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Supplemental Tables

Table 3, expanded. CLS spot settlements, contra currencies, by year.

The sample is all CLS spot settlements in the Aprils of 2010, 2013 and 2016. A row summarizes all settlements in which the row-currency is involved in the exchange. Percentage entries in the row reflect the total USD equivalent value of the settlement, broken out by the other currency in the exchange. For example, of the total dollar value of all settlements involving the AUD, 1.4% occurred in the AUD/CAD pair. Only 2016 values are reported in the paper; these panels include 2010 and 2013. Source: aprilAllCLS.sas → aprilAllCLS_Tables 3 & 4.rtf.

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Table 4, expanded. Settlement size distributions.
The sample is all CLS settlements in the Aprils of 2010, 2013, and 2016. Settlement sizes are stated in USD equivalent. Very small settlements, below one unit of the base currency, are excluded.

Settlement size distributions by year and instrument type.

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Settlement size distributions by year and currency (spot settlements only).

**APR2010**

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Table 8, expanded. Olsen prices and spreads

The sample is Olsen bids and asks in April of the indicated year. Within each ten-second window Olsen reports the first bid and ask. For each such observation, the spread is the ask less the bid (in units of the quote currency, scaled by $10^4$), the bid-ask midpoint is the average of the bid and ask (in units of the quote currency), and the relative spread is the spread divided by the midpoint (scaled to basis points).

Olsen prices and spreads, medians

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Table 9 (expanded). Clustering in Olsen bids and offers

The sample is Olsen bids and asks in April of the indicated year, for selected currency pairs. The price granularity is described by the “pip”. A pip is the traditional tick size in a currency pair, in units of the quote currency: 0.01 for the JPY, 0.0001 for all others (the second decimal place for JPY, the fourth for all others). The post-pip digit is the third place for the JPY and the fifth place for all others. For each bid or ask quote, the digit in the pip and post-pip decimal place is recorded.

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Clustering in Olsen bids and offers, bids and offers combined, by currency pair and year.

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Clustering in Olsen bids and offers, bids and offers reported separately, by currency pair and year.

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Table 10. Distribution of accept times (NM: not matched)
Distribution of accept times by acceptance criteria (variable and factor), as in paper.

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<th>[5s-10s)</th>
<th>[10s,20s)</th>
<th>[20s,30s)</th>
<th>[30s,1m)</th>
<th>[1m,10m)</th>
<th>NM</th>
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<td>8.0%</td>
</tr>
<tr>
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<td></td>
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<td>20.6%</td>
<td>19.4%</td>
<td>15.7%</td>
<td>8.6%</td>
</tr>
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<td>11.2%</td>
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<td>7.3%</td>
<td>3.1%</td>
</tr>
<tr>
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<td></td>
<td>2013APR</td>
<td>11,154,150</td>
<td>36.0%</td>
<td>35.1%</td>
<td>7.7%</td>
<td>3.6%</td>
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<tr>
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<td>8,359,264</td>
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<td>8.1%</td>
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### Distribution of accept times by acceptance criteria (variable and factor), by year and size of settlement

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</tr>
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<td>16.6%</td>
<td>13.6%</td>
<td>8.0%</td>
<td>12.2%</td>
<td>22.0%</td>
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<td>8.0%</td>
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</tr>
<tr>
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<tr>
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<tr>
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<td><strong>2013APR</strong></td>
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<tr>
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<tr>
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<tr>
<td><strong>&gt;100M</strong></td>
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<tr>
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<td>46.7%</td>
<td>44.9%</td>
<td>2.2%</td>
<td>0.6%</td>
<td>1.1%</td>
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<td>43.5%</td>
<td>2.2%</td>
<td>0.6%</td>
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<td>3.8%</td>
</tr>
<tr>
<td>[100K,1M)</td>
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<td>2.6%</td>
<td>2.1%</td>
</tr>
<tr>
<td>1M</td>
<td>3,356,606</td>
<td>48.3%</td>
<td>46.2%</td>
<td>2.2%</td>
<td>0.6%</td>
<td>0.9%</td>
<td>1.4%</td>
<td>0.4%</td>
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<tr>
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<td>0.7%</td>
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<td>5.4%</td>
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<tr>
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<td>34.9%</td>
<td>2.4%</td>
<td>0.8%</td>
<td>1.8%</td>
<td>8.1%</td>
<td>15.7%</td>
</tr>
<tr>
<td><strong>&gt;100M</strong></td>
<td>3,235</td>
<td>40.7%</td>
<td>37.6%</td>
<td>2.4%</td>
<td>0.4%</td>
<td>1.4%</td>
<td>6.2%</td>
<td>11.4%</td>
</tr>
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### Distribution of accept times by acceptance criteria (variable and factor), by year and currency pair

