FX Liquidity and Market Metrics: Online Appendix 2

Reconciliation and comparison of the CLS settlement data with other sources

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FX Liquidity and Market Metrics: New Results Using CLS Bank Settlement Data

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Because the CLS Bank data analyzed in the paper have not been extensively used in other research studies, it is useful to examine coverage and consistency of CLS data with other sources such as the BIS Triennial Survey and the Reuters and EBS electronic platforms. It is important to keep in mind that while the data collected by each institution may be as accurate as possible, it has been collected to meet its own purposes. The BIS attempts to measure all trading activity conducted by banks worldwide. EBS and Reuters track only the trading activity that occurs on their platforms between qualified members, mainly large financial institution. CLS records all settlement instructions for trades between qualified members. In this appendix, we offer more detail about each data source, in order to gauge which data sources could be appropriate for measuring FX liquidity.

We start with the BIS survey figures, which we believe are the most comprehensive. We next compare spot turnover in CLS to the Reuters and EBS electronic platforms. Lastly, we compare, by currency pair, relative spot activity in CLS and EBS.

A2.1 Comparison with BIS turnover.

In its capacity as a "bank to central banks," the Bank for International Settlements has organized a survey of global foreign exchange market turnover since 1989.[1] The first three surveys were limited to the foreign exchange markets and from 1998 thereon, both the foreign exchange and the derivatives markets have been surveyed. The survey design relies on participating central banks, which collect data from banks and dealers in their jurisdiction and calculate aggregate national results. These data are provided to the BIS which compiles global aggregates. The BIS surveys turnover in 5 categories: spot, outright forward, FX swaps, currency swaps, and FX options. In addition, the BIS requests information as to how the trade was executed (e.g. voice or electronic platforms), the type of counterparty (e.g. other reporting dealer, non-financial institution, retail, etc.), the location of the counterparty (local or cross-border), the tenor of the forward contract or swap, and whether the transaction was facilitated using prime brokerage, along with sub-

[1] From the BIS mission statement at http://www.bis.org/about/mission.htm

categories of many descriptors. The survey is conducted in April to minimize the impact of national holidays and end-of-quarter transactions which could distort the results.

The gross totals in the BIS survey data simply aggregate the reported trades. In these gross data, a transaction between a reporting bank and a non-reporting entity is reported once. For example, if Citibank (New York) pays USD and receives EUR from a retail customer or a mutual fund, there is one trade report (from Citibank). When both sides of the exchange are reporting banks, however, there will be two reports. For example, if Citibank (New York) receives 10M EUR from, and pays 12M USD to, Wells Fargo Bank (San Francisco), both banks include the trade in their survey responses. To correct for this, the BIS subtracts from the gross turnover one-half of the value of trades between reporting banks. The correction is made in two stages. "Gross-net" turnover reflects corrections for trades between reporting banks in the same survey jurisdiction (as in the Citibank/Wells Fargo example). "Net-net" turnover additionally includes a correction for reporting banks in different survey jurisdictions. For example, if Citibank (New York) receives 10M EUR from, and pays 12M USD to, the Royal Bank of Scotland (London), the trade is included in Citibank's survey response to the Federal Reserve Bank, and in RBS' response to the Bank of England.

In the examples above, all parties to the trades are acting on their own behalf. There is also a large and growing usage of prime brokerage agreements, wherein one institution (usually a major bank) acts as a broker, facilitating trades on behalf of another (such as an institutional fund, hedge fund or other proprietary trading firm).[2] For example, access to EBS was originally restricted to banks that belonged to the developing consortium. Later, under prime brokerage arrangements, other institutions could trade on EBS through the

[2] The BIS survey instructions specify reporting conventions for prime brokered trades: "Prime brokers are defined as institutions (usually large and highly -rated banks) facilitating trades for their clients (often institutional funds, hedge funds and other proprietary trading firms). Prime brokers enable their clients to conduct trades, subject to credit limits, with a group of predetermined third-party banks in the prime broker's name," (Bank for International Settlements (2012)).

sponsorship of a member, with the member essentially guaranteeing the trade. This has altered the structure of the FX market, transforming what was strictly an interdealer market into one with more direct customer participation.

