is the excess return over uncovered interest rate parity (UIP):

$$r_{j,t+1}^{e} = i_t^f - i_t^d - \Delta p_{j,t+1}, \tag{IA.10}$$

where i_t^f and i_t^d are the foreign and domestic interest rates at day t, respectively, and $\Delta p_{j,t+1}$ is the daily return of currency j at day $t+1$ from the perspective of a U.S. investor. The following asset pricing model on a daily basis is used to explain carry trade returns:

$$r_{j,t}^{e} = \alpha_j + \beta_{AER,j} AER_t + \beta_{IML,j} IML_t + \varepsilon_{j,t}, \tag{IA.11}$$

where $\beta_{AER,j}$ and $\beta_{IML,j}$ denote the exposure of the carry trade return j to the market risk factor and liquidity risk factor, respectively.

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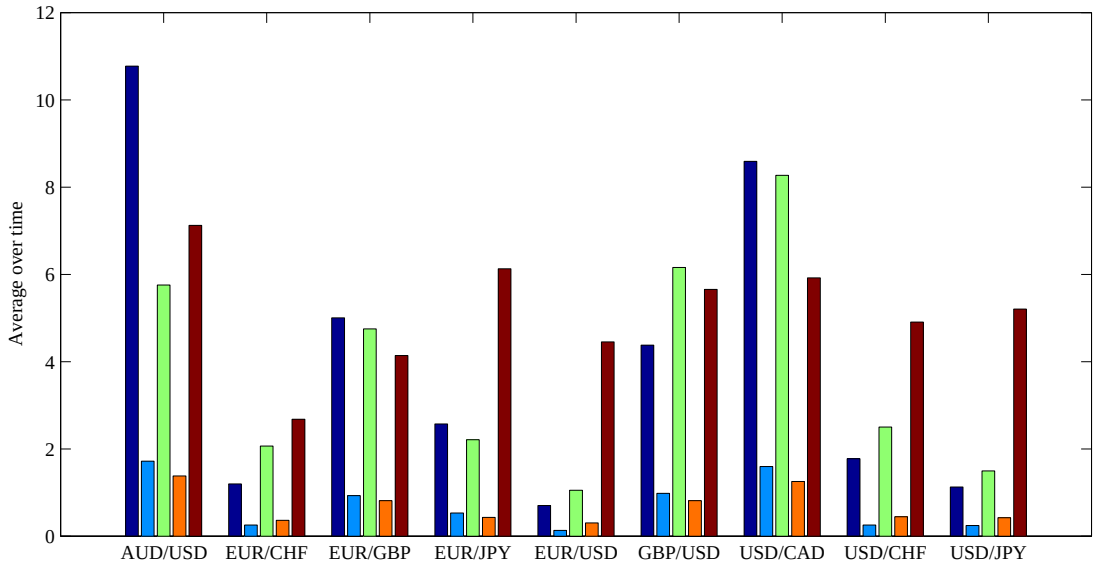
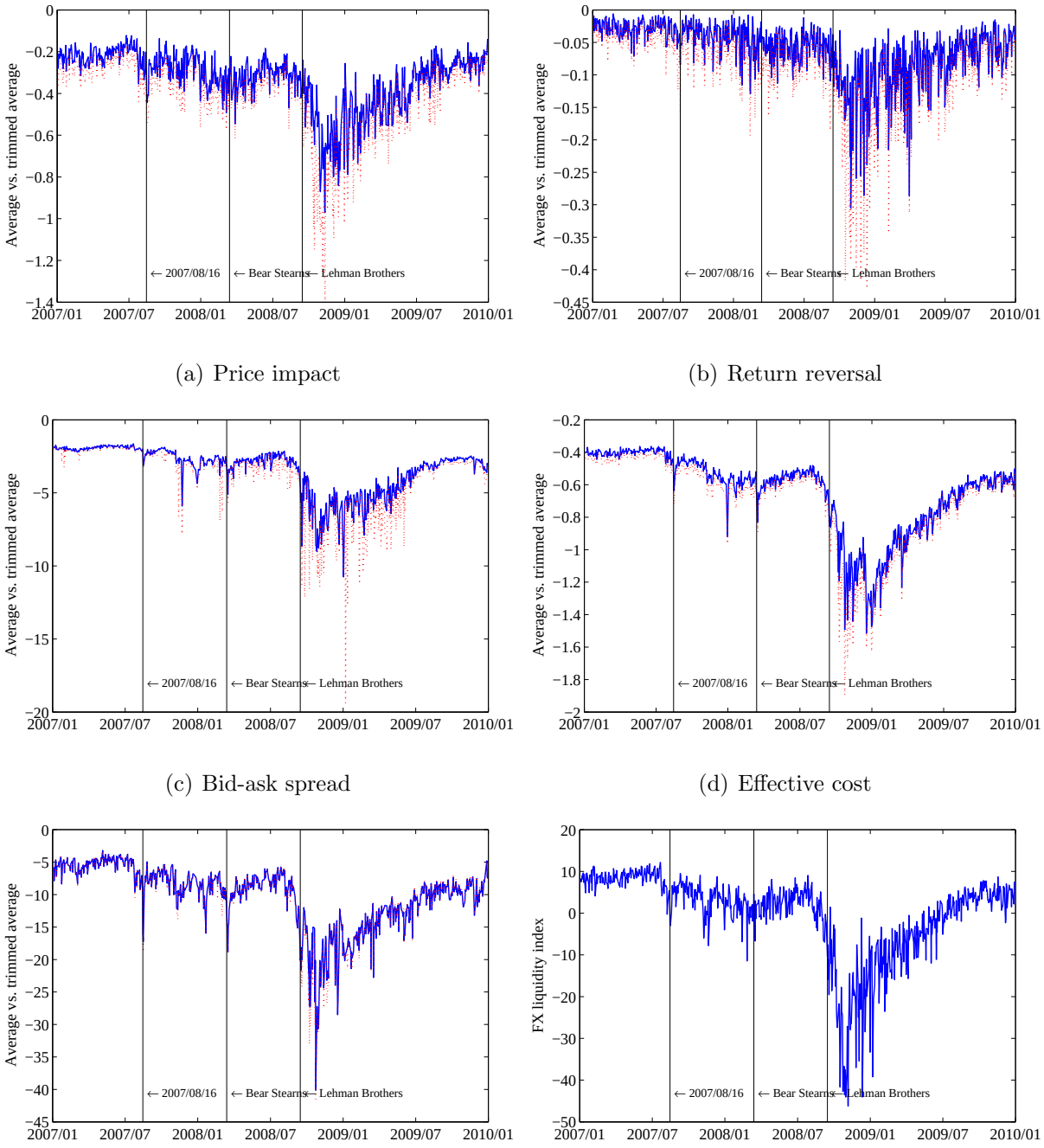


Figure IA.1: FX rates liquidity measures. For each FX rate, the five bars represent the averages of five liquidity measures, from left to right: price impact, return reversal, bid-ask spread, effective cost, and price dispersion. For the readability of the graph, the liquidity measures are scaled by 10, −10, 1, 1, and 0.5, respectively. The graph visually represents averages of the liquidity measures in Tables IA.III and IA.IV in this separate appendix. The sample is January 2, 2007 – December 30, 2009.



(a) Price impact

(b) Return reversal

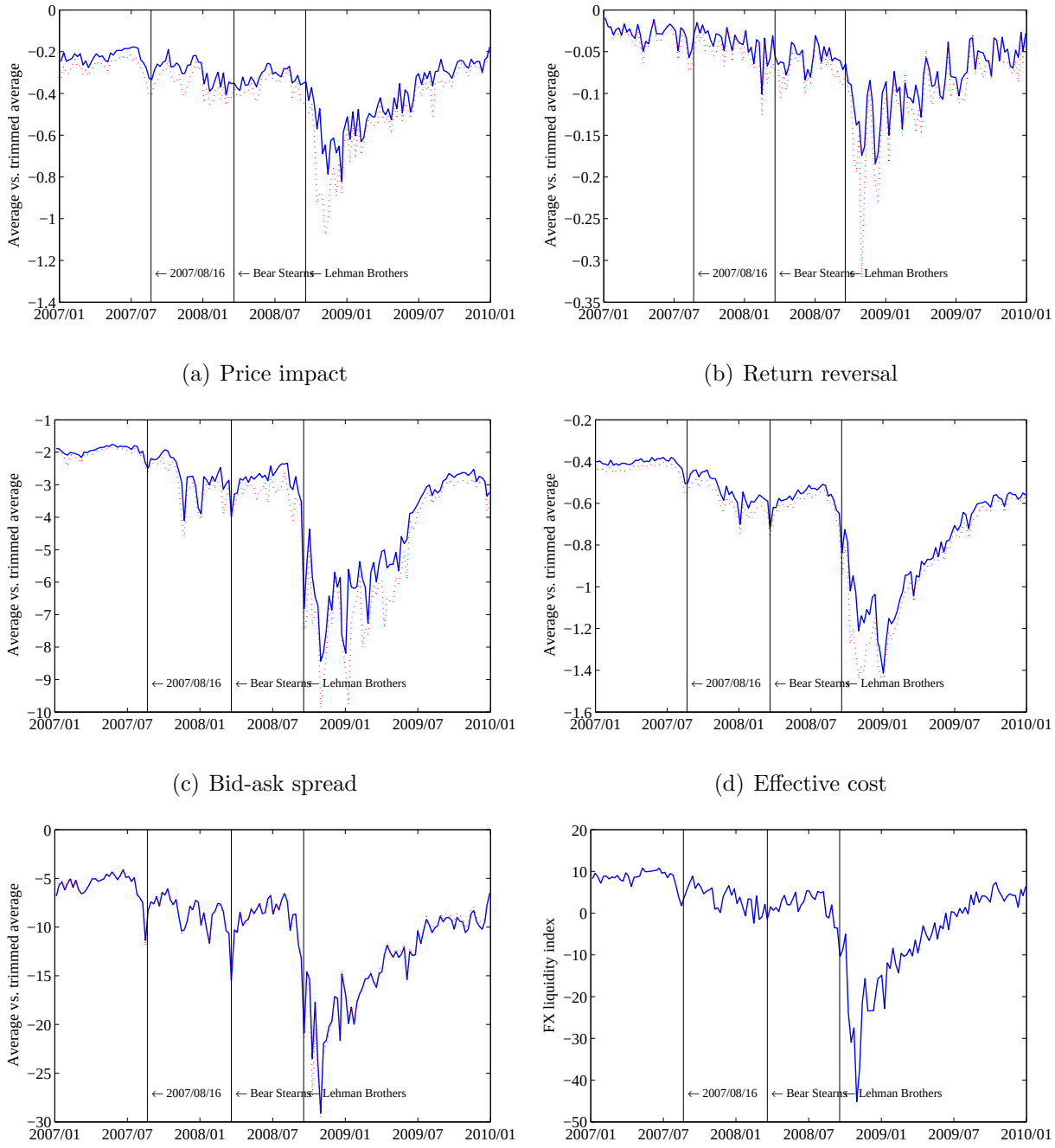
(c) Bid-ask spread

(d) Effective cost

(e) Price dispersion

(f) Liquidity index

Figure IA.2: Daily market-wide FX liquidity. Panels (a)–(e) depict market-wide FX liquidity based on (within measures) trimmed averaging (solid line) and simple averaging (dotted line) of individual exchange rate liquidity (Equation (IA.7)). Market-wide liquidity index obtained from Principle Component Analysis across exchange rates as well as across liquidity measures (Equation (IA.8)) is depicted in Panel (f). The sign of each liquidity measure is adjusted such that the measure represents liquidity rather than illiquidity. The sample is January 2, 2007 – December 30, 2009.



(a) Price impact

(b) Return reversal

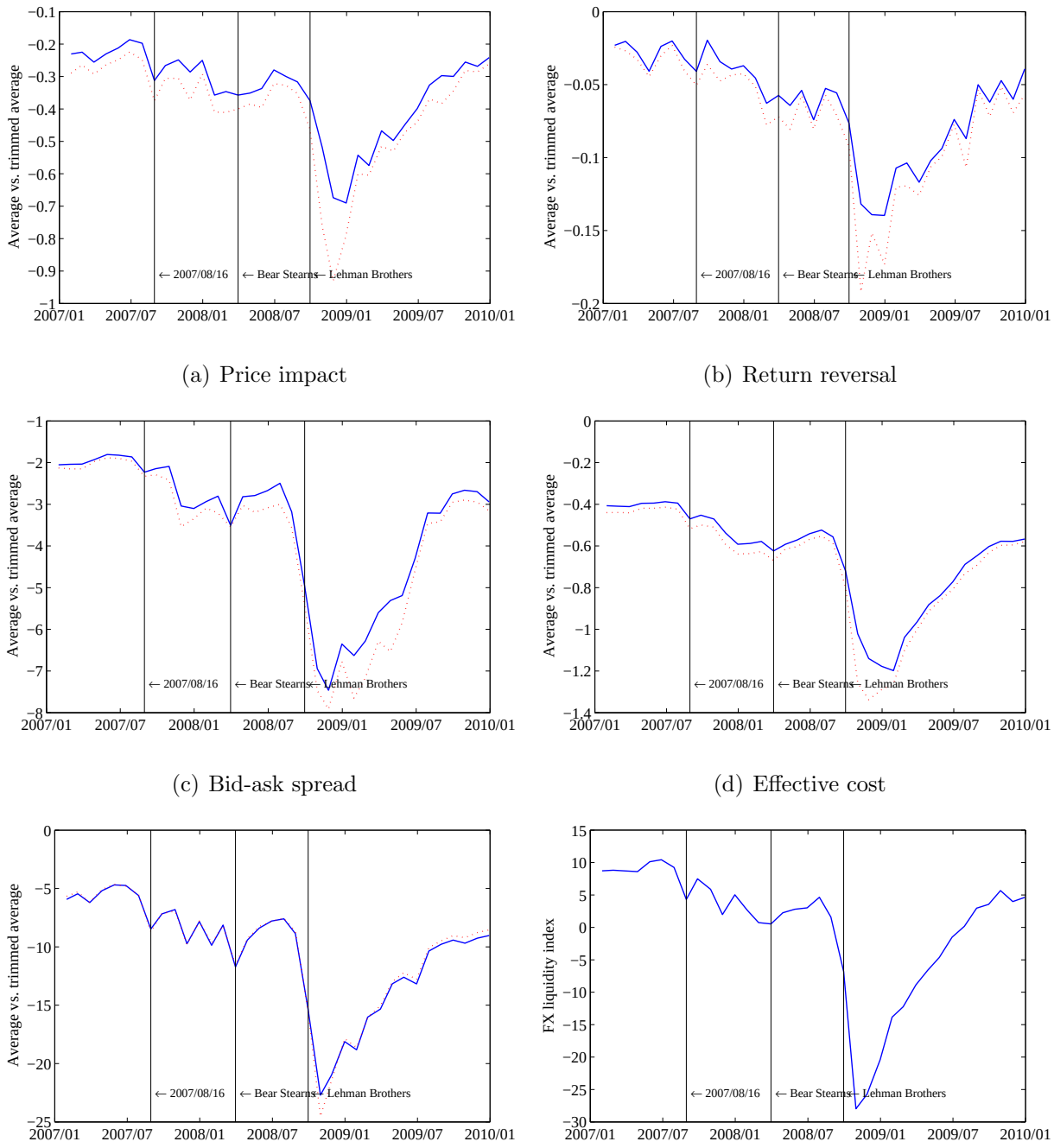
(c) Bid-ask spread

(d) Effective cost

(e) Price dispersion

(f) Latent liquidity

Figure IA.3: Weekly market-wide liquidity. Panels (a)–(e) depict market-wide FX liquidity based on (within measures) trimmed averaging (solid line) and simple averaging (dotted line) of individual exchange rate liquidity (Equation (IA.7)). Market-wide liquidity index obtained from Principle Component Analysis across exchange rates as well as across liquidity measures (Equation (IA.8)) is depicted in Panel (f). The sign of each liquidity measure is adjusted such that the measure represents liquidity rather than illiquidity. The sample is January 2, 2007 – December 30, 2009.