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<tr>
<th>CLS/Olsen reconciliation lag (sec)</th>
<th>[0,5s)</th>
<th>[5s-10s)</th>
<th>[10s,20s)</th>
<th>[20s,30s)</th>
<th>[30s,1m)</th>
<th>[1m,10m)</th>
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<td>All</td>
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<td>20.1%</td>
<td>18.0%</td>
<td>13.6%</td>
<td>8.0%</td>
</tr>
<tr>
<td>AUD/JPY</td>
<td>101,893</td>
<td>24.0%</td>
<td>21.0%</td>
<td>13.7%</td>
<td>7.0%</td>
<td>9.9%</td>
<td>17.2%</td>
</tr>
<tr>
<td>AUD/USD</td>
<td>599,810</td>
<td>24.6%</td>
<td>21.6%</td>
<td>14.1%</td>
<td>7.0%</td>
<td>10.0%</td>
<td>16.8%</td>
</tr>
<tr>
<td>EUR/CHF</td>
<td>167,994</td>
<td>30.6%</td>
<td>26.9%</td>
<td>12.4%</td>
<td>5.9%</td>
<td>7.9%</td>
<td>13.2%</td>
</tr>
<tr>
<td>EUR/GBP</td>
<td>230,132</td>
<td>20.4%</td>
<td>18.6%</td>
<td>14.6%</td>
<td>8.4%</td>
<td>12.8%</td>
<td>20.1%</td>
</tr>
<tr>
<td>EUR/JPY</td>
<td>439,772</td>
<td>17.1%</td>
<td>15.6%</td>
<td>12.8%</td>
<td>8.2%</td>
<td>13.9%</td>
<td>24.8%</td>
</tr>
<tr>
<td>EUR/USD</td>
<td>2,159,652</td>
<td>16.7%</td>
<td>15.2%</td>
<td>13.7%</td>
<td>8.7%</td>
<td>13.9%</td>
<td>24.4%</td>
</tr>
<tr>
<td>GBP/JPY</td>
<td>133,944</td>
<td>22.5%</td>
<td>20.4%</td>
<td>13.8%</td>
<td>8.0%</td>
<td>10.7%</td>
<td>17.5%</td>
</tr>
<tr>
<td>GBP/USD</td>
<td>716,409</td>
<td>16.7%</td>
<td>15.2%</td>
<td>13.5%</td>
<td>9.2%</td>
<td>15.4%</td>
<td>23.6%</td>
</tr>
<tr>
<td>NZD/USD</td>
<td>155,075</td>
<td>30.1%</td>
<td>25.7%</td>
<td>14.4%</td>
<td>5.6%</td>
<td>7.5%</td>
<td>11.3%</td>
</tr>
<tr>
<td>USD/CAD</td>
<td>456,899</td>
<td>24.9%</td>
<td>21.7%</td>
<td>12.8%</td>
<td>6.3%</td>
<td>9.3%</td>
<td>18.6%</td>
</tr>
<tr>
<td>USD/CHF</td>
<td>378,284</td>
<td>22.0%</td>
<td>19.8%</td>
<td>13.5%</td>
<td>7.6%</td>
<td>10.9%</td>
<td>19.0%</td>
</tr>
<tr>
<td>USD/JPY</td>
<td>1,122,776</td>
<td>17.1%</td>
<td>16.4%</td>
<td>14.5%</td>
<td>7.6%</td>
<td>8.7%</td>
<td>15.7%</td>
</tr>
<tr>
<td>USD/MXN</td>
<td>77,325</td>
<td>30.1%</td>
<td>25.7%</td>
<td>14.4%</td>
<td>5.6%</td>
<td>7.5%</td>
<td>11.3%</td>
</tr>
</tbody>
</table>