Suppose that hedge fund *A* trades with Wells Fargo, and *A* is using Citi as the prime broker. There are several ways of characterizing the prime brokerage. One perspective (the "one-trade" view) is that *A* has essentially traded with Wells Fargo, and that Citi's role is incidental, becoming substantial only if *A* were to default on settlement of the trade. The "two trade" perspective cumulatively counts Citi's transfer with Wells Fargo, and *A*'s with Citi. The one-trade interpretation emphasizes the ultimate counterparties to the trade. The two-trade view focuses on the exposures to counterparty risk: *A* vs. Citi and Citi vs. Wells Fargo.[3]

While we do not take a stand on the relative merits of the one- and two-trade views, we do attempt consistency when making comparisons across different data sources. The CLS settlement data report a prime-brokered settlement once, as occurring between the ultimate counterparties. The BIS survey instructions, on the other hand, specify that when a reporting bank is acting as a prime broker it must report both legs of the transaction as two separate deals (allocating them by instrument, currency and counterparty). In addition, both legs are included in a turnover subtotal labeled "of which prime brokered," (o/wPB, available from 2013).

To estimate single-counted turnover in the BIS data we subtract one-half of the o/wPB from the net-net turnover. The following example illustrates the intuition. Suppose that (hedge fund) *A* trades one unit with (proprietary trader) *B*; *A* uses Citi as a prime

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[3] Similar reporting issues arise in other markets with broker and dealer intermediaries. In US securities markets an agency trade (that is, one conducted by a broker on behalf of a customer) is conventionally reported once. Nevertheless FINRA rules also allow for two reports in "riskless principal trades," as when, for example, a broker buys securities in a market and simultaneously sells them to a customer. Even when two reports are submitted, however, only one is considered a "tape" report, and included in the usual trading volume statistics (see FINRA's "Trade Reporting Frequently Asked Questions," FINRA (2015)).

broker and B uses RBS. From the BIS survey perspective, the trade can be diagramed as $A \leftrightarrow Citi \leftrightarrow RBS \leftrightarrow B$. Citi reports both legs, as "2 units, o/w 2 are prime brokered." Similarly, RBS reports "2 units o/w 2 are prime brokered," for a total gross-gross turnover of 4 units, o/w 4 are prime brokered. The double counting of the $Citi \leftrightarrow RBS$ trade is corrected, leaving net-net turnover of 3 units. Subtracting one-half the o/wPB leaves $3 - \frac{4}{2} = 1$, the correct single-counted volume.[4, 5]

The BIS turnover figures are stated on a per (business) day basis, wherein the total over April for a given reporting area is divided by the number of official business days in the same reporting area. We cannot implement this calculation for the CLS figures because we do not know the locations of our settlement parties. The CLS settlement volume is highly concentrated on April weekdays, however, and we therefore divide the totals by the weekday count to arrive at per day estimates.

Table A2.1 reports BIS spot turnover for April of each year (line 1). The next lines contain (when available) the corresponding BIS "of which Prime Brokered" figures (line 2), the implied turnover net of the prime broker adjustment (line 3), the average daily CLS settlement volume (line 4), and the ratio of CLS volume to BIS volume. In 2013 and 2016,

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[4] This example is straightforward only because we have focused on one particular trade. In discussions, BIS personnel have told us that the adjustment cannot be relied upon for correcting the aggregate numbers, particular for trades in which only one side is prime brokered.