(a) Price impact

(b) Return reversal

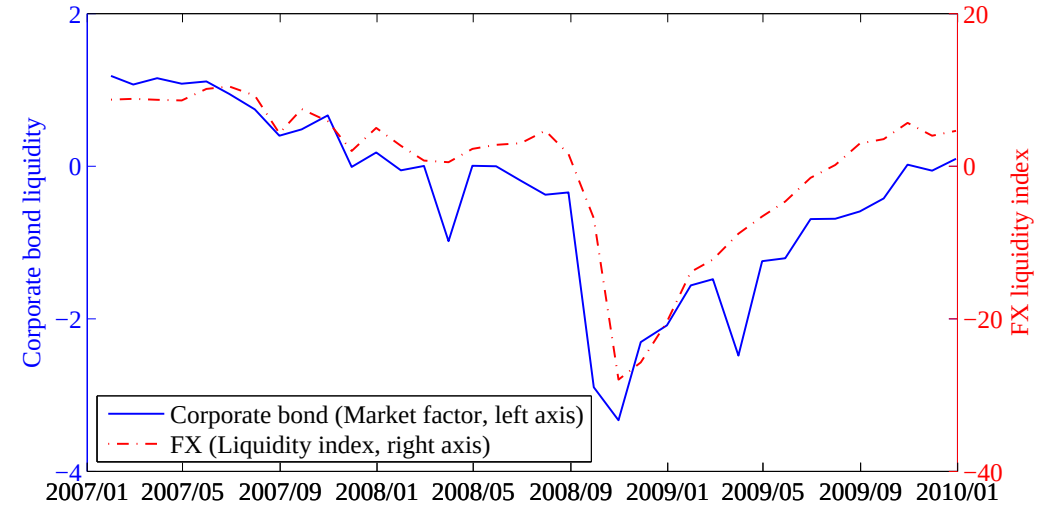
(c) Bid-ask spread

(d) Effective cost

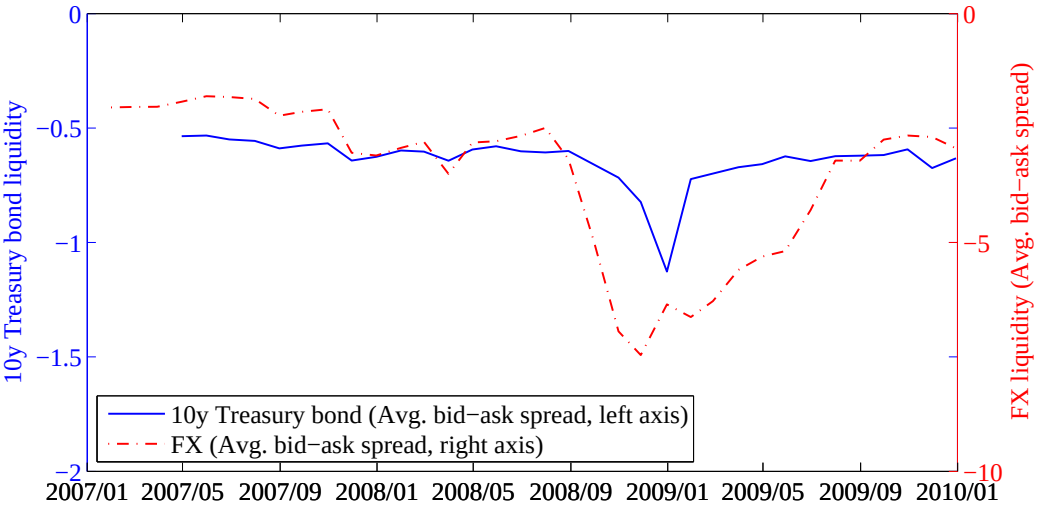
(e) Price dispersion

(f) Latent liquidity

Figure IA.4: Monthly market-wide liquidity. Panels (a)–(e) depict market-wide FX liquidity based on (within measures) trimmed averaging (solid line) and simple averaging (dotted line) of individual exchange rate liquidity (Equation (IA.7)). Market-wide liquidity index obtained from Principle Component Analysis across exchange rates as well as across liquidity measures (Equation (IA.8)) is depicted in Panel (f). The sign of each liquidity measure is adjusted such that the measure represents liquidity rather than illiquidity. The sample is January 2007 – December 2009.

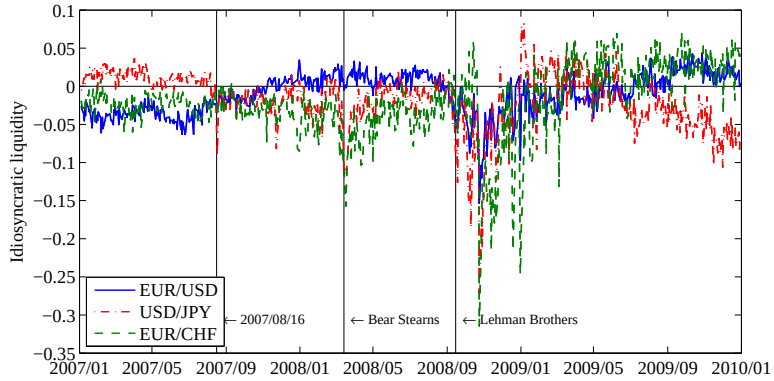


(a)

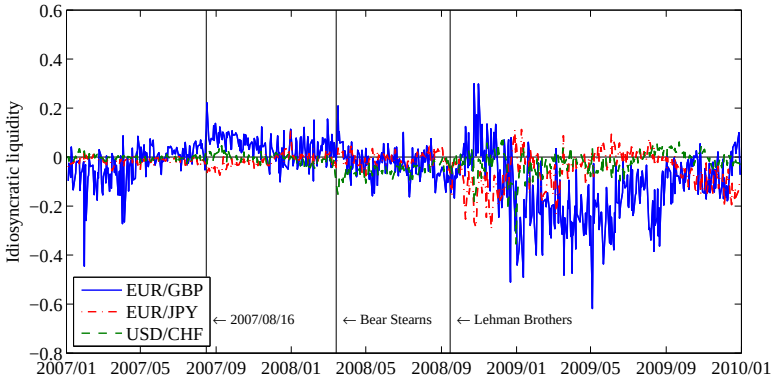


(b)

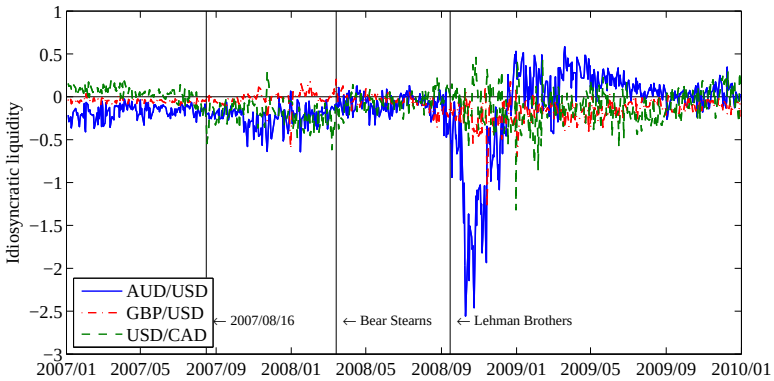
Figure IA.5: Market-wide FX liquidity and bond markets liquidity. Panel (a) shows non-overlapping monthly observations for the FX liquidity index obtained from PCA across different liquidity measures as well as the Dick-Nielsen, Feldhütter, and Lando (2011) liquidity measure for the corporate bond market. Panel (b) shows the average bid-ask spread for the FX market as well as the average bid-ask spread for the U.S. 10-year Treasury bond market. The latter is computed using Broker Tec data and averaging bid-ask spreads of all intraday transactions during New York trading hours. Each observation t represents liquidity for a given month. The sample is January 2007 – December 2009.



(a)

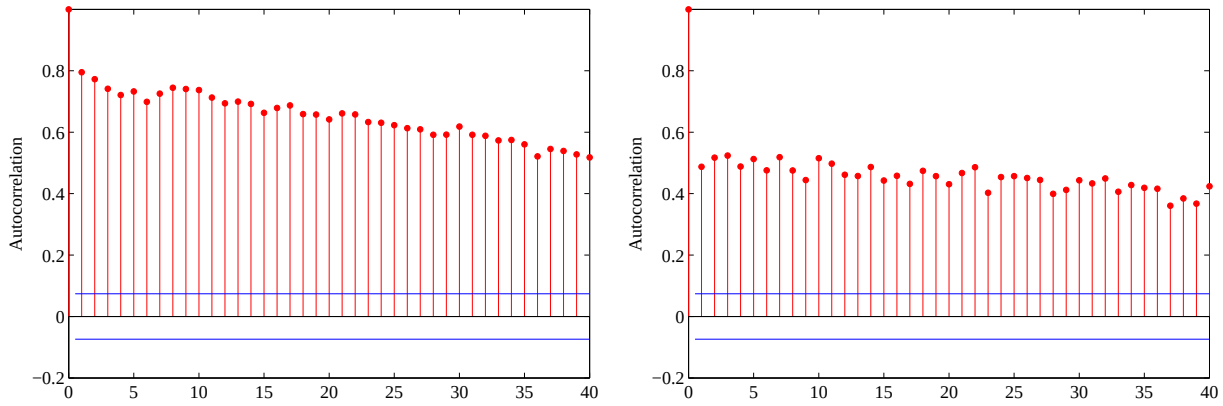


(b)



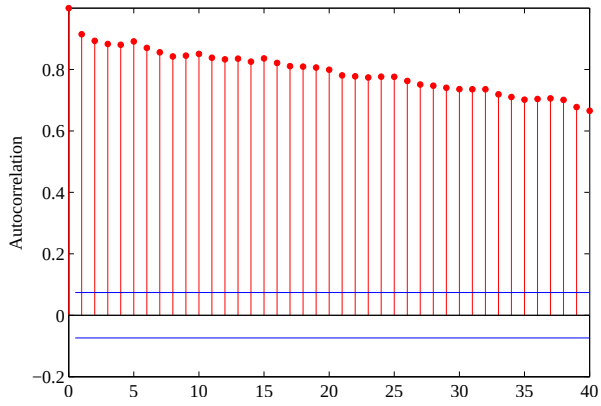
(c)

Figure IA.6: Idiosyncratic liquidity. Idiosyncratic liquidity of FX rate j is estimated as the residuals from regressing liquidity of exchange rate j on average market-wide FX liquidity (Equation (IA.9)). Both individual exchange rate as well as market-wide liquidity are estimated based on effective cost. The sample is January 2, 2007 – December 30, 2009.

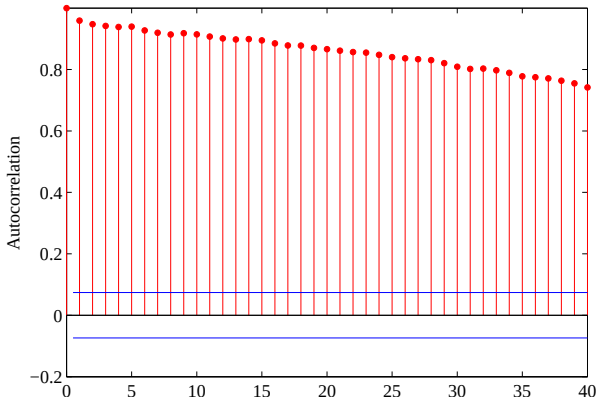


(a) Price impact

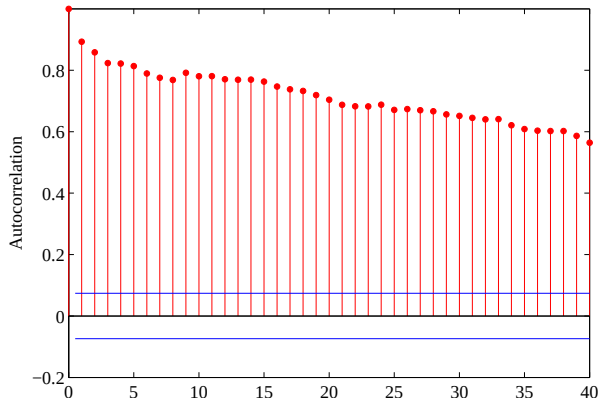
(b) Return reversal



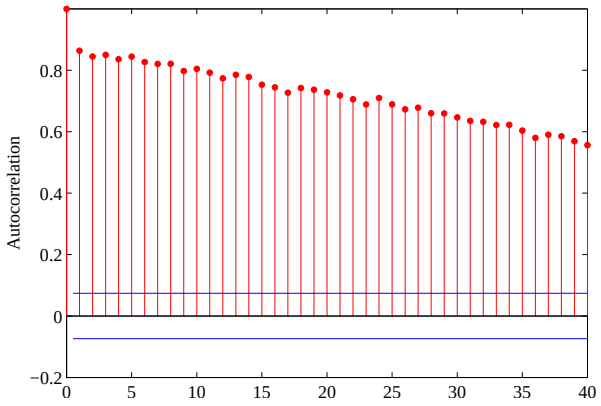
(c) Bid-ask spread



(d) Effective cost

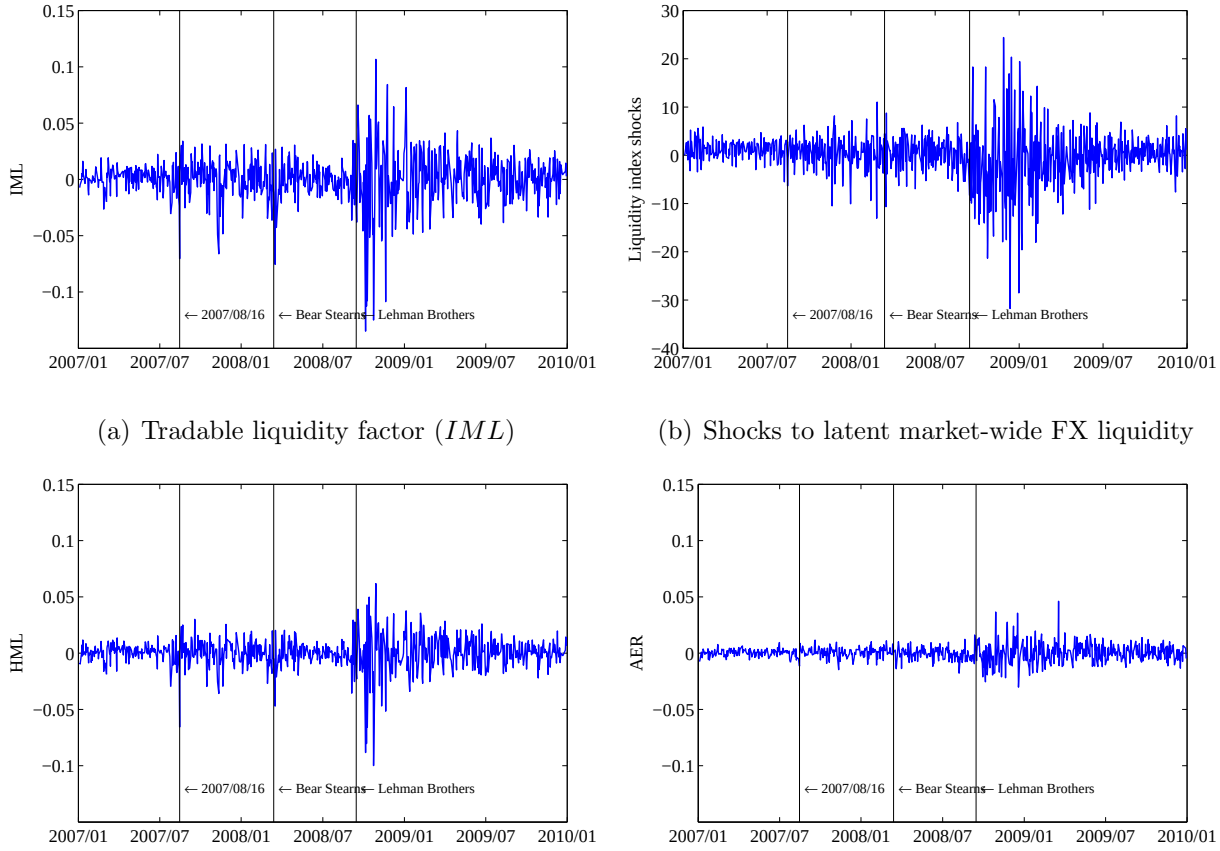


(e) Price dispersion



(f) Latent liquidity

Figure IA.7: Autocorrelations of daily market-wide liquidity. Panels (a)–(e) depict autocorrelations (up to 40 lags) for daily market-wide FX liquidity based on (within measures) averaging of individual exchange rate liquidity (Equation (IA.7)). The autocorrelations for market-wide liquidity index obtain from Principle Component Analysis across exchange rates as well as across liquidity measures (Equation (IA.8)) are depicted in Panel (f). The solid horizontal lines indicate upper and lower 95% confidence bounds. The sample is January 2, 2007 – December 30, 2009.



(a) Tradable liquidity factor (IML)

(b) Shocks to latent market-wide FX liquidity

(c) "Carry trade risk factor" (HML)

(d) Average excess return (AER)

Figure IA.8: Time series of risk factors for carry trade returns. The tradable liquidity risk factor, IML, is shown in Panel (a). This factor is defined as the excess return of a portfolio which is long the two most illiquid and short the two most liquid exchange rates. Panel (b) shows shocks to market-wide FX liquidity index (residuals from AR(1) model fitted to $L_{M,t}^{(pca)}$ from Equation (IA.8)). The slope or carry trade risk factor, HML, of Lustig, Roussanov, and Verdelhan (2011), defined as the excess return of a portfolio which is long the two exchange rates with largest interest rate differential and short the two exchange rates with the smallest interest rate differential, is shown in Panel (c). Panel (d) depicts the market risk factor, AER, of Lustig, Roussanov, and Verdelhan (2011), which is constructed as the average excess return from investing in an equally weighted portfolio of foreign currencies from the perspective of a US investor. The sample is January 2, 2007 – December 30, 2009.