| 2013APR All | 11,154,150 | 20.6% | 19.4% | 15.7% | 8.6% | 12.9% | 16.7% | 6.2% |
| AUD/JPY | 266,051 | 18.8% | 18.4% | 13.9% | 7.8% | 13.1% | 18.9% | 9.2% |
| AUD/USD | 998,667 | 25.7% | 24.1% | 15.1% | 7.5% | 10.4% | 12.5% | 4.6% |
| EUR/CHF | 218,070 | 29.2% | 29.0% | 13.3% | 6.0% | 7.7% | 10.4% | 4.4% |
| EUR/GBP | 281,460 | 25.0% | 24.1% | 14.7% | 7.4% | 9.7% | 13.5% | 5.6% |
| EUR/JPY | 925,315 | 15.5% | 14.9% | 15.4% | 9.3% | 15.2% | 22.4% | 7.2% |
| EUR/USD | 2,860,268 | 19.2% | 17.8% | 16.4% | 9.4% | 14.0% | 17.4% | 5.8% |
| GBP/JPY | 161,893 | 17.5% | 17.1% | 13.5% | 7.3% | 12.2% | 18.6% | 13.9% |
| GBP/USD | 892,404 | 23.1% | 22.5% | 14.8% | 7.7% | 10.6% | 14.7% | 6.6% |
| NZD/USD | 276,383 | 28.3% | 27.1% | 13.7% | 6.1% | 8.2% | 10.7% | 5.8% |
| USD/CAD | 542,166 | 28.9% | 27.1% | 15.3% | 6.7% | 8.4% | 9.8% | 3.8% |
| USD/CHF | 346,210 | 25.6% | 24.2% | 14.1% | 6.9% | 9.6% | 13.3% | 6.3% |
| USD/JPY | 3,116,331 | 17.8% | 16.5% | 16.4% | 9.3% | 14.6% | 18.7% | 6.6% |
| USD/MXN | 268,932 | 17.9% | 16.3% | 17.3% | 9.9% | 15.1% | 18.1% | 5.4% |

<p>| 2016APR All | 8,359,264 | 9.6% | 9.7% | 14.2% | 11.2% | 21.9% | 25.2% | 8.2% |
| AUD/JPY | 180,025 | 7.8% | 7.8% | 11.5% | 8.9% | 19.1% | 30.9% | 14.1% |
| AUD/USD | 915,996 | 10.3% | 10.3% | 14.6% | 11.4% | 22.0% | 23.5% | 7.9% |
| EUR/CHF | 125,367 | 19.0% | 18.8% | 13.9% | 9.4% | 15.9% | 18.1% | 4.9% |
| EUR/GBP | 276,634 | 10.9% | 11.1% | 14.6% | 11.6% | 21.5% | 22.9% | 7.3% |</p>
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<th>Currency Pair</th>
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<td>6,739,965</td>
<td>36.4%</td>
<td>31.8%</td>
<td>7.3%</td>
<td>3.1%</td>
<td>5.0%</td>
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<tr>
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<tr>
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<td>2.2%</td>
<td>5.5%</td>
</tr>
<tr>
<td>EUR/GBP</td>
<td>230,132</td>
<td>40.2%</td>
<td>35.5%</td>
<td>5.9%</td>
<td>2.4%</td>
<td>3.9%</td>
<td>8.8%</td>
</tr>
<tr>
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<td>3.9%</td>
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<tr>
<td>GBP/JPY</td>
<td>133,944</td>
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<td>3.5%</td>
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<td>GBP/USD</td>
<td>716,409</td>
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<td>4.2%</td>
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<td>NZD/USD</td>
<td>155,075</td>
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<td>1.2%</td>
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<td>USD/CAD</td>
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<td>6.5%</td>
<td>1.8%</td>
<td>3.1%</td>
<td>9.2%</td>
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<td>USD/CHF</td>
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<td>5.9%</td>
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<td>3.7%</td>
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</tr>
<tr>
<td>USD/JPY</td>
<td>1,122,776</td>
<td>37.3%</td>
<td>32.6%</td>
<td>7.1%</td>
<td>2.9%</td>
<td>4.7%</td>
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<td>11.1%</td>
<td>4.3%</td>
<td>3.6%</td>
<td>7.5%</td>
</tr>
</tbody>
</table>