[5] BIS turnover figures also include transactions between related parties, defined in the survey instructions as, "trades between desks and offices, and trades with their own branches and subsidiaries and between affiliated firms," (Bank for International Settlements (2012)). Transfers in which a bank "passes the book" between desks in different time zones, for example, would appear to fall in this category. It is difficult to generalize about the extent to which these events constitute substantive legal and economic transfers of ownership, but few would require that the transfer be finalized by any settlement. The BIS tabulations do not break down these transfers by instrument, so we cannot impute an adjustment to spot turnover estimates, but the size of such an adjustment might well be large. The April 2013 survey, for example, reports related party transactions across all instruments as $817,995 million (per day, USD equivalent), or roughly 15% of the $5,344,549 million total turnover.

the CLS spot settlements account for 36.1% and 36.9% of the adjusted BIS values. Although the CLS/BIS spot coverage might initially appear low, the two sources are focusing on different market segments. The BIS turnover includes large components representing reporting banks' transactions directly with customers, including retail and institutions that do not use prime broker arrangements.[6]

A2.2 Comparison with overall EBS and Reuters trade volumes

Lines 6 and 8 of Table A2.1 contain average daily spot volumes for EBS and Reuters (including Reuters Matching and FXall), reported on their websites. Lines 7 and 9 give these volumes relative to adjusted BIS turnover. Lines 10 and 11 report corresponding values for totals over EBS and Reuters. These calculations suggest that CLS settlements cover a substantially greater share of activity. CLS settlements are about five times as large as EBS turnover (line 5 vs line 7) and about two-and-a-half times as large as EBS and Reuters combined (line 5 vs line 11).[7]

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[6] BIS and CLS both classify trades/settlements according to instrument type. Three of the categories in principle agree: spot, outright forwards, and FX swaps (far leg). CLS also reports the near legs of FX settlements, but the BIS survey asks reporting banks to include only far legs.

Both BIS and CLS have a category labeled "options", but the classification differs significantly between the two entities. In the BIS survey, reporting dealers are requested to provide information on turnover for over-the-counter (OTC) FX options. In practice, this implies options that are created *de novo* rather than exchange traded options that are created once and then bought and sold in a public market. More specifically, reporting dealers are asked to report the notional amount of the option implying that a call option on 10M EUR is reported as 10M EUR volume regardless of the strike price or tenor of the contract. At the same time, the BIS asks reporting dealers to exclude option exercise as part of spot FX trading activity. The rationale could be that option exercise reflects a contract that was struck earlier (possibly prior to the April 2013 survey period) and the BIS survey is intended to gauge current market conditions and activities. In the CLS submissions, option settlements arise from option exercises. These are identified by a CLS classification algorithm that flags outliers, that is, settlements occurring at implied rates that differ substantially from current market rates and presumably reflect the exercise of in-the-money options.

[7] The BIS survey classifies turnover according to execution method. In these statistics, EBS and Reuters are combined into one category ("Reuters Matching/EBS", a subcategory of "electronic, indirect" turnover. In 2013, the reported average daily turnover in this category is $313,118M, a value substantially greater than $261,000M total based on the

A2.3 Cross-currency comparisons with EBS

Mancini, Ranaldo and Wrampelmeyer (2013) (MRW) report (in their internet appendix) average daily EBS trade counts for nine major currency pairs. We compare activity in their post-Lehman subsample (mid-September 2008 to December 2009) to the April 2010 BIS and CLS figures. The three sources report different activity measures, so the comparison focuses on relative activity across currency pairs. The first four columns of Table A2.2 reports the levels of the activity measures. The BIS turnover figures in column (1) are over all instruments (not just spot). The BIS data are stated on a "gross-gross" basis: both sides of the trade are reported and there is no adjustment for prime brokerage. The CLS figures in columns (2) and (3) are for spot settlements. Column (4) contains the EBS trade counts reported by MRW.

Columns (5)-(8) of Table A2.2 report the market shares across currencies implied by the levels (columns (1)-(4)). The CLS share percentages are similar to the corresponding BIS values. The EBS shares, however, differ markedly. The pattern of these differences is consistent with the identity of the dominant platform (from London FX Ltd. (2017)). For example, in the EUR/USD pair (EBS-dominant) the CLS share of spot settlements is 34.4%, while the EBS share is 43.0%. In the AUD/USD pair (Reuters-dominant), the CLS share is 11.4%, and the EBS share is 1.2%. Across all pairs, EBS shares overweight when EBS is the dominant market, and underweight when Reuters is the dominant market. In the body of this paper, we show below that this underweighting strongly affects estimated liquidity measures.