Table IA.I: Comparison of different FX data sources

	EBS	Reuters D2000-2	FXFX Reuters quotes	Datastream (WM/Reuters)	Carry trade ETF (The PowerShares DB G10 Currency Harvest Fund; symbol: DBV)	Customer order flow data from custodian banks
Data frequency	intraday, e.g. one-second snaps	intraday, e.g. one-second snaps	intraday, typically five-minute snaps	daily (The fixings are calculated by The WM Company based on data provided by Reuters at or around 4pm London time)	daily	daily
Historical data	yes	no	no	yes	yes	yes
Volume information	yes (volume indicators)	no	no	no	yes (traded volume)	approximation (millions of transactions)
Cross-sectional information	yes	yes	yes	yes	no	yes
Representativeness	60% of interdealer market	Much smaller market share than EBS	Much smaller market share than EBS	Much smaller market share than EBS	Negligible volume compared to overall FX market (about USD 1 million daily as of August 2011)	Data for each custody bank only represents a small share of the market. The top ten banks have approximately USD 100 trillion under custody worldwide with the largest (Bank of NY Mellon) only reaching USD 25 trillion (source: globalcustody.net; numbers as of December 2010/March 2011)
Further comments	Trades and executable quotes	Data have to be recorded and organized by the researchers; there is not continuous / consistent provision by the official trading platform	Indicative quotes from FXFX Reuters screen pages; collection of composite data providers	Indicative quotes; collection of composite data providers		Order flow data needs to be aligned with FX returns; alignment inaccurate if daily order flow data and FX returns are recorded at different points in time; idiosyncratic issues of the collecting bank; e.g. mergers lead to structural breaks; positions can be biased by stale prices; For confidential reasons, many banks provide only aggregate data and only for some categories of customers.
Examples of papers using this data	Berger et al. (2008); our paper	Daníelsson and Payne (2002)	Dacorogna et al. (1993); Bollerslev and Domowitz (1993); Andersen and Bollerslev (1998)	Lustig, Roussanov, and Verdelhan (2011); Menkhoff et al. (2012)		Banti, Phylaktis, and Sarno (2012)

Notes: This table compares various alternative data sources with the EBS data set which we use in this paper.

Table IA.II: Daily FX data

	AUD/USD	EUR/CHF	EUR/GBP	EUR/JPY	EUR/USD	GBP/USD	USD/CAD	USD/CHF	USD/JPY
					Whole Sample				
Return (in bps)	0.05	−0.51	3.07	−1.88	0.30	−2.21	−1.04	−1.68	−1.47
Order flow	−9.96	−29.66	−3.89	−31.47	−156.69	5.62	−12.57	59.77	−3.92
# of trades	500	3,751	479	6,750	19,306	794	323	5,605	13,867
Minimum FX rate	0.602	1.442	0.655	114.87	1.245	1.377	0.920	0.985	86.41
Maximum FX rate	0.980	1.680	0.976	169.51	1.600	2.108	1.302	1.254	123.92
					Prior to bankruptcy of Lehman Brothers				
Return (in bps)	0.59	0.38	2.30	0.40	1.48	−1.18	−2.39	−1.55	−1.09
Order flow	−14.00	−33.07	−4.86	−50.40	−61.06	1.80	−15.05	38.79	30.56
# of trades	411	4,096	430	7,417	17,575	868	334	6,111	15,013
Minimum FX rate	0.770	1.549	0.655	150.24	1.289	1.750	0.920	0.985	97.32
Maximum FX rate	0.980	1.680	0.816	169.51	1.600	2.108	1.185	1.254	123.92
					After bankruptcy of Lehman Brothers				
Return (in bps)	−0.67	−1.67	4.10	−4.89	−1.25	−3.56	0.74	−1.85	−1.97
Order flow	−4.62	−25.17	−2.61	−6.49	−282.89	10.66	−9.29	87.44	−49.42
# of trades	617	3,295	544	5,871	21,590	697	310	4,938	12,355
Minimum FX rate	0.602	1.442	0.774	114.87	1.245	1.377	1.025	0.996	86.41
Maximum FX rate	0.937	1.599	0.976	156.15	1.513	1.856	1.302	1.226	107.41

Notes: This table shows mean return (measured in basis points), order flow (buyer-initiated minus seller-initiated, measured in volume indicators; a size indicator of 1 corresponds to an order flow of 1–5 million, 6 corresponds to an order flow of 6–10 million, etc.) and number of trades per day for various exchange rates. Moreover, the minimum and maximum exchange rates during the sample are shown. The sample is January 2, 2007 – December 30, 2009.

Table IA.III: Daily liquidity measures from Model (1)

	AUD/USD	EUR/CHF	EUR/GBP	EUR/JPY	EUR/USD	GBP/USD	USD/CAD	USD/CHF	USD/JPY
					Price impact				
Mean	1.065	0.118	0.497	0.256	0.070	0.432	0.839	0.177	0.112
Median	0.870	0.098	0.405	0.219	0.060	0.334	0.766	0.159	0.103
Std. dev.	0.775	0.074	0.294	0.146	0.037	0.311	0.469	0.078	0.052
% positive	100.00%	99.32%	100.00%	100.00%	100.00%	100.00%	98.91%	100.00%	100.00%
% pos & significant	99.86%	99.05%	99.59%	100.00%	100.00%	99.59%	97.95%	100.00%	100.00%
					Return reversal ($K = 1$)				
Mean	−0.059	−0.010	−0.044	−0.0216	−0.006	−0.051	−0.0601	−0.008	−0.010
Median	−0.032	−0.007	−0.034	−0.016	−0.005	−0.035	−0.0526	−0.007	−0.009
Std. dev.	0.171	0.016	0.080	0.028	0.006	0.078	0.144	0.019	0.009
% negative	67.12%	77.63%	73.12%	82.95%	92.36%	80.49%	68.76%	69.17%	91.68%
% neg & significant	26.33%	40.11%	33.15%	43.52%	63.03%	46.79%	33.56%	27.69%	64.26%
					Return reversal ($K = 3$)				
Mean	−0.135	−0.020	−0.077	−0.041	−0.011	−0.086	−0.117	−0.019	−0.019
Median	−0.097	−0.014	−0.062	−0.032	−0.009	−0.064	−0.097	−0.016	−0.017
Std. dev.	0.271	0.025	0.117	0.044	0.009	0.115	0.216	0.032	0.014
% negative	73.53%	85.68%	77.76%	88.68%	94.95%	84.17%	72.58%	76.40%	96.73%
% neg & significant	48.43%	64.67%	51.98%	69.30%	84.31%	65.48%	52.93%	52.25%	87.59%
					Return reversal ($K = 5$)				
Mean	−0.172	−0.026	−0.093	−0.053	−0.013	−0.098	−0.160	−0.026	−0.024
Median	−0.124	−0.019	−0.079	−0.041	−0.011	−0.075	−0.131	−0.022	−0.021
Std. dev.	0.324	0.030	0.140	0.052	0.011	0.135	0.261	0.039	0.018
% negative	77.22%	88.40%	77.90%	92.36%	96.04%	83.63%	77.76%	78.17%	98.64%
% neg & significant	54.71%	73.26%	57.16%	78.85%	87.86%	68.49%	58.12%	59.62%	91.68%

Notes: This table shows summary statistics for various daily measures of liquidity. Price impact is the robustly estimated coefficient of contemporaneous order flow, φ_t, in a regression of one-minute returns on contemporaneous and lagged order flow (Equation (IA.6)). Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in the same regression. The sample is January 2, 2007 – December 30, 2009.

Table IA.IV: Daily liquidity measures

	AUD/USD	EUR/CHF	EUR/GBP	EUR/JPY	EUR/USD	GBP/USD	USD/CAD	USD/CHF	USD/JPY
					Bid-ask spread (in bps)				
Mean	5.75	2.07	4.75	2.21	1.05	6.16	8.27	2.50	1.50
Median	4.44	1.81	3.85	1.94	0.91	3.40	6.62	2.28	1.39
Std. dev.	3.87	1.03	2.96	0.96	0.29	7.44	7.63	1.11	0.41
Min	2.64	0.97	1.92	0.98	0.78	1.43	2.88	1.22	0.90
Max	54.03	8.13	29.38	11.49	2.52	67.32	135.72	16.07	3.34
					Effective cost (in bps)				
Mean	1.38	0.36	0.81	0.43	0.31	0.81	1.26	0.45	0.42
Median	1.15	0.33	0.70	0.37	0.28	0.65	1.17	0.42	0.41
Std. dev.	0.78	0.11	0.33	0.17	0.06	0.48	0.46	0.11	0.10
Min	0.57	0.24	0.36	0.23	0.23	0.30	0.59	0.30	0.29
Max	6.00	0.98	2.10	1.17	0.61	3.40	3.81	1.10	0.96
					Volume weighted effective cost (in bps)				
Mean	1.11	0.28	0.71	0.33	0.21	0.66	1.07	0.34	0.27
Median	0.93	0.25	0.61	0.29	0.19	0.52	0.99	0.31	0.26
Std. dev.	0.64	0.10	0.30	0.14	0.04	0.41	0.41	0.10	0.07
Min	0.28	0.14	0.31	0.15	0.16	0.17	0.39	0.21	0.16
Max	4.93	0.78	1.89	0.89	0.42	2.81	3.33	0.90	0.65
					Price dispersion (TSRV, five minutes, in %, annualized)				
Mean	14.25	5.36	8.28	12.26	8.91	11.31	11.84	9.81	10.41
Median	11.67	4.41	7.06	10.22	7.66	8.57	10.99	8.90	9.54
Std. dev.	9.59	3.21	4.36	7.39	4.42	8.29	5.38	4.14	4.84
Min	4.11	1.25	2.56	3.03	2.66	2.90	4.01	3.31	3.13
Max	90.21	29.28	31.52	65.14	29.39	69.05	56.24	33.73	53.36

Notes: This table shows summary statistics for various daily measures of liquidity. Bid-ask spread denotes the average proportional bid-ask spread computed using intraday data for each trading day. Effective cost is the average difference between the transaction price and the bid/ask quote prevailing at the time of the trade. Price dispersion for each trading day is estimated using two-scale realized volatility (TSRV). It is expressed in percentage on an annual basis. The sample is January 2, 2007 – December 30, 2009.

Table IA.V: Principle component loadings for individual exchange rates

	AUD/USD	EUR/CHF	EUR/GBP	EUR/JPY	EUR/USD	GBP/USD	USD/CAD	USD/CHF	USD/JPY	Average
First principle component loadings										
Return reversal	0.277	0.324	0.244	0.343	0.303	0.366	0.252	0.179	0.353	0.294
Price impact	0.430	0.471	0.429	0.469	0.482	0.450	0.388	0.476	0.473	0.452
Bid-ask spread	0.479	0.480	0.453	0.462	0.484	0.422	0.438	0.492	0.481	0.466
Effective cost	0.512	0.489	0.541	0.490	0.470	0.508	0.549	0.520	0.493	0.508
Price dispersion	0.497	0.451	0.509	0.458	0.469	0.477	0.541	0.479	0.421	0.478
Cum. % explained	70.05%	77.21%	59.14%	77.31%	78.90%	63.91%	51.59%	69.18%	77.06%	69.37%
Second principle component loadings										
Return reversal	0.932	0.934	0.948	0.930	0.951	0.766	0.746	0.978	0.927	0.901
Price impact	−0.332	−0.037	0.068	−0.160	−0.118	0.295	0.425	−0.003	−0.072	0.007
Bid-ask spread	−0.081	−0.164	−0.231	−0.092	−0.154	−0.406	−0.431	−0.129	−0.191	−0.209
Effective cost	−0.110	−0.188	−0.151	−0.151	−0.207	−0.113	−0.026	−0.079	−0.205	−0.137
Price dispersion	−0.041	−0.255	−0.145	−0.278	−0.128	−0.385	−0.277	−0.146	−0.239	−0.211
Cum. % explained	86.39%	90.72%	76.95%	89.82%	92.98%	78.78%	71.12%	87.70%	89.02%	84.83%
Third principle component loadings										
Return reversal	−0.217	−0.129	0.202	−0.106	0.049	−0.452	−0.614	0.097	−0.099	−0.141
Price impact	−0.773	0.435	−0.867	−0.412	−0.138	0.515	0.656	−0.755	0.399	−0.105
Bid-ask spread	0.525	0.303	0.397	0.726	0.334	−0.642	−0.400	−0.022	0.362	0.176
Effective cost	0.001	0.132	0.081	0.238	0.525	0.337	0.177	0.087	0.050	0.181
Price dispersion	0.283	−0.827	0.197	−0.486	−0.766	0.072	−0.039	0.642	−0.835	−0.196
Cum. % explained	94.72%	95.52%	88.39%	95.72%	96.40%	89.17%	86.61%	93.78%	96.96%	93.03%

Notes: This table shows principle component loadings for the first three factors together with the cumulative variation in liquidity that is explained by each factor. For each exchange rate j, all five demeaned and standardized liquidity measures (price impact, return reversal, bid-ask spread, effective cost, price dispersion) are collected in the $5 \times T$ matrix $\widetilde{\mathbf{L}}_j$, where T is the number of sample days. The eigenvector decomposition of the empirical covariance matrix is $\widetilde{\mathbf{L}}_j \, \widetilde{\mathbf{L}}_j' \, \mathbf{U}_j = \mathbf{U}_j \, \mathbf{D}_j$, where $\mathbf{U}_j$ is the 5×5 eigenvector matrix, and $\mathbf{D}_j$ the 5×5 diagonal matrix of eigenvalues in descending order. The first three principal component loadings are given by the first three columns of $\mathbf{U}_j$. The sample is January 2, 2007 – December 30, 2009.

Table IA.VI: Principle component loadings across exchange rates

	AUD/USD	EUR/CHF	EUR/GBP	EUR/JPY	EUR/USD	GBP/USD	USD/CAD	USD/CHF	USD/JPY
First principle component loadings									
Price impact	0.303	0.364	0.287	0.376	0.393	0.308	0.172	0.367	0.373
Return reversal ($K = 1$)	0.308	0.330	0.289	0.446	0.390	0.367	0.176	0.194	0.398
Return reversal ($K = 3$)	0.329	0.349	0.272	0.400	0.382	0.380	0.117	0.301	0.378
Return reversal ($K = 5$)	0.313	0.384	0.243	0.405	0.351	0.365	0.133	0.287	0.420
Bid-ask spread	0.311	0.380	0.273	0.380	0.388	0.241	0.220	0.374	0.379
Effective cost	0.327	0.336	0.322	0.343	0.327	0.344	0.325	0.338	0.338
Effective cost, volume-weighted	0.319	0.338	0.327	0.341	0.334	0.341	0.324	0.341	0.336
Price dispersion (TSRV, one minute)	0.331	0.345	0.338	0.355	0.360	0.286	0.293	0.344	0.339
Price dispersion (TSRV, five minute)	0.333	0.333	0.340	0.349	0.356	0.319	0.308	0.331	0.330
Average	0.319	0.351	0.300	0.377	0.364	0.328	0.230	0.320	0.366
Second principle component loadings									
Price impact	0.180	0.136	0.173	0.099	0.007	−0.027	−0.952	−0.048	−0.011
Return reversal ($K = 1$)	0.443	0.213	0.308	0.092	−0.350	−0.310	0.236	−0.617	−0.022
Return reversal ($K = 3$)	0.474	0.238	0.524	−0.007	−0.255	−0.206	0.082	−0.564	−0.112
Return reversal ($K = 5$)	0.153	0.099	0.585	−0.115	−0.347	0.278	−0.560	−0.317	0.013
Bid-ask spread	0.178	0.111	−0.449	0.007	0.015	−0.624	0.601	0.050	0.042
Effective cost	−0.542	−0.210	0.577	−0.087	−0.345	0.173	0.352	0.195	−0.105
Effective cost, volume-weighted	0.661	0.140	−0.498	0.169	0.118	−0.225	−0.297	−0.265	0.210
Price dispersion (TSRV, one minute)	−0.029	−0.020	−0.105	0.065	0.053	−0.834	0.481	0.115	0.201
Price dispersion (TSRV, five minute)	−0.457	−0.022	0.298	−0.401	0.239	0.261	0.153	0.416	−0.469
Average	0.118	0.076	0.157	−0.020	−0.096	−0.168	0.011	−0.115	−0.028

Notes: Given a standardized daily measure of liquidity, each row of the table shows principle component loadings for each exchange rate obtained by conducting Principle Component Analysis across the FX rate liquidities. The Principal Component Analysis is repeated for each liquidity measure. The sample is January 2, 2007 – December 30, 2009.

Table IA.VII: Principle component loadings across liquidity measures and exchange rates: Average loading for FX rates

	AUD/USD	EUR/CHF	EUR/GBP	EUR/JPY	EUR/USD	GBP/USD	USD/CAD	USD/CHF	USD/JPY
					Daily data				
PC1	0.309	0.044	0.102	0.079	0.030	0.171	0.170	0.045	0.037
PC2	−0.144	0.009	0.062	0.019	0.012	0.168	0.116	0.022	0.009
PC3	0.134	0.007	−0.014	0.011	0.001	−0.054	−0.185	−0.002	0.004
					Weekly data				
PC1	0.312	0.048	0.108	0.087	0.032	0.174	0.157	0.048	0.040
PC2	−0.179	0.015	0.119	0.030	0.021	0.241	0.089	0.037	0.010
PC3	0.113	0.005	−0.028	0.015	0.001	0.001	−0.182	−0.006	0.003
					Monthly data				
PC1	0.308	0.051	0.114	0.091	0.034	0.186	0.154	0.051	0.041
PC2	−0.222	0.002	0.130	0.010	0.016	0.227	0.116	0.033	0.003
PC3	0.030	0.001	0.024	−0.001	0.002	0.103	−0.200	−0.009	−0.010

Notes: Principle component loadings across FX liquidity measures and exchange rates are extracted by Principle Component Analysis. The table reports the average loading for each exchange rate at different time frequencies. The sample is January 2, 2007 – December 30, 2009.

