Central Bank Swap Lines

Saleem Bahaj  
Bank of England

Ricardo Reis  
LSE

Banque de France - Bundesbank
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The views expressed are those of the presenters and not necessarily those of the Bank of England, the MPC, the FPC or the PRC.
What are the effects of lending facilities?

Federal Reserve Lending Facilities:
- DW: Discount window facility
- TAF: Term Auction Facility
- TALF: Term Asset-Backed Securities Loan Facility
- CPFF: Commercial Paper Funding Facility
- AMLF: Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility
- MMIF: Money Market Investor Facility
- CBSL: Central Bank Swap Line
The governor of the Reserve Bank of India on Sunday called on major central banks to extend their network of currency swap lines deep into emerging markets, saying a type of “virtual apartheid” in the provision of foreign currencies hampers efforts to fight financial instability.” Wall Street Journal, October 15, 2017.
I. Central bank effects: how the swap lines work
ECB borrowing USD from Fed

1. Fed sells dollars to ECB, ECB sells euros back at today’s spot exchange rate.
2. Agree in one week to resell, so euros are collateral.
3. Settlement happens at the same exchange rate.
4. Fed charges an interest rate in dollars set at start ($ OIS+spread).
5. ECB lends to EA bank, charges same rate, collect HQLA as collateral, determines who is eligible.
6. ECB in charge of collecting payment.

Liquidity assistance to foreign bank using foreign central bank to do the monitoring of collateral and bank.
Functions and alternatives

Properties

• US monetary policy on monetary base and rate, not EA monetary policy
• No exchange-rate or interest-rate risk, ECB has credit risk as in any lending facility

Basic function of central banks:

• Fed: provide liquidity when there is a funding crisis
• ECB: judge banks eligible for liquidity assistance
• Not exchange-rate pegs, not IMF loans, not about scarcity of dollars

Alternatives:

1. Fed lends directly to EZ banks through discount window? But (i) stigma, (ii) less efficient monitoring, Fed refuse, (iii) branches/subsidiaries did not have collateral.
2. EZ banks borrow euros from ECB buy dollars, swap out the currency risk? Spot and forward markets never closed, but cost…
2. Financial market effects of swap lines
Theory

- Trade involving only a bank and the central bank
  - EZ bank borrows dollars for one week from ECB swap line, pay $i_s$
  - Buys euros at spot rate $s$, lock forward rate $f$ in one week
  - Deposit euros at ECB at rate $i_v^*$
  - Swap overnight for one-week rate at cost $i^*-i^p^*$

\[ i^s_t \geq s_t - f_t + (i^v_t + i^*_t - i^p_t) \]

- Deviations from CIP:

\[ x_t = s_t - f_t + i^*_t - i_t \]

- **Proposition:** Deviations from covered interest parity have a ceiling given by the spread between the source swap and interbank rates plus the difference between the recipient central bank policy and deposit rates:

\[ x_t \leq (i^s_t - i_t) + (i^p_t - i^v_t) \]
Further discussion

- **Proposition:** Deviations from covered interest parity have a ceiling given by the spread between the source swap and interbank rates, plus the difference between the recipient central bank policy and deposit rates, plus the shadow value of collateral, plus the shadow cost of regulation on banks that is triggered by borrowing and lending from their central bank:

\[
x_t \leq (i_t^s - i_t) + (i_t^{P*} - i_t^{v*}) + (1 - \xi)(i_{j,t} - i_t^s) + \zeta_{j,t}
\]

- Safe bank or sovereign fund: minimum.
- Clear measure of CIP is the OIS one, even though no borrowing from banks.
- Why only needed post 2008: when CIP basis arose.
- Independent sources of variation: foreign and domestic.
Euro (USD) basis, ECB ceiling

- Lehmann Collapse, Sep-08
- Fed Cuts Swap Line Rate, Nov-11
Difference-in-differences visually
Effect on distribution of CIP deviations

- swap line currencies
  - Density
  - CIP deviation
  - Green: before
  - White: after

- non-swap line currencies
  - Density
  - CIP deviation
  - Green: before
  - White: after
### Table 1: Difference-in-differences estimates of the effect of the swap line rate change on CIP deviations

<table>
<thead>
<tr>
<th></th>
<th>Swap Line Currencies</th>
<th>Non-Swap-Line Currencies</th>
<th>D-in-D-D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
</tr>
<tr>
<td>Mean</td>
<td>.248</td>
<td>.153</td>
<td>.136</td>
</tr>
<tr>
<td>Median</td>
<td>.261</td>
<td>.117</td>
<td>.120</td>
</tr>
<tr>
<td>25th Percentile</td>
<td>.411</td>
<td>.209</td>
<td>.456</td>
</tr>
<tr>
<td>10th Percentile</td>
<td>.471</td>
<td>.279</td>
<td>.523</td>
</tr>
</tbody>
</table>