<p>| 2013APR | All | 11,154,150 | 36.0% | 35.1% | 7.7% | 3.6% | 5.6% | 8.5% | 3.5% |
| AUD/JPY | 266,051 | 33.4% | 34.5% | 6.6% | 3.4% | 5.7% | 10.2% | 6.3% |
| AUD/USD | 998,667 | 41.4% | 38.9% | 6.8% | 2.0% | 3.0% | 5.1% | 2.8% |
| EUR/CHF | 218,070 | 44.4% | 44.0% | 3.6% | 1.0% | 1.4% | 3.3% | 2.4% |
| EUR/GBP | 281,460 | 41.2% | 40.2% | 5.2% | 1.8% | 2.7% | 5.4% | 3.3% |
| EUR/JPY | 925,315 | 31.3% | 31.4% | 8.6% | 4.6% | 7.6% | 12.2% | 4.2% |
| EUR/USD | 2,860,268 | 35.5% | 34.2% | 8.2% | 4.0% | 6.0% | 9.1% | 2.9% |
| GBP/JPY | 161,893 | 32.5% | 33.1% | 5.9% | 3.1% | 5.2% | 10.3% | 9.8% |
| GBP/USD | 892,404 | 39.2% | 38.7% | 5.4% | 2.5% | 3.7% | 6.9% | 3.8% |
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| USD/CHF | 346,210 | 41.2% | 39.9% | 4.8% | 1.8% | 2.7% | 5.9% | 3.7% |</p>
<table>
<thead>
<tr>
<th>Currency Pair</th>
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### CLS/Olsen reconciliation lag (sec)

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<th>[30s,1m)</th>
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<tr>
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<tr>
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## CLS/Olsen reconciliation lag (sec)

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<tr>
<td></td>
<td>USD/MXN</td>
<td>77,325</td>
<td>26.1%</td>
<td>22.1%</td>
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<td>8.5%</td>
<td>15.4%</td>
<td>6.1%</td>
</tr>
</tbody>
</table>

|      | 2013APR | All     | 11,154,150 | 32.4%    | 31.4%     | 9.5%     | 4.8%     | 7.3%    | 10.6%   | 4.1%    |
|      | AUD/JPY | 266,051 | 28.2%    | 28.5%    | 9.1%      | 5.1%      | 8.4%     | 13.4%   | 7.3%    |
|      | AUD/USD | 998,667 | 37.7%    | 35.4%    | 8.8%      | 3.2%      | 4.7%     | 6.9%    | 3.3%    |
|      | EUR/CHF | 218,070 | 40.3%    | 39.9%    | 5.8%      | 2.2%      | 3.1%     | 5.4%    | 3.3%    |
|      | EUR/GBP | 281,460 | 38.0%    | 37.1%    | 7.0%      | 2.9%      | 4.1%     | 7.2%    | 3.8%    |
|      | EUR/JPY | 925,315 | 24.6%    | 24.3%    | 11.6%     | 6.7%      | 11.0%    | 16.5%   | 5.3%    |
|      | EUR/USD | 2,860,268 | 32.5%   | 31.2%    | 9.8%      | 5.0%      | 7.5%     | 10.6%   | 3.4%    |
|      | GBP/JPY | 161,893 | 24.0%    | 24.1%    | 10.2%     | 5.5%      | 9.1%     | 15.1%   | 12.1%   |
|      | GBP/USD | 892,404 | 34.0%    | 33.4%    | 8.4%      | 4.1%      | 5.9%     | 9.5%    | 4.7%    |
|      | NZD/USD | 276,383 | 38.2%    | 36.5%    | 7.8%      | 2.8%      | 3.9%     | 6.5%    | 4.3%    |
|      | USD/CAD | 542,166 | 39.9%    | 37.7%    | 7.7%      | 2.7%      | 3.7%     | 5.6%    | 2.7%    |
|      | USD/CHF | 346,210 | 37.4%    | 36.1%    | 6.9%      | 3.0%      | 4.3%     | 7.8%    | 4.4%    |
|      | USD/JPY | 3,116,331 | 30.9%   | 30.4%    | 9.8%      | 5.3%      | 8.2%     | 11.4%   | 4.0%    |
|      | USD/MXN | 268,932 | 18.6%    | 16.9%    | 17.2%     | 9.7%      | 14.8%    | 17.5%   | 5.3%    |