Table IA.VIII: Principle component loadings across liquidity measures and exchange rates: Average loading for liquidity measures

	Return reversal	Price impact	Bid-ask spread	Effective cost	Price dispersion
			Daily data		
PC1	0.118	0.116	0.117	0.1025	0.094
PC2	−0.067	0.043	0.103	0.044	0.028
PC3	−0.099	0.042	−0.009	0.000	0.012
			Weekly data		
PC1	0.122	0.122	0.109	0.106	0.100
PC2	−0.024	0.030	0.103	0.071	0.032
PC3	−0.105	0.056	−0.010	−0.001	0.017
			Monthly data		
PC1	0.119	0.126	0.110	0.113	0.105
PC2	0.028	−0.004	0.087	0.054	0.010
PC3	−0.104	0.026	0.047	−0.005	0.002

Notes: Principle component loadings across FX liquidity measures and exchange rates are extracted by Principle Component Analysis. The table reports the average loading for each measure of liquidity at different time frequencies. The sample is January 2, 2007 – December 30, 2009.

Table IA.IX: Commonality in liquidity using within measure PCA factors

Measure	$\overline{R}^2$ *Factor 1*	$\overline{R}^2$ *Factors 1,2*	$\overline{R}^2$ *Factors 1,2,3*
Daily data			
Price impact	0.628	0.725	0.808
Return reversal ($K = 1$)	0.270	0.401	0.513
Return reversal ($K = 3$)	0.296	0.420	0.535
Return reversal ($K = 5$)	0.291	0.412	0.523
Bid-ask spread	0.689	0.776	0.855
Effective cost	0.880	0.918	0.941
Effective cost, volume-weighted	0.888	0.925	0.946
Price dispersion (TSRV, one minute)	0.795	0.850	0.899
Price dispersion (TSRV, five minute)	0.803	0.856	0.902
Weekly data			
Price impact	0.734	0.826	0.888
Return reversal ($K = 1$)	0.451	0.598	0.692
Return reversal ($K = 3$)	0.497	0.641	0.722
Return reversal ($K = 5$)	0.516	0.640	0.727
Bid-ask spread	0.785	0.861	0.909
Effective cost	0.907	0.941	0.961
Effective cost, volume-weighted	0.920	0.953	0.969
Price dispersion (TSRV, one minute)	0.871	0.913	0.940
Price dispersion (TSRV, five minute)	0.871	0.919	0.949
Monthly data			
Price impact	0.806	0.894	0.944
Return reversal ($K = 1$)	0.668	0.793	0.848
Return reversal ($K = 3$)	0.696	0.798	0.861
Return reversal ($K = 5$)	0.725	0.808	0.863
Bid-ask spread	0.863	0.935	0.965
Effective cost	0.922	0.954	0.974
Effective cost, volume-weighted	0.936	0.966	0.982
Price dispersion (TSRV, one minute)	0.912	0.944	0.964
Price dispersion (TSRV, five minute)	0.912	0.947	0.972

Notes: For each daily standardized measure of liquidity the first three common factors are extracted using principle component analysis. Then, for each exchange rate and each standardized liquidity measure, liquidity is regressed on its common factors. The table shows the average adjusted-R^2, $\overline{R}^2$, of these regressions using one, two and three factors. The sample is January 2, 2007 – December 30, 2009.

Table IA.X: Commonality in liquidity using within measure PCA factors based on FX rates against USD

Measure	$\overline{R}^2$ *Factor 1*	$\overline{R}^2$ *Factors 1,2*	$\overline{R}^2$ *Factors 1,2,3*
Daily data			
Price impact	0.628	0.767	0.8749
Return reversal ($K = 1$)	0.299	0.481	0.634
Return reversal ($K = 3$)	0.333	0.505	0.662
Return reversal ($K = 5$)	0.321	0.490	0.643
Bid-ask spread	0.668	0.791	0.902
Effective cost	0.883	0.928	0.956
Effective cost, volume-weighted	0.887	0.932	0.960
Price dispersion (TSRV, one minute)	0.773	0.855	0.920
Price dispersion (TSRV, five minute)	0.795	0.857	0.915
Weekly data			
Price impact	0.723	0.845	0.925
Return reversal ($K = 1$)	0.474	0.679	0.791
Return reversal ($K = 3$)	0.520	0.717	0.823
Return reversal ($K = 5$)	0.530	0.711	0.821
Bid-ask spread	0.775	0.861	0.929
Effective cost	0.909	0.949	0.974
Effective cost, volume-weighted	0.919	0.958	0.980
Price dispersion (TSRV, one minute)	0.864	0.915	0.955
Price dispersion (TSRV, five minute)	0.871	0.926	0.960
Monthly data			
Price impact	0.795	0.905	0.965
Return reversal ($K = 1$)	0.658	0.838	0.912
Return reversal ($K = 3$)	0.683	0.836	0.902
Return reversal ($K = 5$)	0.718	0.842	0.910
Bid-ask spread	0.860	0.934	0.968
Effective cost	0.923	0.961	0.983
Effective cost, volume-weighted	0.935	0.968	0.989
Price dispersion (TSRV, one minute)	0.912	0.949	0.974
Price dispersion (TSRV, five minute)	0.916	0.954	0.981

Notes: For each standardized daily measure of liquidity the first three common factors are extracted using Principle Component Analysis. Then, for each exchange rate and each standardized liquidity measure, liquidity is regressed on its common factors. The table shows the average adjusted-R^2, $\overline{R}^2$, of these regressions using one, two and three factors. The sample is January 2, 2007 – December 30, 2009. This analysis is conducted using only currency pairs that include the USD.

Table IA.XI: Further evidence for commonality

Liquidity measure	Mean β	Std. β	% pos.	% pos. & signif.	Adj.-R^2
Daily data					
Price impact	0.341	0.105	100.00%	77.78%	0.014
Return reversal ($K = 1$)	0.017	0.146	55.56%	22.22%	0.005
Return reversal ($K = 3$)	0.140	0.141	77.78%	55.56%	0.006
Return reversal ($K = 5$)	0.161	0.142	77.78%	44.44%	0.007
Bid-ask spread	0.486	0.190	88.89%	88.89%	0.106
Effective cost	0.946	0.061	100.00%	100.00%	0.346
Effective cost, volume-weighted	0.884	0.066	100.00%	100.00%	0.296
Price dispersion (TSRV, one minute)	0.878	0.067	100.00%	100.00%	0.374
Price dispersion (TSRV, five minute)	0.887	0.053	100.00%	100.00%	0.379
Weekly data					
Price impact	0.693	0.223	100.00%	77.78%	0.072
Return reversal ($K = 1$)	0.697	0.296	88.89%	44.44%	0.044
Return reversal ($K = 3$)	0.450	0.279	100.00%	44.44%	0.059
Return reversal ($K = 5$)	0.197	0.271	88.89%	55.56%	0.057
Bid-ask spread	0.562	0.269	88.89%	77.78%	0.347
Effective cost	1.075	0.103	100.00%	100.00%	0.487
Effective cost, volume-weighted	1.064	0.105	100.00%	100.00%	0.462
Price dispersion (TSRV, one minute)	1.083	0.093	100.00%	100.00%	0.565
Price dispersion (TSRV, five minute)	1.027	0.081	100.00%	100.00%	0.564
Monthly data					
Price impact	1.257	0.365	100.00%	88.89%	0.389
Return reversal ($K = 1$)	0.830	0.577	88.89%	44.44%	0.162
Return reversal ($K = 3$)	0.891	0.575	88.89%	44.44%	0.121
Return reversal ($K = 5$)	0.811	0.549	88.89%	55.56%	0.157
Bid-ask spread	1.145	0.294	100.00%	88.89%	0.548
Effective cost	1.364	0.176	100.00%	100.00%	0.713
Effective cost, volume-weighted	1.333	0.180	100.00%	100.00%	0.713
Price dispersion (TSRV, one minute)	1.134	0.146	100.00%	100.00%	0.701
Price dispersion (TSRV, five minute)	1.114	0.137	100.00%	100.00%	0.705

Notes: This table shows time-series regression results when daily relative changes in individual exchange rate j liquidity are regressed on relative changes in market-wide FX liquidity. The latter is given by the average liquidity across exchange rates, without exchange rate j, similarly to Chordia, Roll, and Subrahmanyam (2000). Mean β and Std. β denote cross-sectional average and standard deviation of slope coefficients. % pos. and % pos. & signif. denote the percentages of estimates which are positive as well as positive and significantly different from zero. The last column shows the adjusted-R^2. The sample is January 2, 2007 – December 30, 2009.

Table IA.XII: Further evidence for liquidity spirals in the FX market using LIBOR-OIS spread

	$const$	$L_{M,t-1}^{(pca)}$	VIX_{t-1}	$LIBOR\text{-}OIS_{t-1}$	Adj. R^2
Coefficient	16.753		−0.527	−4.901	0.788
Std. error	(0.805)		(0.042)	(0.984)	
Coefficient	8.418			−13.332	0.635
Std. error	(0.704)			(1.402)	
Coefficient	10.661	0.355	−0.329	−3.368	0.814
Std. error	(1.281)	(0.076)	(0.049)	(0.637)	
Coefficient	3.215	0.623		−5.093	0.750
Std. error	(0.462)	(0.047)		(0.859)	

Notes: Regression of daily market-wide FX liquidity index ($L_{M,t}^{(pca)}$) on lagged VIX and lagged LIBOR-OIS spread. Four different specifications of the regression model are estimated. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parenthesis. The sample is January 2, 2007 – December 30, 2009.

Table IA.XIII: Further evidence for liquidity spirals in the FX market up to Lehman bankruptcy

	const	$L_{M,t-1}^{(pca)}$	VIX_{t-1}	TED_{t-1}	VXY_{t-1}	Adj. R^2
Coefficient	14.915		−0.553	−0.433		0.413
Std. error	(0.788)		(0.052)	(0.430)		
Coefficient	14.751		−0.523			0.412
Std. error	(0.784)		(0.044)			
Coefficient	6.974			−2.356		0.111
Std. error	(0.595)			(0.503)		
Coefficient	7.396	0.496	−0.275	−0.270		0.550
Std. error	(1.011)	(0.060)	(0.042)	(0.251)		
Coefficient	13.985	0.270	−0.084	0.706	−1.085	0.612
Std. error	(1.198)	(0.060)	(0.048)	(0.266)	(0.143)	

Notes: Regression of daily market-wide FX liquidity index ($L_{M,t}^{(pca)}$) on lagged VIX and lagged TED spread. Various specifications of the regression model are estimated. The last specification additionally control for the JP Morgan Implied Volatility Index for the G7 currencies, VXY. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parentheses. The number of observation is 417. The sample is January 2, 2007 – September 12, 2008, i.e., using data only up to Lehman bankruptcy.

Table IA.XIV: VAR model for daily market-wide liquidity and volatility of FX and U.S. Treasury bond markets

	c	$LIQ_{FX,t-1}$	$LIQ_{Bond,t-1}$	$VOL_{FX,t-1}$	$VOL_{Bond,t-1}$	R^2
$LIQ_{FX,t}$	10.994	0.537	−0.605	−0.650	−0.416	0.780
	(1.380)	(0.034)	(0.331)	(0.088)	(0.080)	
$LIQ_{Bond,t}$	−2.021	0.008	0.176	−0.006	−0.042	0.256
	(0.161)	(0.004)	(0.039)	(0.010)	(0.009)	
$VOL_{FX,t}$	−0.301	0.006	−0.086	0.985	0.019	0.987
	(0.139)	(0.003)	(0.033)	(0.009)	(0.008)	
$VOL_{Bond,t}$	0.102	0.005	0.024	0.015	0.985	0.974
	(0.185)	(0.005)	(0.044)	(0.012)	(0.011)	

Notes: Estimation results for the vector autoregressive (VAR) model $y_t = c + Ay_{t-1} + \text{error}_t$, where $y_t = [LIQ_{FX,t}, LIQ_{Bond,t}, VOL_{FX,t}, VOL_{Bond,t}]'$ is a 4×1 vector of market-wide relevant variables at day t; $LIQ_{FX,t}$ is the FX liquidity index extracted via PCA (i.e., $L_{M,t}^{(pca)}$); $LIQ_{Bond,t}$ the U.S. 10-year Treasury bond liquidity computed using BrokerTec data and then averaging bid-ask spreads of all intraday transactions during New York trading hours; $VOL_{FX,t}$ the JP Morgan Implied Volatility Index for the G7 currencies, VXY; $VOL_{Bond,t}$ the U.S. Treasury bond option volatility MOVE index computed by Merrill Lynch (divided by 10 to have all variables on a similar scale), which is a yield curve weighted index of the normalized implied volatility on 1-month Treasury options. Second column reports the estimation of c in the VAR model. Third to sixth columns report the estimation of A in the VAR model. Last column reports the R^2 for each individual equation. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parentheses. The number of observation is 658. The sample is April 2, 2007 – December 30, 2009.

Table IA.XV: Granger causality tests for daily market-wide liquidity and volatility of FX and U.S. Treasury bond markets

	LIQ_{FX}	LIQ_{Bond}	VOL_{FX}	VOL_{Bond}
LIQ_{FX}	–	4.321	2.716	1.237
		(0.038)	(0.099)	(0.267)
LIQ_{Bond}	3.351	–	6.633	0.294
	(0.068)		(0.010)	(0.588)
VOL_{FX}	54.625	0.332	–	1.589
	(0.000)	(0.565)		(0.208)
VOL_{Bond}	27.349	20.532	4.9507	–
	(0.000)	(0.000)	(0.026)	

Notes: Granger causality test statistics (p-values in parentheses) for daily market-wide liquidity and volatility of FX and U.S. Treasury bond markets. The null hypothesis is that the row variable does not Granger cause the column variable. Test statistics are based on the vector autoregressive (VAR) model in Table IA.XIV. LIQ_{FX} is the FX liquidity index extracted via PCA (i.e., $L^{(pca)}_{M,t}$); LIQ_{Bond} the U.S. 10-year Treasury bond liquidity computed using BrokerTec data and then averaging bid-ask spreads of all intraday transactions during New York trading hours; VOL_{FX} the JP Morgan Implied Volatility Index for the G7 currencies, VXY; VOL_{Bond} the U.S. Treasury bond option volatility MOVE index computed by Merrill Lynch (divided by 10 to have all variables on a similar scale), which is a yield curve weighted index of the normalized implied volatility on 1-month Treasury options. The number of observation is 658. The sample is April 2, 2007 – December 30, 2009.

Table IA.XVI: Currency liquidity sensitivity to changes in market-wide FX liquidity (including own rate when computing average market-wide liquidity)

	AUD/USD	EUR/CHF	EUR/GBP	EUR/JPY	EUR/USD	GBP/USD	USD/CAD	USD/CHF	USD/JPY
Panel (a): Sensitivity to changes in common liquidity									
Whole sample									
a_j	0.487	−0.096	−0.043	−0.018	−0.173	0.380	−0.162	−0.185	−0.191
	(0.028)	(0.004)	(0.015)	(0.005)	(0.002)	(0.012)	(0.019)	(0.004)	(0.003)
b_j	2.699	0.384	1.113	0.595	0.191	1.726	1.580	0.378	0.334
	(0.037)	(0.006)	(0.020)	(0.007)	(0.003)	(0.016)	(0.025)	(0.005)	(0.004)
R^2	0.879	0.866	0.816	0.919	0.824	0.938	0.847	0.869	0.894
Pre-Lehman									
a_j	0.318	−0.079	−0.113	−0.067	−0.285	0.294	0.173	−0.124	−0.118
	(0.029)	(0.006)	(0.022)	(0.005)	(0.004)	(0.021)	(0.033)	(0.008)	(0.005)
b_j	2.493	0.445	0.906	0.482	−0.012	1.513	2.213	0.500	0.459
	(0.053)	(0.011)	(0.040)	(0.010)	(0.007)	(0.039)	(0.060)	(0.014)	(0.009)
R^2	0.843	0.793	0.554	0.858	0.007	0.786	0.766	0.748	0.873
Post-Lehman									
a_j	0.924	0.005	−0.296	−0.079	−0.123	0.217	−0.226	−0.173	−0.249
	(0.069)	(0.008)	(0.033)	(0.012)	(0.003)	(0.028)	(0.044)	(0.009)	(0.007)
b_j	3.097	0.472	0.893	0.544	0.242	1.586	1.503	0.385	0.278
	(0.073)	(0.009)	(0.035)	(0.013)	(0.004)	(0.029)	(0.046)	(0.010)	(0.007)
R^2	0.852	0.907	0.679	0.853	0.936	0.903	0.771	0.830	0.821
Panel (b): Standard deviation of idiosyncratic liquidity									
Whole sample	0.371	0.046	0.122	0.055	0.027	0.114	0.179	0.038	0.036
Pre-Lehman	0.124	0.023	0.072	0.021	0.023	0.068	0.145	0.029	0.023
Post-Lehman	0.545	0.062	0.136	0.073	0.031	0.127	0.214	0.047	0.045

Notes: For each exchange rate j, daily individual liquidity (effective cost), $L_{j,t}^{(ec)}$, is regressed on average market-wide FX liquidity $L_{M,t}^{(ec)}$, i.e., we run the time-series regression $L_{j,t}^{(\cdot)} = a_j + b_j L_{M,t}^{(\cdot)} + L_{I,j,t}^{(\cdot)}$, where $L_{I,j,t}^{(\cdot)}$ represents an idiosyncratic liquidity shock. Liquidity of FX rate j is included when computing $L_{M,t}^{(ec)}$. Panel (a) shows the regression results. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parenthesis. Panel (b) shows the standard deviation of idiosyncratic liquidity, which is defined as the residuals of the regression above. The number of observations is 733. The sample is January 2, 2007 – December 30, 2009.