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markets' self-reported figures. We believe that the discrepancy is largely due to prime brokerage: the markets' own figures would report only execution volume conducted on their systems, implying a single-counting of trades. The BIS survey instructions state that for prime-brokered trades conducted on indirect electronic systems, both legs of the trade should be counted.

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Table A2.1 Alternative measures of spot foreign exchange turnover

Daily turnover (volume) for April of the indicated year. BIS turnover figures are from triennial BIS Surveys; CLS settlement volume is estimated from data supplied by the CLS Bank; EBS and Reuters values are reported on their websites. o/w: "of which"; PB: prime brokered. Dollar amounts are Million USD per day.

Line	Source	2010	2013	2016
1	BIS turnover	$1,490,205	$2,046,158	$1,652,349
2	BIS o/w PB		$598,252	$564,007
3	BIS net of PB		$1,747,032	$1,370,346
4	CLS	$617,012	$645,233	$494,746
5	$\frac{CLS}{BIS\ net\ of\ PB}$		36.1%	36.9%
6	EBS turnover	$154,200	$128,300	$82,300
7	$\frac{EBS}{BIS\ net\ of\ PB}$		7.3%	6.0%
8	Reuters spot turnover		$133,000	$97,000
9	$\frac{Reuters\ spot}{BIS\ net\ of\ PB}$		7.6%	7.1%
10	EBS + Reuters		$261,300	$179,300
11	$\frac{EBS + Reuters}{BIS\ net\ of\ PB}$		15.0%	13.1%

Table A2.2. Alternative measures of foreign exchange turnover, MRW currency pairs

Table reports alternative activity measures (levels and shares). For each currency pair, column (1) reports daily turnover (all instruments, BIS April 2010 Triennial Survey); column (2), daily turnover (spot settlements, April 2010, CLS); column (3), average daily number of CLS spot settlements (April 2010); column (5), average daily number of trades on the EBS system over 2008 and 2009 (from the internet appendix to Mancini, Ranaldo and Wrampelmeyer (2013), Table IA-II, post-Lehman subsample). Columns (5)-(8) are the percentage shares (across currency pairs), corresponding to columns (1)-(4). The annotation following the pair indicates the location of the dominant market: EBS (E) or Reuters (R) according to London FX Ltd. (2017).

		Levels				Percentage Shares			
		Turnover (Billion USD)		Settlements	Trades	Turnover (Billion USD)		Settlements	Trades
		BIS 2010	CLS 2010	CLS 2010	EBS 2008-9	BIS 2010	CLS 2010	CLS 2010	EBS 2008-9
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EUR/USD	E	1,098	417	98,195	21,590	37.7%	39.2%	34.4%	43.0%
USD/JPY	E	567	169	51,047	12,355	19.5%	15.9%	17.9%	24.6%
AUD/USD	R	248	122	32,575	617	8.5%	11.5%	11.4%	1.2%
GBP/USD	R	360	98	27,274	697	12.4%	9.2%	9.6%	1.4%
USD/CAD	R	182	89	20,772	310	6.3%	8.4%	7.3%	0.6%
EUR/JPY	E	111	50	19,992	5,871	3.8%	4.7%	7.0%	11.7%
EUR/GBP	R	109	47	17,197	544	3.7%	4.4%	6.0%	1.1%
USD/CHF	E	166	41	10,464	4,938	5.7%	3.9%	3.7%	9.8%
EUR/CHF	E	71	30	7,637	3,295	2.4%	2.8%	2.7%	6.6%
Total		2,912	1,062	285,152	50,217	100.0%	100.0%	100.0%	100.0%