<p>|      | 2016APR | All     | 8,359,264 | 24.7%    | 24.4%     | 10.5%     | 7.2%     | 12.3%   | 15.2%   | 5.6%    |
|      | AUD/JPY | 180,025 | 19.6%    | 19.4%    | 9.6%      | 6.5%      | 12.6%    | 20.7%   | 11.6%   |
|      | AUD/USD | 915,996 | 27.3%    | 26.8%    | 10.1%     | 6.6%      | 10.8%    | 13.0%   | 5.3%    |
|      | EUR/CHF | 125,367 | 36.9%    | 35.8%    | 6.8%      | 3.7%      | 5.8%     | 8.1%    | 2.9%    |
|      | EUR/GBP | 276,634 | 30.4%    | 30.1%    | 8.8%      | 5.7%      | 8.8%     | 11.6%   | 4.6%    |
|      | EUR/JPY | 255,422 | 21.5%    | 21.2%    | 10.3%     | 7.3%      | 13.1%    | 16.9%   | 9.7%    |</p>
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<th>[10s,20s)</th>
<th>[20s,30s)</th>
<th>[30s,1m)</th>
<th>[1m,10m)</th>
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<td>25.5%</td>
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<td>141,694</td>
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<td>15.5%</td>
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<tr>
<td><strong>GBP/USD</strong></td>
<td>874,550</td>
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<tr>
<td><strong>NZD/USD</strong></td>
<td>341,514</td>
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<td>5.5%</td>
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<tr>
<td><strong>USD/CAD</strong></td>
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<td>15.7%</td>
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<tr>
<td><strong>USD/CHF</strong></td>
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<tr>
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<td>11.6%</td>
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<tr>
<td><strong>USD/MXN</strong></td>
<td>77,325</td>
<td>26.5%</td>
<td>22.5%</td>
<td>14.2%</td>
<td>7.3%</td>
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</tr>
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<td><strong>AUD/JPY</strong></td>
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<td>3.5%</td>
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<td>10.3%</td>
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<tr>
<td><strong>EUR/CHF</strong></td>
<td>218,070</td>
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<tr>
<td><strong>EUR/GBP</strong></td>
<td>281,460</td>
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<td>41.7%</td>
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<td>4.5%</td>
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<tr>
<td><strong>EUR/JPY</strong></td>
<td>925,315</td>
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<td>8.0%</td>
<td>12.7%</td>
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<tr>
<td><strong>EUR/USD</strong></td>
<td>2,860,268</td>
<td>38.7%</td>
<td>37.4%</td>
<td>6.6%</td>
<td>2.9%</td>
<td>4.5%</td>
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<tr>
<td><strong>GBP/JPY</strong></td>
<td>161,893</td>
<td>28.8%</td>
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<tr>
<td><strong>GBP/USD</strong></td>
<td>892,404</td>
<td>39.0%</td>
<td>38.5%</td>
<td>5.5%</td>
<td>2.5%</td>
<td>3.7%</td>
<td>7.0%</td>
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<tr>
<td><strong>NZD/USD</strong></td>
<td>276,383</td>
<td>42.3%</td>
<td>40.4%</td>
<td>5.6%</td>
<td>1.6%</td>
<td>2.2%</td>
<td>4.5%</td>
</tr>
<tr>
<td><strong>USD/CAD</strong></td>
<td>542,166</td>
<td>43.8%</td>
<td>41.4%</td>
<td>5.4%</td>
<td>1.4%</td>
<td>2.0%</td>
<td>3.8%</td>
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<tr>
<td><strong>USD/CHF</strong></td>
<td>346,210</td>
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<td>40.6%</td>
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<td><strong>CLS/Olsen reconciliation lag (sec)</strong></td>
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<td>[30s,1m)</td>
<td>[1m,10m)</td>
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<tr>
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<td>6.5%</td>
<td>3.3%</td>
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<td>4.7%</td>
<td>7.8%</td>
</tr>
</tbody>
</table>