Table IA.XVII: Currency liquidity sensitivity to relative changes in market-wide FX liquidity

	AUD/USD	EUR/CHF	EUR/GBP	EUR/JPY	EUR/USD	GBP/USD	USD/CAD	USD/CHF	USD/JPY
Whole sample									
a_j	0.912	−0.802	0.165	−0.544	−1.061	0.353	0.642	−0.603	−0.667
	(0.066)	(0.037)	(0.059)	(0.036)	(0.031)	(0.059)	(0.054)	(0.027)	(0.022)
b_j	1.261	0.674	0.981	0.944	0.383	1.586	0.880	0.584	0.564
	(0.021)	(0.012)	(0.019)	(0.011)	(0.010)	(0.018)	(0.017)	(0.008)	(0.007)
R^2	0.838	0.825	0.793	0.904	0.674	0.911	0.791	0.868	0.899
Pre-Lehman									
a_j	0.973	−0.740	−0.063	−0.668	−1.308	0.275	0.847	−0.555	−0.629
	(0.126)	(0.057)	(0.124)	(0.050)	(0.041)	(0.127)	(0.137)	(0.061)	(0.038)
b_j	1.305	0.710	0.717	0.788	−0.047	1.547	1.141	0.643	0.648
	(0.039)	(0.018)	(0.039)	(0.016)	(0.013)	(0.039)	(0.042)	(0.019)	(0.012)
R^2	0.732	0.792	0.454	0.860	0.031	0.788	0.637	0.736	0.876
Post-Lehman									
a_j	0.940	−0.832	0.193	−0.518	−1.048	0.356	0.619	−0.613	−0.662
	(0.141)	(0.055)	(0.090)	(0.073)	(0.030)	(0.075)	(0.094)	(0.051)	(0.042)
b_j	1.492	0.962	0.752	0.798	0.634	1.230	0.816	0.639	0.441
	(0.045)	(0.018)	(0.028)	(0.023)	(0.009)	(0.024)	(0.030)	(0.016)	(0.013)
R^2	0.780	0.905	0.692	0.792	0.936	0.896	0.707	0.835	0.777

Notes: For each exchange rate j, the logarithm of daily individual liquidity (effective cost), $\log(L_{j,t}^{(ec)})$, is regressed on the logarithm of average market-wide FX liquidity $\log(L_{M,t}^{(ec)})$, i.e., we run the time-series regression $\log(L_{j,t}^{(ec)}) = a_j + b_j \log(L_{M,t}^{(ec)}) + \text{error}_{j,t}$. Liquidity of FX rate j is excluded before computing $L_{M,t}^{(ec)}$. Panel (a) shows the regression results. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parenthesis. Panel (b) shows the standard deviation of idiosyncratic liquidity, which is defined as the residuals of the regression in the regression above. The number of observations is 733. The sample is January 2, 2007 – December 30, 2009.

Table IA.XVIII: Correlation between FX liquidity and carry trade returns

Currency	AUD	CAD	DKK	EUR	JPY	NZD	SEK	CHF	GBP
Panel (a): Daily data									
Liquidity level	0.080	0.094	0.052	0.053	−0.080	0.074	0.076	0.014	0.096
Shocks	0.191	0.149	0.108	0.115	−0.139	0.154	0.126	0.030	0.099
Unexpected shocks	0.194	0.158	0.096	0.107	−0.144	0.155	0.097	0.022	0.082
Panel (b): Monthly data									
Liquidity level	0.316	0.356	0.168	0.164	−0.296	0.332	0.287	0.043	0.479
Shocks	0.696	0.595	0.447	0.413	−0.429	0.499	0.516	0.124	0.526
Unexpected shocks	0.626	0.554	0.436	0.407	−0.336	0.436	0.466	0.067	0.393

Notes: Correlation between FX rate liquidity (level, shocks, unexpected shocks) and carry trade returns with USD being the base currency. Liquidity level is the liquidity index across exchange rates and liquidity measures extracted by Principal Component Analysis. Shocks and unexpected shocks are obtained as the residuals of an AR(1) and AR(2) model fitted on the liquidity level, respectively. The number of observation is 733. The sample is January 2, 2007 – December 30, 2009.

Table IA.XIX: Factor model time-series regression results for FX rate (rather than carry trade) returns

	AUD	CAD	DKK	EUR	JPY	NZD	SEK	CHF	GBP
Panel (a): Whole sample									
α	0.011	0.011	−0.003	0.001	0.021	−0.003	−0.013	0.006	−0.033
	(0.016)	(0.017)	(0.008)	(0.008)	(0.016)	(0.021)	(0.018)	(0.013)	(0.019)
β_{AER}	1.049	0.651	1.108	1.093	0.607	1.157	1.366	1.137	0.831
	(0.026)	(0.029)	(0.013)	(0.014)	(0.026)	(0.034)	(0.031)	(0.021)	(0.032)
β_{IML}	0.330	0.197	−0.090	−0.091	−0.382	0.230	−0.026	−0.200	0.032
	(0.009)	(0.010)	(0.004)	(0.005)	(0.009)	(0.011)	(0.010)	(0.007)	(0.011)
R^2	0.892	0.714	0.913	0.903	0.730	0.802	0.774	0.803	0.576
Panel (b): Prior to Lehman bankruptcy									
α	0.000	0.021	0.006	0.006	0.015	−0.025	−0.008	0.004	−0.020
	(0.015)	(0.019)	(0.008)	(0.008)	(0.016)	(0.024)	(0.015)	(0.010)	(0.018)
β_{AER}	1.170	0.605	1.092	1.092	0.683	1.202	1.197	1.208	0.751
	(0.035)	(0.043)	(0.018)	(0.018)	(0.038)	(0.055)	(0.034)	(0.023)	(0.041)
β_{IML}	0.288	0.226	−0.082	−0.082	−0.405	0.298	−0.036	−0.233	0.026
	(0.011)	(0.014)	(0.006)	(0.006)	(0.012)	(0.017)	(0.011)	(0.007)	(0.013)
R^2	0.852	0.607	0.904	0.904	0.750	0.720	0.756	0.882	0.481
Panel (c): After Lehman bankruptcy									
α	0.025	−0.002	−0.014	−0.005	0.028	0.024	−0.017	0.009	−0.048
	(0.030)	(0.032)	(0.016)	(0.016)	(0.029)	(0.035)	(0.038)	(0.026)	(0.038)
β_{AER}	0.981	0.684	1.119	1.098	0.567	1.173	1.426	1.093	0.859
	(0.039)	(0.042)	(0.020)	(0.022)	(0.038)	(0.046)	(0.050)	(0.034)	(0.050)
β_{IML}	0.355	0.181	−0.094	−0.096	−0.368	0.201	−0.028	−0.182	0.031
	(0.013)	(0.014)	(0.007)	(0.007)	(0.013)	(0.016)	(0.017)	(0.012)	(0.017)
R^2	0.907	0.757	0.916	0.903	0.721	0.846	0.784	0.768	0.606

Notes: Time series regression results for the daily factor model in Equation (IA.11) with FX returns, i.e., $-\Delta p_{j,t}$, replacing carry trade returns. $\beta_{AER,j}$ is the factor loading of the market risk factor defined as the average excess FX rate return from the perspective of a U.S. investor. $\beta_{IML,j}$ is the factor loading of the liquidity risk factor defined as the excess return of a portfolio which is long the two most illiquid and short the two most liquid exchange rates. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parenthesis. Panel (a) shows regression results for the whole sample which ranges from January 2, 2007 to December 30, 2009. Regression results for two subsamples prior to and after the bankruptcy of Lehman Brothers are reported in Panels (b) and (c), respectively.

Table IA.XX: Factor model time-series regression results for FX rate (rather than carry trade) returns with interest rate differential as explanatory variable

	AUD	CAD	DKK	EUR	JPY	NZD	SEK	CHF	GBP
Panel (a): Whole sample									
α	−0.096	0.248	−0.177	−0.050	0.203	0.145	−0.153	−0.318	0.198
	(0.217)	(0.240)	(0.109)	(0.115)	(0.217)	(0.282)	(0.255)	(0.174)	(0.267)
β_{AER}	1.048	0.652	1.107	1.093	0.607	1.162	1.367	1.135	0.829
	(0.026)	(0.029)	(0.013)	(0.014)	(0.026)	(0.034)	(0.031)	(0.021)	(0.032)
β_{IML}	0.331	0.196	−0.091	−0.091	−0.383	0.232	−0.025	−0.202	0.033
	(0.009)	(0.010)	(0.004)	(0.005)	(0.009)	(0.011)	(0.010)	(0.007)	(0.011)
β_{IRD}	0.012	−0.090	0.048	0.011	−0.089	0.039	0.055	0.015	−0.001
	(0.066)	(0.073)	(0.033)	(0.035)	(0.066)	(0.086)	(0.078)	(0.053)	(0.081)
R^2	0.893	0.720	0.915	0.904	0.734	0.806	0.775	0.806	0.582
Panel (b): Prior to Lehman bankruptcy									
α	0.748	−0.438	−0.414	−0.470	0.780	0.027	0.063	0.479	−0.775
	(0.746)	(0.913)	(0.367)	(0.368)	(0.799)	(1.148)	(0.714)	(0.487)	(0.863)
β_{AER}	1.167	0.608	1.091	1.091	0.684	1.205	1.196	1.203	0.756
	(0.036)	(0.044)	(0.018)	(0.018)	(0.039)	(0.056)	(0.035)	(0.024)	(0.042)
β_{IML}	0.288	0.225	−0.080	−0.080	−0.407	0.297	−0.036	−0.233	0.026
	(0.011)	(0.014)	(0.006)	(0.006)	(0.012)	(0.017)	(0.011)	(0.007)	(0.013)
β_{IRD}	−0.077	0.012	0.063	0.071	−0.136	−0.008	−0.001	−0.054	0.130
	(0.091)	(0.112)	(0.045)	(0.045)	(0.098)	(0.141)	(0.088)	(0.060)	(0.106)
R^2	0.854	0.611	0.906	0.905	0.754	0.724	0.759	0.883	0.490
Panel (c): After Lehman bankruptcy									
α	−0.110	0.513	−0.125	0.183	0.220	0.118	−0.660	−0.580	0.439
	(0.404)	(0.422)	(0.207)	(0.219)	(0.388)	(0.468)	(0.509)	(0.347)	(0.518)
β_{AER}	0.983	0.688	1.116	1.096	0.575	1.177	1.427	1.089	0.850
	(0.040)	(0.042)	(0.020)	(0.022)	(0.038)	(0.046)	(0.050)	(0.034)	(0.051)
β_{IML}	0.354	0.180	−0.096	−0.095	−0.371	0.204	−0.028	−0.184	0.034
	(0.014)	(0.014)	(0.007)	(0.007)	(0.013)	(0.016)	(0.017)	(0.012)	(0.017)
β_{IRD}	0.015	−0.170	0.049	−0.019	−0.137	0.114	0.150	0.091	−0.093
	(0.128)	(0.133)	(0.065)	(0.069)	(0.122)	(0.148)	(0.161)	(0.110)	(0.163)
R^2	0.909	0.772	0.920	0.908	0.735	0.854	0.789	0.776	0.614

Notes: Time series regression results for the daily factor model in Equation (IA.11) with FX returns replacing carry trade returns and the interest rate differential (IRD) as additional explanatory variable; see Table IA.XIX for explanation of entries.

Table IA.XXI: Factor model time-series regression results with shocks to market-wide FX liquidity replacing IML

	AUD	CAD	DKK	EUR	JPY	NZD	SEK	CHF	GBP
Panel (a): Whole sample									
α	0.007	0.002	0.002	0.003	0.025	0.000	−0.014	0.006	−0.032
	(0.027)	(0.022)	(0.010)	(0.010)	(0.030)	(0.026)	(0.018)	(0.018)	(0.019)
β_{AER}	1.515	0.933	0.979	0.960	0.069	1.485	1.327	0.854	0.878
	(0.039)	(0.032)	(0.015)	(0.015)	(0.044)	(0.038)	(0.027)	(0.027)	(0.028)
$\beta_{\Delta L_M^{pca}}$	2.046	0.846	−0.281	−0.153	−2.379	1.010	0.129	−1.149	−0.068
	(0.540)	(0.437)	(0.200)	(0.207)	(0.597)	(0.513)	(0.370)	(0.367)	(0.389)
R^2	0.681	0.550	0.862	0.850	0.023	0.690	0.772	0.582	0.571
Panel (b): Prior to Lehman bankruptcy									
α	−0.019	0.015	0.011	0.010	0.037	−0.039	−0.005	0.014	−0.024
	(0.025)	(0.025)	(0.010)	(0.010)	(0.032)	(0.031)	(0.015)	(0.019)	(0.018)
β_{AER}	1.375	0.795	1.028	1.028	0.390	1.415	1.174	1.036	0.760
	(0.055)	(0.055)	(0.021)	(0.021)	(0.071)	(0.069)	(0.034)	(0.042)	(0.040)
$\beta_{\Delta L_M^{pca}}$	3.644	0.063	−0.498	−0.476	−4.716	3.714	−0.637	−2.300	1.207
	(0.827)	(0.825)	(0.318)	(0.319)	(1.067)	(1.044)	(0.506)	(0.628)	(0.606)
R^2	0.629	0.344	0.853	0.853	0.095	0.529	0.750	0.599	0.481
Panel (c): After Lehman bankruptcy									
α	0.029	−0.005	−0.009	−0.003	0.029	0.024	−0.016	0.005	−0.054
	(0.054)	(0.039)	(0.020)	(0.021)	(0.055)	(0.044)	(0.038)	(0.035)	(0.039)
β_{AER}	1.557	0.977	0.964	0.939	−0.030	1.504	1.376	0.798	0.915
	(0.059)	(0.043)	(0.022)	(0.023)	(0.060)	(0.048)	(0.042)	(0.038)	(0.042)
$\beta_{\Delta L_M^{pca}}$	1.731	1.020	−0.264	−0.097	−1.813	0.432	0.315	−0.881	−0.444
	(0.798)	(0.581)	(0.291)	(0.304)	(0.812)	(0.645)	(0.561)	(0.513)	(0.571)
R^2	0.699	0.633	0.866	0.850	0.018	0.765	0.782	0.586	0.602

Notes: Time series regression results for the daily factor model in Equation (IA.11) with ΔL_M^{pca} replacing IML. $\beta_{AER,j}$ is the factor loading of the market risk factor defined as the average excess FX rate return from the perspective of a US investor. $\beta_{\Delta L_M^{pca},j}$ is the factor loading of the liquidity risk factor defined as shocks to market-wide FX liquidity index. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parenthesis. Panel (a) shows regression results for the whole sample which ranges from January 2, 2007 to December 30, 2009. Regression results for two subsamples prior to and after the bankruptcy of Lehman Brothers are reported in Panels (b) and (c), respectively.

Table IA.XXII: Factor model time-series regression results when IML is the only explanatory variable

	AUD	CAD	DKK	EUR	JPY	NZD	SEK	CHF	GBP
Panel (a): Whole sample									
α	0.026	0.014	0.014	0.015	0.025	0.018	0.002	0.017	−0.021
	(0.028)	(0.023)	(0.026)	(0.026)	(0.021)	(0.033)	(0.036)	(0.028)	(0.027)
β_{IML}	0.499	0.302	0.089	0.085	−0.284	0.416	0.194	−0.017	0.166
	(0.014)	(0.011)	(0.012)	(0.012)	(0.010)	(0.016)	(0.017)	(0.014)	(0.013)
R^2	0.652	0.514	0.065	0.061	0.528	0.488	0.151	0.002	0.186
Panel (b): Prior to Lehman bankruptcy									
α	0.016	0.022	0.021	0.020	0.018	−0.003	0.006	0.015	−0.008
	(0.029)	(0.023)	(0.024)	(0.024)	(0.022)	(0.035)	(0.029)	(0.027)	(0.024)
β_{IML}	0.385	0.276	0.008	0.009	−0.349	0.397	0.063	−0.133	0.088
	(0.020)	(0.016)	(0.017)	(0.017)	(0.015)	(0.024)	(0.021)	(0.019)	(0.017)
R^2	0.462	0.421	0.001	0.001	0.556	0.392	0.022	0.104	0.063
Panel (c): After Lehman default									
α	0.044	0.004	0.007	0.010	0.038	0.047	0.001	0.022	−0.036
	(0.052)	(0.043)	(0.050)	(0.050)	(0.038)	(0.061)	(0.072)	(0.054)	(0.053)
β_{IML}	0.541	0.311	0.118	0.113	−0.260	0.424	0.242	0.025	0.194
	(0.019)	(0.016)	(0.019)	(0.018)	(0.014)	(0.023)	(0.026)	(0.020)	(0.020)
R^2	0.723	0.551	0.115	0.108	0.527	0.530	0.212	0.005	0.240

Notes: Time series regression results for the daily factor model in Equation (IA.11), when the liquidity risk factor IML is the only explanatory variable. $\beta_{IML,j}$ is the factor loading of the liquidity risk factor defined as the excess return of a portfolio which is long in the two most illiquid and short in the two most liquid exchange rates. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parenthesis. Panel (a) shows regression results for the whole sample which ranges from January 2, 2007 to December 30, 2009. Regression results for two subsamples prior to and after the bankruptcy of Lehman Brothers are reported in Panels (b) and (c), respectively.

Table IA.XXIII: Factor model time-series regression results for Deutsche Bank's carry trade index returns (DBV)

	Whole sample	Prior to Lehman bankruptcy	After Lehman bankruptcy
α	−0.018	−0.008	−0.031
	(0.033)	(0.027)	(0.069)
β_{AER}	0.274	0.173	0.318
	(0.055)	(0.064)	(0.091)
β_{IML}	0.314	0.324	0.305
	(0.018)	(0.020)	(0.031)
R^2	0.418	0.435	0.415

Notes: Time series regression results for the daily factor model in Equation (IA.11) for Deutsche Bank's exchange traded fund returns, "G10 Currency Harvest Fund," DBV. β_{AER} is the factor loading of the market risk factor defined as the average excess FX rate return from the perspective of a U.S. investor. β_{IML} is the factor loading of the liquidity risk factor defined as the excess return of a portfolio which is long the two most illiquid and short the two most liquid exchange rates. Heteroscedasticity and autocorrelation (HAC) robust standard errors are shown in parenthesis. The second column shows regression results for the whole sample which ranges from January 2, 2007 to December 30, 2009. Regression results for two subsamples prior to and after the bankruptcy of Lehman Brothers are reported in columns three and four, respectively.

Table IA.XXIV: Economic significance of liquidity betas

AUD	CAD	DKK	EUR	JPY	NZD	SEK	CHF	GBP
				Whole sample				
0.534	0.468	−0.259	−0.265	−0.978	0.386	−0.052	−0.545	0.083
				Prior to bankruptcy of Lehman Brothers				
0.509	0.532	−0.236	−0.235	−0.866	0.470	−0.086	−0.563	0.074
				After bankruptcy of Lehman Brothers				
0.558	0.433	−0.271	−0.279	−1.026	0.346	−0.054	−0.522	0.078

Notes: Entries show the change in carry trade returns (in number of standard deviations) in response to an increase of one standard deviation in our tradable liquidity risk factor, IML. The change in carry trade return reflects the liquidity beta of the currency. Carry trade returns use USD as base currency.

Table IA.XXV: Robustness check: Estimated price impact from Model (1)

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
1-minute data; $K = 1$									
Mean	1.065	0.118	0.497	0.256	0.070	0.432	0.839	0.177	0.112
Median	0.870	0.098	0.405	0.219	0.060	0.334	0.766	0.159	0.103
Std	0.775	0.074	0.294	0.146	0.037	0.311	0.469	0.078	0.052
% positive	100.0%	99.3%	100.0%	100.0%	100.0%	100.0%	98.9%	100.0%	100.0%
% pos & signif.	99.9%	99.0%	99.6%	100.0%	100.0%	99.6%	98.0%	100.0%	100.0%
1-minute data; $K = 2$									
Mean	1.019	0.109	0.458	0.236	0.065	0.388	0.787	0.169	0.103
Median	0.826	0.092	0.377	0.202	0.055	0.304	0.721	0.152	0.093
Std	0.782	0.068	0.284	0.135	0.035	0.284	0.462	0.077	0.049
% positive	100.0%	99.6%	99.6%	100.0%	100.0%	99.7%	98.2%	100.0%	100.0%
% pos & signif.	99.9%	99.2%	99.0%	100.0%	100.0%	99.0%	96.9%	100.0%	100.0%
1-minute data; $K = 3$									
Mean	0.978	0.104	0.439	0.224	0.062	0.368	0.765	0.164	0.098
Median	0.791	0.087	0.362	0.192	0.052	0.283	0.689	0.145	0.089
Std	0.775	0.067	0.286	0.130	0.034	0.279	0.467	0.078	0.049
% positive	99.7%	99.9%	99.5%	100.0%	100.0%	99.6%	98.1%	100.0%	100.0%
% pos & signif.	99.3%	99.3%	98.8%	100.0%	100.0%	98.8%	96.9%	100.0%	100.0%
1-minute data; $K = 4$									
Mean	0.947	0.101	0.426	0.217	0.060	0.354	0.737	0.159	0.094
Median	0.753	0.085	0.349	0.184	0.050	0.268	0.666	0.143	0.084
Std	0.770	0.065	0.284	0.130	0.034	0.275	0.476	0.075	0.047
% positive	99.9%	99.9%	99.2%	100.0%	100.0%	99.2%	98.2%	100.0%	100.0%
% pos & signif.	98.9%	99.2%	98.4%	100.0%	100.0%	97.5%	95.5%	100.0%	100.0%
1-minute data; $K = 5$									
Mean	0.922	0.097	0.415	0.209	0.058	0.347	0.715	0.155	0.091
Median	0.741	0.081	0.340	0.176	0.048	0.264	0.637	0.137	0.082
Std	0.771	0.064	0.283	0.127	0.033	0.274	0.472	0.076	0.046
% positive	99.5%	100.0%	99.5%	100.0%	100.0%	99.3%	97.1%	100.0%	100.0%
% pos & signif.	98.1%	99.3%	97.4%	100.0%	100.0%	97.5%	95.8%	99.9%	100.0%
1-minute data; $K = 6$									
Mean	0.908	0.095	0.408	0.205	0.057	0.342	0.700	0.152	0.089
Median	0.725	0.080	0.334	0.172	0.048	0.258	0.632	0.135	0.081
Std	0.770	0.064	0.289	0.128	0.033	0.273	0.476	0.078	0.045
% positive	99.7%	99.9%	99.0%	100.0%	100.0%	98.8%	96.0%	100.0%	100.0%
% pos & signif.	97.4%	99.3%	97.0%	100.0%	100.0%	96.9%	94.0%	99.9%	100.0%

Notes: This table shows summary statistics for daily estimates of price impact. Price impact is the robustly estimated coefficient of contemporaneous order flow, φ_t, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in the same regression thus K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
1-minute data; $K = 8$									
Mean	0.875	0.091	0.398	0.196	0.055	0.330	0.670	0.146	0.086
Median	0.711	0.076	0.329	0.164	0.046	0.258	0.598	0.130	0.078
Std	0.760	0.064	0.291	0.128	0.033	0.260	0.492	0.080	0.044
% positive	98.8%	99.9%	98.9%	100.0%	100.0%	98.8%	94.8%	100.0%	100.0%
% pos & signif.	97.8%	99.2%	96.2%	99.7%	100.0%	96.6%	92.6%	99.9%	100.0%
1-minute data; $K = 9$									
Mean	0.872	0.090	0.397	0.193	0.055	0.324	0.650	0.144	0.084
Median	0.706	0.074	0.325	0.159	0.046	0.249	0.590	0.127	0.074
Std	0.756	0.065	0.293	0.129	0.033	0.264	0.495	0.079	0.044
% positive	99.3%	99.9%	98.8%	99.9%	100.0%	98.0%	93.7%	99.9%	100.0%
% pos & signif.	97.7%	99.2%	96.6%	99.7%	100.0%	95.2%	91.7%	99.9%	100.0%
1-minute data; $K = 10$									
Mean	0.865	0.088	0.391	0.188	0.054	0.326	0.650	0.142	0.083
Median	0.713	0.072	0.329	0.155	0.045	0.249	0.586	0.125	0.073
Std	0.751	0.065	0.294	0.128	0.033	0.266	0.495	0.078	0.045
% positive	98.8%	99.7%	98.6%	99.9%	100.0%	97.8%	94.1%	99.9%	100.0%
% pos & signif.	97.1%	98.9%	95.1%	99.6%	100.0%	95.8%	92.2%	99.7%	100.0%
2-minute data; $K = 1$									
Mean	0.991	0.120	0.467	0.252	0.070	0.378	0.866	0.170	0.109
Median	0.810	0.100	0.384	0.216	0.060	0.293	0.764	0.152	0.100
Std	0.766	0.077	0.296	0.142	0.036	0.281	0.529	0.072	0.049
% positive	100.0%	100.0%	99.6%	100.0%	100.0%	99.7%	99.5%	100.0%	100.0%
% pos & signif.	99.9%	100.0%	99.3%	100.0%	100.0%	98.8%	98.6%	100.0%	100.0%
2-minute data; $K = 2$									
Mean	0.918	0.108	0.425	0.227	0.063	0.329	0.795	0.159	0.097
Median	0.729	0.089	0.352	0.193	0.054	0.253	0.687	0.141	0.088
Std	0.761	0.071	0.296	0.133	0.034	0.264	0.541	0.072	0.046
% positive	100.0%	100.0%	98.8%	100.0%	100.0%	98.9%	98.1%	100.0%	100.0%
% pos & signif.	99.2%	100.0%	96.7%	100.0%	100.0%	97.4%	97.0%	99.9%	100.0%
2-minute data; $K = 3$									
Mean	0.865	0.100	0.400	0.213	0.060	0.313	0.751	0.152	0.090
Median	0.691	0.082	0.327	0.182	0.051	0.248	0.655	0.136	0.083
Std	0.747	0.066	0.295	0.132	0.033	0.257	0.530	0.073	0.043
% positive	99.7%	100.0%	98.8%	100.0%	100.0%	98.2%	97.4%	100.0%	100.0%
% pos & signif.	98.1%	100.0%	95.1%	100.0%	100.0%	95.6%	95.9%	99.7%	100.0%

Notes: This table shows summary statistics for daily estimates of price impact. Price impact is the robustly estimated coefficient of contemporaneous order flow, φ_t, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in the same regression thus K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
2-minute data; $K = 5$									
Mean	0.829	0.093	0.391	0.197	0.057	0.296	0.684	0.141	0.084
Median	0.654	0.076	0.317	0.166	0.049	0.229	0.620	0.124	0.077
Std	0.735	0.067	0.307	0.132	0.033	0.256	0.547	0.077	0.042
% positive	99.2%	99.9%	98.0%	100.0%	100.0%	97.3%	95.9%	99.9%	100.0%
% pos & signif.	96.6%	99.5%	93.5%	99.7%	100.0%	93.6%	91.7%	99.3%	100.0%
2-minute data; $K = 6$									
Mean	0.806	0.089	0.379	0.191	0.056	0.291	0.675	0.136	0.082
Median	0.653	0.072	0.312	0.159	0.046	0.222	0.610	0.122	0.074
Std	0.747	0.066	0.307	0.133	0.034	0.259	0.568	0.077	0.042
% positive	98.2%	99.9%	95.6%	99.9%	100.0%	95.5%	94.3%	99.7%	100.0%
% pos & signif.	95.2%	99.6%	92.5%	99.7%	100.0%	92.6%	91.8%	99.0%	100.0%
2-minute data; $K = 7$									
Mean	0.802	0.086	0.380	0.187	0.055	0.285	0.663	0.135	0.080
Median	0.638	0.070	0.312	0.155	0.045	0.212	0.595	0.119	0.072
Std	0.759	0.066	0.317	0.135	0.035	0.265	0.576	0.080	0.042
% positive	97.5%	99.5%	95.1%	99.7%	100.0%	95.8%	93.0%	99.3%	100.0%
% pos & signif.	93.7%	98.9%	90.9%	98.9%	100.0%	91.3%	90.3%	98.1%	100.0%
2-minute data; $K = 8$									
Mean	0.780	0.084	0.380	0.185	0.055	0.278	0.652	0.133	0.079
Median	0.617	0.067	0.306	0.154	0.045	0.211	0.596	0.116	0.071
Std	0.772	0.065	0.322	0.139	0.035	0.266	0.575	0.082	0.041
% positive	96.3%	99.0%	95.2%	99.6%	100.0%	93.9%	92.2%	99.2%	100.0%
% pos & signif.	93.3%	98.2%	89.6%	98.6%	100.0%	90.6%	88.9%	97.7%	100.0%
3-minute data; $K = 1$									
Mean	0.911	0.118	0.446	0.253	0.069	0.351	0.833	0.165	0.107
Median	0.748	0.098	0.375	0.215	0.059	0.270	0.732	0.147	0.099
Std	0.753	0.076	0.285	0.147	0.035	0.268	0.545	0.071	0.049
% positive	100.0%	100.0%	99.5%	100.0%	100.0%	99.5%	99.2%	100.0%	100.0%
% pos & signif.	99.7%	100.0%	98.0%	100.0%	100.0%	98.1%	98.1%	100.0%	100.0%
3-minute data; $K = 2$									
Mean	0.819	0.104	0.394	0.222	0.062	0.306	0.739	0.151	0.093
Median	0.664	0.085	0.328	0.187	0.054	0.230	0.632	0.138	0.085
Std	0.755	0.068	0.289	0.138	0.033	0.257	0.511	0.072	0.044
% positive	99.5%	100.0%	98.1%	100.0%	100.0%	97.4%	96.9%	99.9%	100.0%
% pos & signif.	97.8%	100.0%	94.8%	100.0%	100.0%	95.8%	95.0%	99.6%	100.0%

Notes: This table shows summary statistics for daily estimates of price impact. Price impact is the robustly estimated coefficient of contemporaneous order flow, φ_t, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in the same regression thus K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
3-minute data; $K = 3$									
Mean	0.780	0.095	0.383	0.207	0.059	0.288	0.695	0.144	0.087
Median	0.623	0.078	0.309	0.173	0.050	0.220	0.597	0.132	0.080
Std	0.739	0.065	0.302	0.135	0.033	0.249	0.541	0.077	0.042
% positive	98.8%	100.0%	97.5%	100.0%	100.0%	97.1%	95.4%	99.7%	100.0%
% pos & signif.	95.6%	100.0%	92.9%	100.0%	100.0%	94.1%	92.4%	99.3%	100.0%
3-minute data; $K = 4$									
Mean	0.752	0.090	0.378	0.195	0.058	0.284	0.653	0.137	0.083
Median	0.611	0.073	0.311	0.159	0.049	0.223	0.558	0.122	0.075
Std	0.726	0.065	0.313	0.136	0.034	0.251	0.556	0.079	0.043
% positive	97.7%	99.7%	96.3%	99.9%	100.0%	96.3%	92.9%	99.6%	100.0%
% pos & signif.	93.9%	99.5%	91.3%	99.5%	100.0%	91.5%	88.7%	98.9%	100.0%
3-minute data; $K = 5$									
Mean	0.737	0.086	0.371	0.190	0.057	0.272	0.637	0.133	0.081
Median	0.595	0.070	0.302	0.154	0.047	0.208	0.563	0.119	0.073
Std	0.757	0.065	0.324	0.139	0.035	0.257	0.584	0.084	0.043
% positive	95.9%	99.3%	95.2%	100.0%	100.0%	95.1%	90.7%	98.8%	100.0%
% pos & signif.	91.3%	98.5%	90.3%	99.3%	100.0%	90.2%	87.6%	97.7%	100.0%
3-minute data; $K = 6$									
Mean	0.729	0.083	0.366	0.187	0.056	0.269	0.616	0.131	0.079
Median	0.565	0.068	0.299	0.154	0.046	0.215	0.519	0.116	0.070
Std	0.756	0.065	0.340	0.143	0.035	0.260	0.615	0.087	0.043
% positive	95.8%	98.6%	94.3%	99.5%	100.0%	93.5%	88.5%	98.2%	100.0%
% pos & signif.	91.4%	97.8%	89.4%	98.8%	100.0%	89.6%	84.3%	96.9%	100.0%
4-minute data; $K = 1$									
Mean	0.880	0.119	0.437	0.252	0.068	0.336	0.811	0.162	0.105
Median	0.732	0.098	0.351	0.215	0.059	0.255	0.708	0.145	0.095
Std	0.727	0.076	0.308	0.145	0.035	0.272	0.541	0.072	0.047
% positive	100.0%	100.0%	98.8%	100.0%	100.0%	98.6%	98.5%	99.9%	100.0%
% pos & signif.	99.0%	100.0%	97.3%	100.0%	100.0%	96.7%	96.7%	99.9%	100.0%
4-minute data; $K = 2$									
Mean	0.777	0.101	0.390	0.217	0.061	0.292	0.722	0.147	0.090
Median	0.628	0.085	0.316	0.183	0.052	0.229	0.639	0.132	0.083
Std	0.715	0.066	0.314	0.134	0.033	0.259	0.561	0.074	0.042
% positive	98.4%	100.0%	96.9%	100.0%	100.0%	96.7%	95.5%	99.9%	100.0%
% pos & signif.	95.4%	100.0%	92.5%	100.0%	100.0%	94.0%	92.0%	99.6%	100.0%