<p>| <strong>2013APR</strong> | All | 11,154,150 | 46.8% | 45.8% | 2.8% | 0.5% | 0.9% | 1.8% | 1.3% |
| AUD/JPY | 266,051 | 44.6% | 45.9% | 2.0% | 0.5% | 0.9% | 3.0% | 3.1% |
| AUD/USD | 998,667 | 48.5% | 45.3% | 4.2% | 0.1% | 0.2% | 0.7% | 1.0% |
| EUR/CHF | 218,070 | 48.6% | 48.2% | 2.1% | 0.1% | 0.1% | 0.4% | 0.4% |</p>
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<th>[5s-10s)</th>
<th>[10s,20s)</th>
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<td>0.3%</td>
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Alternative computations of Amihud illiquidity ratios

Illiquidity ratios under alternative timing assumptions

Amihud illiquidity measures by year and currency pair. Using settlements in April of a given year, illiquidity ratios ($|r|/Volume$) are formed over one-minute windows. $r$ is the quote-midpoint return over the window, in basis points, using Olsen bids and asks. $Volume$ is the sum of all settlements in the window, in units of million US dollars, under alternative timing assumptions. In Group I, the volume in a given window is determined by imputed trade time (using a one-pip acceptance region), and settlements that can't be matched (NM) are excluded. Groups II and III use the reported settlement times. NM settlements are excluded in Group II and included in Group III. Table entries are medians over all one-minute windows with non-zero volume.

Source: amihudShift.sas

<table>
<thead>
<tr>
<th></th>
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Illiquidity ratios under alternative window sizes.

Amihud illiquidity measures by year and currency pair. Using settlements in April of a given year, illiquidity ratios \( |r|/Volume \) are formed over one-, two- and five-minute windows. \( r \) is the quote-midpoint return over the window, in basis points, using Olsen bids and asks. \( Volume \) is the sum of all settlements in the window, in units of million US dollars (using the average spot exchange rate for the month). Medians are estimated across all windows. Settlements below one million units and above 100 million units of the base currency are excluded. Time stamps of settlements are adjusted using the delay imputed by reference to lagged Olsen bids and asks, with a one-pip acceptance region. Intervals with no settlement volume are dropped.

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Illiquidity ratios under alternative volume normalizations

Median illiquidity ratios. In the left group of estimates, the ratios are normalized as basis points per one million USD; in the right group, the normalization is to one million units of the base currency.

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Illiquidity ratios under alternative acceptance regions

The acceptance region used to impute the settlement reporting delay is $\pm pip$. This table investigates alternative acceptance regions, corresponding to those defined in Table 10.

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<th>$\pm pip$</th>
<th>$\pm 2 \times pip$</th>
<th>$\pm 10 \times pip$</th>
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<td>USD/JPY</td>
<td>0.0395</td>
<td>0.0242</td>
<td>0.0304</td>
<td>0.0378</td>
<td>0.0229</td>
</tr>
<tr>
<td>USD/MXN</td>
<td>0.1550</td>
<td>0.0820</td>
<td>0.1898</td>
<td>0.1502</td>
<td>0.0805</td>
</tr>
</tbody>
</table>
Supplemental Figures

Figure 3 Median Olsen spreads by year
Relative spreads (as in paper)
Absolute spreads (in units of quote currency)
Intraday patterns in spot settlement activity, by currency and year

Currency=ALL; Spot settlements in April 2010

Currency=ALL; Spot settlements in April 2013

Currency=ALL; Spot settlements in April 2016
Currency=CHF; Spot settlements in April 2010

Currency=CHF; Spot settlements in April 2013

Currency=CHF; Spot settlements in April 2016
Currency=ILS; Spot settlements in April 2010

Currency=ILS; Spot settlements in April 2013

Currency=ILS; Spot settlements in April 2016
Currency=NOK; Spot settlements in April 2010

Currency=NOK; Spot settlements in April 2013

Currency=NOK; Spot settlements in April 2016
Currency=SGD; Spot settlements in April 2010

Currency=SGD; Spot settlements in April 2013

Currency=SGD; Spot settlements in April 2016
Currency=USD: Spot settlements in April 2010

Currency=USD: Spot settlements in April 2013

Currency=USD: Spot settlements in April 2016
Intraday patterns in spot settlement activity, smoothed, by currency and year.
Currency=GBP; Spot settlements in April; Smoothed.