Notes: This table shows summary statistics for daily estimates of price impact. Price impact is the robustly estimated coefficient of contemporaneous order flow, φ_t, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in the same regression thus K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
4-minute data; $K = 3$									
Mean	0.742	0.095	0.374	0.203	0.058	0.275	0.671	0.139	0.084
Median	0.602	0.077	0.304	0.167	0.050	0.213	0.596	0.122	0.078
Std	0.710	0.066	0.321	0.135	0.034	0.259	0.604	0.079	0.041
% positive	97.3%	100.0%	95.0%	99.9%	100.0%	94.5%	91.4%	99.7%	100.0%
% pos & signif.	93.6%	100.0%	90.5%	99.7%	100.0%	90.9%	88.3%	98.8%	100.0%
4-minute data; $K = 4$									
Mean	0.718	0.088	0.369	0.194	0.057	0.266	0.644	0.136	0.080
Median	0.588	0.072	0.300	0.161	0.048	0.209	0.578	0.121	0.073
Std	0.729	0.063	0.336	0.140	0.035	0.259	0.591	0.082	0.041
% positive	96.7%	99.6%	93.9%	99.6%	100.0%	93.9%	90.7%	98.8%	100.0%
% pos & signif.	91.5%	98.9%	88.9%	99.2%	100.0%	89.1%	87.4%	98.0%	99.9%
4-minute data; $K = 5$									
Mean	0.719	0.084	0.359	0.192	0.057	0.261	0.631	0.132	0.078
Median	0.596	0.069	0.298	0.156	0.047	0.207	0.583	0.115	0.072
Std	0.764	0.065	0.339	0.148	0.036	0.262	0.630	0.089	0.040
% positive	94.7%	98.9%	92.8%	99.5%	100.0%	92.2%	88.7%	98.2%	99.9%
% pos & signif.	89.1%	98.0%	87.4%	98.5%	100.0%	87.6%	83.9%	96.6%	99.9%
5-minute data; $K = 1$									
Mean	0.856	0.119	0.427	0.252	0.068	0.313	0.820	0.155	0.103
Median	0.699	0.098	0.349	0.214	0.059	0.248	0.716	0.138	0.095
Std	0.782	0.078	0.304	0.141	0.035	0.268	0.592	0.073	0.046
% positive	99.7%	100.0%	98.8%	100.0%	100.0%	97.7%	98.0%	99.9%	100.0%
% pos & signif.	97.7%	99.9%	96.6%	100.0%	100.0%	95.8%	97.1%	99.7%	100.0%
5-minute data; $K = 2$									
Mean	0.759	0.101	0.388	0.216	0.060	0.270	0.695	0.140	0.088
Median	0.594	0.083	0.321	0.179	0.052	0.206	0.610	0.123	0.082
Std	0.755	0.072	0.316	0.138	0.033	0.258	0.592	0.078	0.043
% positive	98.1%	99.7%	96.6%	100.0%	100.0%	94.7%	93.7%	99.7%	100.0%
% pos & signif.	94.0%	99.7%	93.7%	99.7%	100.0%	91.1%	90.3%	99.2%	100.0%
5-minute data; $K = 3$									
Mean	0.721	0.092	0.372	0.199	0.058	0.259	0.669	0.131	0.083
Median	0.568	0.076	0.308	0.165	0.050	0.196	0.593	0.115	0.077
Std	0.735	0.071	0.322	0.132	0.035	0.262	0.658	0.081	0.042
% positive	97.4%	99.6%	94.5%	99.6%	100.0%	92.9%	90.9%	98.9%	100.0%
% pos & signif.	92.4%	99.2%	89.6%	99.0%	100.0%	87.9%	86.5%	98.0%	100.0%

Notes: This table shows summary statistics for daily estimates of price impact. Price impact is the robustly estimated coefficient of contemporaneous order flow, φ_t, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in the same regression thus K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
5-minute data; $K = 4$									
Mean	0.715	0.087	0.365	0.194	0.057	0.249	0.639	0.128	0.079
Median	0.574	0.071	0.308	0.160	0.047	0.197	0.539	0.111	0.072
Std	0.795	0.068	0.329	0.141	0.035	0.267	0.702	0.089	0.042
% positive	95.1%	99.3%	93.0%	99.7%	100.0%	91.0%	87.7%	97.7%	100.0%
% pos & signif.	89.1%	97.7%	88.0%	98.5%	99.9%	85.4%	82.8%	96.3%	100.0%
6-minute data; $K = 1$									
Mean	0.820	0.118	0.413	0.252	0.067	0.308	0.792	0.155	0.102
Median	0.668	0.096	0.335	0.218	0.058	0.238	0.680	0.138	0.094
Std	0.762	0.076	0.305	0.143	0.035	0.273	0.588	0.073	0.047
% positive	99.3%	100.0%	97.8%	100.0%	100.0%	97.7%	96.5%	99.7%	100.0%
% pos & signif.	97.5%	99.9%	94.5%	100.0%	100.0%	95.2%	95.0%	99.6%	100.0%
6-minute data; $K = 2$									
Mean	0.724	0.100	0.377	0.214	0.060	0.262	0.679	0.138	0.087
Median	0.597	0.082	0.300	0.177	0.051	0.205	0.606	0.119	0.080
Std	0.766	0.070	0.330	0.138	0.034	0.260	0.601	0.078	0.044
% positive	96.2%	100.0%	95.0%	99.9%	100.0%	94.3%	92.4%	99.6%	100.0%
% pos & signif.	91.8%	99.7%	90.3%	99.9%	100.0%	88.7%	89.8%	98.9%	100.0%
6-minute data; $K = 3$									
Mean	0.694	0.090	0.363	0.205	0.058	0.255	0.646	0.131	0.082
Median	0.553	0.074	0.301	0.168	0.048	0.196	0.566	0.114	0.074
Std	0.787	0.069	0.349	0.151	0.036	0.268	0.734	0.084	0.045
% positive	95.1%	99.5%	91.4%	99.9%	100.0%	91.4%	88.7%	98.4%	100.0%
% pos & signif.	90.0%	98.5%	86.9%	99.2%	100.0%	87.4%	85.0%	97.1%	100.0%
6-minute data; $K = 4$									
Mean	0.683	0.086	0.349	0.196	0.057	0.248	0.636	0.124	0.078
Median	0.548	0.069	0.288	0.161	0.046	0.188	0.542	0.107	0.070
Std	0.820	0.071	0.358	0.154	0.036	0.279	0.733	0.096	0.043
% positive	93.3%	98.8%	89.5%	99.5%	100.0%	89.8%	86.9%	96.0%	99.9%
% pos & signif.	87.3%	97.8%	83.1%	98.8%	100.0%	82.8%	82.8%	93.6%	99.7%
10-minute data; $K = 1$									
Mean	0.728	0.119	0.394	0.250	0.065	0.255	0.759	0.148	0.098
Median	0.606	0.101	0.325	0.216	0.056	0.200	0.643	0.132	0.089
Std	0.743	0.077	0.332	0.150	0.035	0.252	0.685	0.076	0.047
% positive	97.1%	99.9%	96.2%	99.9%	100.0%	92.5%	95.0%	99.2%	100.0%
% pos & signif.	93.6%	99.7%	91.1%	99.7%	100.0%	87.9%	91.7%	98.6%	100.0%

Notes: This table shows summary statistics for various daily measures of liquidity. Price impact is the robustly estimated coefficient of contemporaneous order flow, φ_t, in a regression of one-minute returns on contemporaneous and lagged order flow (Equation (IA.6)). Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in the same regression. K is the number of periods over which the return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
10-minute data; $K = 2$									
Mean	0.643	0.095	0.354	0.214	0.058	0.222	0.667	0.130	0.084
Median	0.500	0.076	0.282	0.182	0.049	0.178	0.555	0.118	0.076
Std	0.735	0.072	0.359	0.149	0.035	0.271	0.702	0.083	0.043
% positive	92.6%	99.3%	90.0%	99.7%	100.0%	87.0%	87.7%	97.5%	100.0%
% pos & signif.	86.5%	98.8%	85.0%	98.9%	100.0%	81.0%	84.6%	95.6%	100.0%
10-minute data; $K = 3$									
Mean	0.638	0.091	0.342	0.204	0.056	0.216	0.637	0.124	0.079
Median	0.487	0.073	0.285	0.170	0.047	0.156	0.514	0.108	0.071
Std	0.798	0.074	0.391	0.155	0.037	0.300	0.814	0.095	0.044
% positive	89.5%	98.6%	86.6%	99.5%	99.9%	83.1%	84.0%	94.8%	99.9%
% pos & signif.	83.6%	97.5%	80.9%	98.1%	99.9%	76.7%	79.3%	92.0%	99.7%
15-minute data; $K = 1$									
Mean	0.687	0.117	0.391	0.245	0.062	0.238	0.708	0.141	0.096
Median	0.526	0.098	0.325	0.205	0.053	0.173	0.586	0.127	0.087
Std	0.816	0.077	0.407	0.151	0.034	0.266	0.677	0.083	0.047
% positive	95.5%	100.0%	90.5%	99.7%	100.0%	89.9%	90.6%	98.1%	100.0%
% pos & signif.	89.4%	99.9%	86.1%	99.6%	99.9%	83.5%	86.8%	96.2%	100.0%
15-minute data; $K = 2$									
Mean	0.632	0.095	0.358	0.214	0.056	0.206	0.597	0.125	0.082
Median	0.481	0.075	0.288	0.176	0.046	0.166	0.494	0.110	0.074
Std	0.895	0.077	0.448	0.158	0.036	0.288	0.806	0.099	0.047
% positive	90.5%	98.4%	85.1%	99.3%	99.6%	82.1%	82.5%	94.4%	99.7%
% pos & signif.	83.6%	97.3%	80.5%	98.8%	99.6%	75.9%	79.3%	92.2%	99.7%
20-minute data; $K = 1$									
Mean	0.648	0.117	0.367	0.246	0.060	0.219	0.690	0.137	0.092
Median	0.517	0.097	0.289	0.209	0.052	0.161	0.581	0.124	0.084
Std	0.814	0.080	0.397	0.156	0.035	0.303	0.719	0.088	0.046
% positive	90.2%	100.0%	89.2%	99.9%	99.9%	84.3%	89.8%	97.3%	100.0%
% pos & signif.	85.1%	99.9%	83.9%	99.7%	99.7%	78.0%	86.1%	94.7%	100.0%
20-minute data; $K = 2$									
Mean	0.583	0.094	0.347	0.212	0.055	0.187	0.613	0.117	0.078
Median	0.455	0.076	0.286	0.177	0.046	0.140	0.455	0.106	0.068
Std	0.905	0.078	0.471	0.159	0.036	0.334	0.888	0.104	0.047
% positive	86.2%	98.1%	84.0%	98.6%	99.3%	77.4%	79.7%	91.8%	99.5%
% pos & signif.	79.3%	96.3%	78.2%	97.7%	99.3%	70.5%	75.4%	88.3%	99.2%

Notes: This table shows summary statistics for various daily measures of liquidity. Price impact is the robustly estimated coefficient of contemporaneous order flow, φ_t, in a regression of one-minute returns on contemporaneous and lagged order flow (Equation (IA.6)). Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in the same regression. K is the number of periods over which the return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

Table IA.XXVI: Robustness check: Estimated return reversal from Model (1)

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
1-minute data; $K = 1$									
Mean	−0.059	−0.010	−0.044	−0.022	−0.006	−0.051	−0.060	−0.008	−0.010
Median	−0.032	−0.007	−0.033	−0.016	−0.005	−0.035	−0.053	−0.007	−0.009
Std	0.171	0.016	0.080	0.028	0.006	0.078	0.144	0.019	0.009
% negative	67.1%	77.6%	73.1%	82.9%	92.4%	80.5%	68.8%	69.2%	91.7%
% neg & signif.	26.3%	40.1%	33.2%	43.5%	63.0%	46.8%	33.6%	27.7%	64.3%
1-minute data; $K = 2$									
Mean	−0.052	−0.006	−0.022	−0.013	−0.003	−0.025	−0.030	−0.006	−0.006
Median	−0.036	−0.005	−0.018	−0.009	−0.003	−0.018	−0.023	−0.006	−0.005
Std	0.137	0.013	0.067	0.023	0.005	0.056	0.135	0.018	0.007
% negative	67.5%	73.4%	66.0%	75.7%	81.0%	73.4%	62.1%	67.9%	82.7%
% neg & signif.	20.5%	30.3%	19.1%	29.5%	38.3%	29.6%	23.9%	25.0%	43.2%
1-minute data; $K = 3$									
Mean	−0.039	−0.004	−0.016	−0.009	−0.002	−0.016	−0.034	−0.005	−0.005
Median	−0.026	−0.003	−0.015	−0.008	−0.002	−0.011	−0.027	−0.004	−0.004
Std	0.121	0.012	0.059	0.022	0.004	0.056	0.123	0.018	0.007
% negative	64.8%	66.4%	61.4%	70.3%	73.9%	62.9%	66.3%	61.9%	77.6%
% neg & signif.	17.1%	24.4%	17.7%	22.4%	26.6%	20.2%	23.6%	20.5%	32.6%
1-minute data; $K = 4$									
Mean	−0.030	−0.004	−0.013	−0.008	−0.002	−0.008	−0.031	−0.004	−0.003
Median	−0.021	−0.003	−0.012	−0.006	−0.001	−0.005	−0.022	−0.005	−0.003
Std	0.117	0.011	0.065	0.020	0.004	0.052	0.120	0.016	0.007
% negative	62.9%	65.5%	58.9%	69.6%	69.4%	55.9%	60.0%	64.3%	70.0%
% neg & signif.	15.0%	22.9%	15.4%	18.8%	23.5%	16.0%	22.6%	21.6%	25.0%
1-minute data; $K = 5$									
Mean	−0.017	−0.003	−0.007	−0.006	−0.001	−0.007	−0.015	−0.003	−0.003
Median	−0.014	−0.002	−0.007	−0.005	−0.001	−0.005	−0.015	−0.003	−0.002
Std	0.122	0.012	0.069	0.022	0.004	0.054	0.121	0.017	0.007
% negative	59.2%	63.7%	55.4%	64.1%	65.9%	55.8%	58.7%	59.1%	67.8%
% neg & signif.	10.5%	19.1%	13.1%	16.4%	19.8%	15.4%	19.6%	16.5%	21.7%
1-minute data; $K = 6$									
Mean	−0.017	−0.003	−0.004	−0.006	−0.001	−0.006	−0.019	−0.003	−0.002
Median	−0.012	−0.002	−0.004	−0.004	−0.001	−0.004	−0.015	−0.003	−0.002
Std	0.118	0.012	0.069	0.021	0.005	0.053	0.117	0.017	0.007
% negative	57.3%	60.3%	53.2%	63.0%	62.1%	56.9%	57.4%	59.5%	64.7%
% neg & signif.	12.4%	19.6%	12.3%	17.1%	20.3%	17.1%	20.7%	16.9%	17.9%

Notes: This table shows summary statistics for daily estimates of return reversal. Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
1-minute data; $K = 8$									
Mean	−0.007	−0.002	−0.004	−0.004	−0.001	−0.005	−0.017	−0.003	−0.002
Median	−0.009	−0.001	−0.004	−0.002	−0.001	−0.005	−0.010	−0.002	−0.002
Std	0.110	0.011	0.061	0.021	0.005	0.050	0.113	0.018	0.006
% negative	54.8%	59.3%	53.3%	56.9%	59.9%	55.4%	57.3%	55.9%	62.6%
% neg & signif.	9.3%	15.7%	11.2%	12.8%	17.1%	14.5%	19.5%	16.2%	15.4%
1-minute data; $K = 9$									
Mean	−0.010	−0.002	−0.006	−0.005	−0.001	−0.001	−0.007	−0.002	−0.001
Median	−0.007	−0.002	−0.005	−0.004	−0.001	−0.002	−0.005	−0.002	−0.001
Std	0.105	0.011	0.064	0.019	0.005	0.054	0.122	0.018	0.006
% negative	55.0%	60.6%	53.2%	60.0%	58.8%	52.7%	53.1%	57.3%	60.3%
% neg & signif.	10.5%	16.9%	10.6%	16.0%	16.4%	12.7%	16.1%	14.1%	12.7%
1-minute data; $K = 10$									
Mean	−0.011	−0.002	−0.004	−0.003	0.000	−0.006	−0.016	−0.002	−0.001
Median	−0.007	−0.001	−0.004	−0.002	0.000	−0.003	−0.012	−0.002	−0.001
Std	0.113	0.011	0.062	0.019	0.004	0.050	0.112	0.016	0.007
% negative	54.0%	59.2%	53.3%	54.8%	54.8%	55.1%	56.6%	56.1%	59.5%
% neg & signif.	10.0%	15.1%	10.9%	12.3%	13.6%	15.3%	17.9%	15.1%	12.6%
2-minute data; $K = 1$									
Mean	−0.087	−0.014	−0.049	−0.028	−0.007	−0.054	−0.081	−0.012	−0.013
Median	−0.068	−0.011	−0.040	−0.023	−0.006	−0.037	−0.065	−0.010	−0.012
Std	0.196	0.020	0.102	0.036	0.007	0.092	0.191	0.026	0.011
% negative	71.9%	83.4%	71.4%	85.9%	93.9%	77.1%	69.6%	71.1%	94.7%
% neg & signif.	37.9%	56.1%	38.2%	58.7%	70.5%	50.9%	44.3%	42.4%	76.3%
2-minute data; $K = 2$									
Mean	−0.058	−0.009	−0.027	−0.015	−0.003	−0.019	−0.054	−0.008	−0.007
Median	−0.043	−0.006	−0.025	−0.014	−0.003	−0.013	−0.042	−0.006	−0.006
Std	0.164	0.017	0.094	0.026	0.006	0.083	0.177	0.023	0.010
% negative	66.6%	73.3%	65.6%	76.4%	76.0%	62.8%	64.1%	64.3%	79.5%
% neg & signif.	29.6%	39.3%	29.7%	37.7%	41.6%	32.2%	32.9%	33.7%	46.2%
2-minute data; $K = 3$									
Mean	−0.030	−0.006	−0.007	−0.011	−0.002	−0.014	−0.037	−0.006	−0.004
Median	−0.022	−0.005	−0.005	−0.010	−0.002	−0.008	−0.035	−0.006	−0.003
Std	0.166	0.015	0.080	0.027	0.006	0.072	0.165	0.023	0.009
% negative	58.0%	67.8%	53.8%	68.6%	67.3%	57.8%	61.3%	62.6%	68.2%
% neg & signif.	22.6%	32.6%	19.8%	30.0%	31.8%	27.3%	32.7%	30.6%	32.9%

Notes: This table shows summary statistics for daily estimates of return reversal. Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
2-minute data; $K = 5$									
Mean	−0.025	−0.005	−0.010	−0.006	−0.001	−0.006	−0.016	−0.005	−0.002
Median	−0.012	−0.004	−0.008	−0.005	−0.001	−0.006	−0.015	−0.004	−0.002
Std	0.165	0.015	0.088	0.026	0.006	0.066	0.159	0.023	0.010
% negative	54.7%	64.8%	55.9%	61.5%	60.3%	55.7%	54.7%	61.1%	64.5%
% neg & signif.	21.1%	30.0%	21.3%	23.9%	24.7%	21.4%	26.5%	26.6%	25.5%
2-minute data; $K = 6$									
Mean	−0.009	−0.003	−0.001	−0.004	−0.001	−0.007	−0.010	−0.002	−0.002
Median	−0.012	−0.003	−0.004	−0.004	−0.000	−0.005	−0.003	−0.001	−0.002
Std	0.152	0.014	0.090	0.027	0.006	0.070	0.185	0.021	0.009
% negative	53.9%	60.7%	52.4%	58.5%	55.7%	53.2%	50.5%	53.9%	61.0%
% neg & signif.	19.5%	26.9%	18.3%	21.1%	21.0%	22.8%	25.1%	21.1%	24.8%
2-minute data; $K = 7$									
Mean	−0.019	−0.003	−0.002	−0.003	−0.001	−0.006	−0.021	−0.002	−0.002
Median	−0.013	−0.002	−0.003	−0.004	−0.001	−0.005	−0.013	−0.002	−0.001
Std	0.168	0.016	0.088	0.026	0.006	0.066	0.167	0.022	0.009
% negative	56.2%	59.1%	51.6%	57.2%	55.9%	53.1%	53.1%	55.0%	56.9%
% neg & signif.	20.5%	25.8%	17.2%	20.6%	20.9%	22.4%	27.4%	20.6%	19.9%
3-minute data; $K = 1$									
Mean	−0.102	−0.016	−0.055	−0.033	−0.008	−0.046	−0.104	−0.014	−0.016
Median	−0.076	−0.012	−0.050	−0.028	−0.007	−0.037	−0.074	−0.012	−0.013
Std	0.228	0.024	0.118	0.040	0.008	0.091	0.237	0.030	0.013
% negative	71.8%	83.6%	71.8%	85.9%	90.2%	73.8%	69.3%	69.7%	93.9%
% neg & signif.	42.2%	58.9%	45.0%	65.2%	73.0%	49.8%	47.9%	45.6%	80.6%
3-minute data; $K = 2$									
Mean	−0.047	−0.010	−0.012	−0.017	−0.003	−0.020	−0.049	−0.008	−0.006
Median	−0.028	−0.007	−0.009	−0.014	−0.002	−0.013	−0.040	−0.008	−0.005
Std	0.212	0.021	0.108	0.033	0.007	0.092	0.226	0.029	0.011
% negative	59.5%	73.4%	53.6%	74.8%	69.0%	61.1%	60.4%	66.4%	75.6%
% neg & signif.	30.4%	46.4%	25.9%	42.2%	39.2%	34.0%	38.2%	39.3%	46.5%

Notes: This table shows summary statistics for daily estimates of return reversal. Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
3-minute data; $K = 3$									
Mean	−0.031	−0.006	−0.005	−0.012	−0.002	−0.005	−0.040	−0.007	−0.004
Median	−0.021	−0.005	−0.005	−0.008	−0.001	−0.006	−0.028	−0.005	−0.003
Std	0.183	0.017	0.110	0.033	0.007	0.087	0.216	0.029	0.011
% negative	56.3%	67.1%	52.7%	66.7%	62.6%	54.7%	58.0%	60.8%	67.4%
% neg & signif.	26.3%	37.4%	23.9%	34.7%	35.2%	28.4%	36.0%	35.1%	35.3%
3-minute data; $K = 4$									
Mean	−0.015	−0.005	−0.008	−0.006	−0.001	−0.012	−0.020	−0.004	−0.003
Median	−0.007	−0.004	−0.008	−0.006	−0.001	−0.007	−0.015	−0.004	−0.002
Std	0.188	0.018	0.103	0.035	0.007	0.093	0.207	0.029	0.011
% negative	53.3%	62.2%	53.2%	59.2%	60.2%	56.3%	54.3%	57.8%	60.4%
% neg & signif.	24.3%	32.3%	24.6%	27.3%	26.3%	28.9%	33.3%	29.3%	30.8%
3-minute data; $K = 5$									
Mean	−0.007	−0.004	−0.004	−0.004	−0.001	−0.004	−0.021	−0.003	−0.002
Median	−0.002	−0.003	−0.002	−0.005	0.000	−0.004	−0.016	−0.001	−0.001
Std	0.182	0.017	0.103	0.032	0.006	0.079	0.220	0.027	0.010
% negative	50.9%	60.4%	49.2%	58.3%	54.8%	54.0%	55.1%	51.0%	58.3%
% neg & signif.	21.8%	33.6%	22.5%	26.1%	24.6%	22.6%	32.9%	25.6%	25.5%
4-minute data; $K = 1$									
Mean	−0.109	−0.020	−0.050	−0.037	−0.008	−0.047	−0.098	−0.016	−0.015
Median	−0.088	−0.014	−0.044	−0.029	−0.006	−0.033	−0.072	−0.015	−0.013
Std	0.236	0.025	0.126	0.041	0.009	0.108	0.269	0.036	0.014
% negative	69.2%	84.6%	68.6%	87.2%	87.3%	69.3%	65.3%	70.8%	91.3%
% neg & signif.	45.4%	64.8%	44.2%	66.3%	71.2%	48.2%	47.7%	51.0%	75.4%
4-minute data; $K = 2$									
Mean	−0.037	−0.009	−0.018	−0.016	−0.003	−0.017	−0.054	−0.008	−0.006
Median	−0.021	−0.006	−0.016	−0.012	−0.003	−0.014	−0.034	−0.009	−0.005
Std	0.209	0.019	0.134	0.039	0.009	0.091	0.259	0.034	0.012
% negative	56.1%	70.1%	56.8%	70.3%	67.1%	59.9%	58.4%	64.3%	74.6%
% neg & signif.	28.5%	43.2%	31.7%	39.2%	44.3%	33.7%	38.6%	40.0%	45.4%

Notes: This table shows summary statistics for daily estimates of return reversal. Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
4-minute data; $K = 3$									
Mean	−0.026	−0.008	−0.006	−0.008	−0.001	−0.008	−0.027	−0.004	−0.004
Median	−0.019	−0.005	−0.006	−0.008	−0.001	−0.006	−0.010	−0.004	−0.004
Std	0.205	0.020	0.113	0.036	0.008	0.104	0.240	0.033	0.012
% negative	55.0%	66.6%	52.1%	63.8%	61.4%	54.4%	52.8%	56.8%	67.0%
% neg & signif.	28.8%	40.8%	25.4%	30.7%	33.4%	30.2%	32.7%	32.3%	39.0%
4-minute data; $K = 4$									
Mean	−0.003	−0.004	−0.010	−0.004	−0.001	−0.007	−0.018	−0.005	−0.003
Median	−0.000	−0.003	−0.003	−0.004	−0.001	−0.005	−0.013	−0.004	−0.002
Std	0.217	0.019	0.118	0.035	0.008	0.085	0.252	0.031	0.011
% negative	50.2%	60.2%	50.8%	55.7%	55.5%	53.3%	53.5%	57.0%	62.1%
% neg & signif.	24.3%	36.2%	26.1%	27.6%	28.8%	29.2%	32.7%	32.5%	31.2%
4-minute data; $K = 5$									
Mean	−0.003	−0.003	−0.005	−0.006	−0.001	−0.007	−0.027	−0.005	−0.002
Median	−0.006	−0.002	−0.004	−0.006	−0.001	−0.004	−0.020	−0.004	−0.002
Std	0.202	0.018	0.117	0.043	0.009	0.097	0.263	0.033	0.011
% negative	52.1%	55.1%	51.3%	59.8%	56.8%	53.6%	54.8%	56.2%	59.9%
% neg & signif.	22.6%	31.0%	25.5%	31.1%	31.0%	30.3%	33.4%	33.3%	31.2%
5-minute data; $K = 1$									
Mean	−0.102	−0.020	−0.043	−0.039	−0.007	−0.043	−0.126	−0.015	−0.015
Median	−0.071	−0.015	−0.033	−0.031	−0.006	−0.033	−0.100	−0.015	−0.014
Std	0.266	0.025	0.143	0.048	0.010	0.116	0.291	0.038	0.015
% negative	67.8%	83.8%	65.1%	84.4%	83.2%	66.7%	71.2%	69.7%	91.3%
% neg & signif.	44.1%	66.0%	41.2%	66.0%	66.3%	47.6%	51.4%	49.7%	76.9%
5-minute data; $K = 2$									
Mean	−0.039	−0.010	−0.013	−0.017	−0.002	−0.014	−0.026	−0.009	−0.006
Median	−0.028	−0.008	−0.010	−0.013	−0.003	−0.009	−0.010	−0.007	−0.005
Std	0.249	0.022	0.154	0.044	0.009	0.100	0.280	0.036	0.013
% negative	58.5%	70.9%	53.3%	68.9%	66.6%	56.2%	52.5%	61.5%	71.8%
% neg & signif.	32.9%	49.5%	29.5%	40.9%	42.6%	34.0%	37.1%	37.2%	43.1%
5-minute data; $K = 3$									
Mean	−0.009	−0.006	−0.011	−0.005	−0.001	−0.010	−0.031	−0.004	−0.004
Median	−0.006	−0.004	−0.001	−0.005	−0.001	−0.005	−0.025	−0.003	−0.003
Std	0.246	0.023	0.129	0.040	0.008	0.102	0.279	0.037	0.012
% negative	52.1%	62.8%	50.9%	57.6%	58.0%	53.1%	55.9%	55.5%	63.2%
% neg & signif.	26.9%	38.2%	29.1%	32.1%	32.5%	30.8%	39.2%	33.3%	35.3%

Notes: This table shows summary statistics for daily estimates of return reversal. Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
5-minute data; $K = 4$									
Mean	−0.011	−0.002	−0.009	−0.005	−0.001	−0.008	−0.022	−0.007	−0.003
Median	−0.006	−0.002	−0.003	−0.005	−0.001	−0.009	−0.021	−0.005	−0.003
Std	0.237	0.019	0.142	0.042	0.009	0.114	0.283	0.037	0.013
% negative	52.5%	56.5%	51.2%	56.9%	57.6%	53.9%	54.7%	56.3%	62.2%
% neg & signif.	27.3%	31.4%	29.3%	31.8%	33.4%	35.1%	32.9%	35.7%	33.3%
6-minute data; $K = 1$									
Mean	−0.104	−0.021	−0.040	−0.039	−0.007	−0.046	−0.118	−0.018	−0.016
Median	−0.075	−0.015	−0.034	−0.031	−0.006	−0.034	−0.098	−0.017	−0.014
Std	0.265	0.027	0.157	0.050	0.010	0.121	0.299	0.040	0.016
% negative	69.6%	87.0%	60.8%	84.2%	84.2%	67.9%	70.0%	71.6%	90.7%
% neg & signif.	44.5%	67.9%	44.3%	65.3%	65.3%	47.3%	52.3%	52.3%	77.4%
6-minute data; $K = 2$									
Mean	−0.029	−0.011	−0.018	−0.011	−0.002	−0.009	−0.049	−0.007	−0.005
Median	−0.026	−0.009	−0.015	−0.009	−0.002	−0.005	−0.035	−0.006	−0.005
Std	0.266	0.023	0.159	0.045	0.010	0.119	0.311	0.038	0.014
% negative	57.7%	72.0%	56.5%	61.9%	63.4%	53.3%	57.2%	60.0%	69.3%
% neg & signif.	33.2%	48.7%	33.8%	38.2%	39.4%	31.9%	41.1%	38.2%	44.2%
6-minute data; $K = 3$									
Mean	−0.006	−0.005	−0.012	−0.009	−0.001	−0.011	−0.013	−0.007	−0.004
Median	−0.008	−0.004	−0.004	−0.007	−0.001	−0.007	−0.005	−0.007	−0.003
Std	0.246	0.022	0.152	0.043	0.010	0.109	0.298	0.039	0.014
% negative	51.6%	61.9%	52.5%	60.6%	57.6%	55.5%	51.8%	59.5%	63.4%
% neg & signif.	28.4%	38.1%	31.1%	36.2%	34.7%	32.2%	34.8%	38.9%	39.0%
10-minute data; $K = 1$									
Mean	−0.091	−0.024	−0.040	−0.037	−0.007	−0.036	−0.096	−0.019	−0.015
Median	−0.070	−0.020	−0.039	−0.031	−0.006	−0.025	−0.085	−0.017	−0.013
Std	0.329	0.031	0.206	0.062	0.014	0.141	0.399	0.049	0.019
% negative	61.9%	86.1%	60.3%	78.6%	77.8%	60.6%	61.8%	66.4%	86.9%
% neg & signif.	45.3%	73.7%	44.5%	62.5%	64.4%	44.6%	48.8%	53.3%	70.3%

Notes: This table shows summary statistics for daily estimates of return reversal. Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.

	AUD/ USD	EUR/ CHF	EUR/ GBP	EUR/ JPY	EUR/ USD	GBP/ USD	USD/ CAD	USD/ CHF	USD/ JPY
10-minute data; $K = 2$									
Mean	−0.011	−0.006	−0.008	−0.012	−0.002	−0.015	−0.036	−0.007	−0.005
Median	−0.011	−0.006	−0.011	−0.010	−0.001	−0.016	−0.024	−0.006	−0.004
Std	0.311	0.028	0.197	0.060	0.012	0.139	0.381	0.047	0.015
% negative	52.8%	62.1%	53.1%	61.7%	57.2%	56.5%	53.2%	55.0%	65.8%
% neg & signif.	31.9%	41.9%	34.7%	42.7%	39.3%	39.6%	40.9%	41.2%	42.7%
10-minute data; $K = 3$									
Mean	−0.023	−0.007	−0.008	−0.007	−0.001	−0.010	−0.026	−0.004	−0.004
Median	−0.000	−0.004	−0.010	−0.005	−0.000	−0.001	−0.024	−0.005	−0.002
Std	0.329	0.027	0.177	0.055	0.013	0.134	0.364	0.049	0.017
% negative	49.9%	59.5%	47.6%	56.2%	50.5%	50.2%	54.4%	55.1%	59.1%
% neg & signif.	31.9%	40.5%	30.6%	36.3%	33.8%	35.2%	38.2%	38.7%	39.0%
15-minute data; $K = 1$									
Mean	−0.063	−0.024	−0.032	−0.032	−0.006	−0.037	−0.108	−0.017	−0.015
Median	−0.052	−0.020	−0.033	−0.027	−0.006	−0.026	−0.094	−0.018	−0.013
Std	0.426	0.036	0.248	0.062	0.017	0.163	0.465	0.062	0.021
% negative	57.7%	81.3%	56.6%	73.9%	72.9%	61.9%	62.5%	65.9%	82.3%
% neg & signif.	42.0%	68.8%	43.5%	58.5%	60.4%	46.0%	50.9%	53.8%	67.8%
15-minute data; $K = 2$									
Mean	−0.037	−0.007	−0.001	−0.015	−0.001	−0.016	−0.033	−0.007	−0.006
Median	−0.013	−0.006	−0.006	−0.013	−0.001	−0.015	−0.034	−0.008	−0.005
Std	0.408	0.031	0.240	0.065	0.016	0.167	0.533	0.057	0.020
% negative	53.2%	61.4%	48.2%	62.6%	56.8%	56.5%	52.9%	58.0%	64.8%
% neg & signif.	35.3%	44.6%	33.0%	44.3%	38.1%	39.8%	42.6%	43.2%	45.7%
20-minute data; $K = 1$									
Mean	−0.076	−0.025	−0.030	−0.035	−0.005	−0.032	−0.087	−0.019	−0.015
Median	−0.047	−0.019	−0.025	−0.028	−0.004	−0.021	−0.097	−0.013	−0.012
Std	0.469	0.039	0.274	0.074	0.020	0.213	0.575	0.065	0.022
% negative	56.2%	79.0%	55.5%	74.1%	67.1%	57.3%	59.6%	62.5%	80.5%
% neg & signif.	41.9%	67.3%	41.9%	60.8%	54.4%	44.5%	50.9%	49.0%	68.9%
20-minute data; $K = 2$									
Mean	−0.018	−0.007	−0.004	−0.013	−0.002	−0.009	−0.006	−0.005	−0.006
Median	−0.015	−0.006	−0.001	−0.010	−0.001	−0.009	−0.014	−0.005	−0.005
Std	0.426	0.036	0.275	0.075	0.018	0.221	0.538	0.068	0.024
% negative	52.3%	62.1%	49.9%	58.9%	54.4%	52.9%	51.4%	53.3%	61.9%
% neg & signif.	37.4%	46.7%	35.1%	41.6%	40.2%	41.2%	41.1%	43.1%	48.7%

Notes: This table shows summary statistics for daily estimates of return reversal. Return reversal is the sum of the coefficients of lagged order flow, $\sum_{k=1}^{K} \gamma_{t,k}$, in a regression of FX returns on contemporaneous and lagged order flow (Equation (IA.6)). K is the number of periods over which return reversal is computed. The sample is January 2, 2007 – December 30, 2009.