Currency=HKD; Spot settlements in April; Smoothed.
Currency=KRW: Spot settlements in April: Smoothened.

Currency=MXN: Spot settlements in April: Smoothened.
Intraday patterns in Amihud illiquidity ratios, smoothed

AUD/JPY illiquidity (smoothed)

AUD/USD illiquidity (smoothed)
USD/CHF illiquidity (smoothed)

USD/JPY illiquidity (smoothed)
Notes on programs, data filters and observational counts.

Programs. SAS is used for all analyses:

- `aprilAllCLS.sas` reads raw CLS data; computes average USD exchange rates used for valuations; generates first tables; settlement size distribution figures.
- `aprilAllOlsen.sas` reads raw Olsen data; generates spreads, bid-ask midpoints, etc.; merges the Olsen and CLS datasets.
- `clsChecks.sas` documents the imputed reporting delays.
- `Amihud.sas` constructs the illiquidity ratios and performs further analysis.

Data screening.

The data are screened prior to analysis to remove observations that are few and not representative of the broader sample.

The first cut is on “aprilAccepts”: observations for which the first accept date is in April of the sample year. 447,843 observations are dropped at this point:

<table>
<thead>
<tr>
<th></th>
<th>APR2010</th>
<th>APR2013</th>
<th>APR2016</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>32,920,384</td>
<td>7,930,957</td>
<td>13,629,338</td>
<td>10,912,246</td>
</tr>
</tbody>
</table>

Source: `aprilAllCLS.sas`; `%prelimCounts`; clsPrelimCounts.docx.

The second cut is on “major pair”: everything except cases where the buy or sell currency code is HUF, RUB or CLS. The third cut removes observations where there is no average spot rate. (These were pair-years in which all settlements had an instrument type of “other”: there were no spot transactions.):

<table>
<thead>
<tr>
<th></th>
<th>APR2010</th>
<th>APR2013</th>
<th>APR2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>7,930,957</td>
<td>13,629,338</td>
<td>10,912,246</td>
</tr>
<tr>
<td>Less settlements not in a major pair</td>
<td>7,208</td>
<td>22,752</td>
<td>2,283</td>
</tr>
<tr>
<td>Remainder</td>
<td>7,923,749</td>
<td>13,606,586</td>
<td>10,909,963</td>
</tr>
<tr>
<td>Less settlements with no average spot rate</td>
<td>4,955</td>
<td>5,083</td>
<td>8,170</td>
</tr>
<tr>
<td>Remainder</td>
<td>7,918,794</td>
<td>13,601,503</td>
<td>10,901,793</td>
</tr>
</tbody>
</table>

Source: `aprilAllCLS.sas`; `%addCLS`; clsAddCLS.docx.

These counts in the last row should be consistent with the “All” rows in Table 1.
When the CLS data are merged with the Olsen data, some further loss occurs because we only have Olsen data for thirteen pairs, and a few settlements occur in low-activity periods. Here, we're starting with spot settlements and April accepts. (The first line in following table matches the spot counts in Table 1.)

<table>
<thead>
<tr>
<th></th>
<th>APR 2010</th>
<th>APR 2013</th>
<th>APR 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLS spot settlements</td>
<td>7,265,894</td>
<td>12,490,361</td>
<td>9,937,550</td>
</tr>
<tr>
<td>Less: settlements in non-Olsen pairs</td>
<td>523,773</td>
<td>1,320,546</td>
<td>1,561,085</td>
</tr>
<tr>
<td>Remainder</td>
<td>6,742,121</td>
<td>11,169,815</td>
<td>8,376,465</td>
</tr>
<tr>
<td>Less settlements in periods of low activity</td>
<td>2,156</td>
<td>15,665</td>
<td>17,201</td>
</tr>
<tr>
<td>Remainder</td>
<td>6,739,965</td>
<td>11,154,150</td>
<td>8,359,264</td>
</tr>
</tbody>
</table>

The number of settlements that is used in the analysis of imputed reporting delays is slightly smaller (due to the requirement that we have a ten-minute history of Olsen quotes). The observation counts for Table 8 are:

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2013</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>6,738,302</td>
<td>11,152,534</td>
<td>8,355,877</td>
</tr>
</tbody>
</table>

*Source: clsCheckLags.docx*