Notes: Swap line currencies refers to the EUR, GBP, CAD, JPY, and CHF. Non-swap line currencies refers to the AUD, NZD, SEK, NOK, and DKK. The dependent variable is the 1-week CIP deviation vis-a-vis the USD. Before refers to the days in November 2011 and after to the days in January 2012. Standard errors, block-bootstrapped at the currency level, are in brackets. The quantile difference-in-differences estimators are estimated simultaneously with the cross equation covariance matrix is estimated using bootstrapping. *** denotes statistical significance at the 1% level; ** 5% level; * 10% level.
Domestic variation

\[ x_{j,t} = \alpha_j + \beta c_{j,t} + \varepsilon_{j,t} \]

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Censored</th>
<th>Time fixed effect</th>
<th>Shorter sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling ((c_{j,t}))</td>
<td>(0.1996^{***})</td>
<td>(0.6578^{*})</td>
<td>(0.1675^{**})</td>
<td>(0.248^{***})</td>
</tr>
<tr>
<td></td>
<td>((0.037))</td>
<td>((0.249))</td>
<td>((0.057))</td>
<td>((0.039))</td>
</tr>
<tr>
<td>(N)</td>
<td>9500</td>
<td>9500</td>
<td>950</td>
<td>8195</td>
</tr>
<tr>
<td>Adjusted (R^2)</td>
<td>0.08</td>
<td>0.16</td>
<td>0.67</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Notes: Estimates of equation (5). The dependent variable is the 1-week CIP deviation of the CAD, CHF, EUR, GBP, and JPY vis-a-vis the USD. The sample runs from 19th September 2008 (the date of the first multilateral Federal Reserve swap agreement) through to 31st December 2015. All regressions include currency fixed effects. Column (1): panel least squares estimator. Column (2): panel least squares estimator conditional on \(x_{j,t}\) being in the 90th percentile of the unconditional distribution. Column (3): panel least squares estimator including time fixed effects. Column (4): Removes 2015 observations so the sample ends on the 31st of December of 2014. Standard errors, clustered by currency and date, are in brackets. *** denotes statistical significance at the 1% level; ** 5% level; * 10% level.
Swap dollar funding allocation
Elasticity of allotment to gain

\[
\log(q_{j,t}) = \alpha_j + \beta_j x_{j,t-1} + \varepsilon_{j,t}
\]

<table>
<thead>
<tr>
<th></th>
<th>ECB: USD Auctions</th>
<th>BoJ: USD Auctions</th>
<th>ECB: EUR Auctions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\log(q_{j,t}))</td>
<td>(\log(q_{j,t}))</td>
<td>(\log(q_{j,t}))</td>
</tr>
<tr>
<td>(x_{j,t-1}: CIP)</td>
<td>2.2353***</td>
<td>2.4262***</td>
<td>1.5804***</td>
</tr>
<tr>
<td></td>
<td>(0.527)</td>
<td>(0.9891)</td>
<td>(0.587)</td>
</tr>
<tr>
<td>(x_{j,t-1}: 1\text{-week Libor-OIS})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5804***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.587)</td>
</tr>
<tr>
<td>(N)</td>
<td>217</td>
<td>90</td>
<td>388</td>
</tr>
<tr>
<td>Adjusted (R^2)</td>
<td>0.08</td>
<td>0.14</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Notes: Estimates of equation (6). CIP deviation is the 1-week EUR or JPY vis-a-vis the USD on the day prior to the auctions. We consider auctions where a positive amount is allotted between the 19th September 2008 (the date of the first multilateral Federal Reserve swap agreement) through to 31st December 2015. Robust standard errors are in brackets. *** denotes statistical significance at the 1% level; ** 5% level; * 10% level.
3. Macroeconomic effects of the swap lines
Model: 3 periods, 2 countries

Representative source-country firm, aside from local inputs, also foreign capital

\[
F(k_0^*, k^*) \quad \frac{\partial^2 F(\cdot)}{\partial k_0^* \partial k^*} > 0
\]

Without financial frictions, the optimum is:

\[
\frac{\partial F(\cdot)}{\partial k^*} = i \quad \frac{\partial F(\cdot)}{\partial k_0^*} = \rho \quad \hat{k}_0^*, \hat{k}^*
\]

Limited ability of recipient-country bank to attract source-country funders:

\[
l^* < \bar{l} - \chi \quad G(\chi) \quad [0, \bar{l}] \quad \bar{l} > \hat{k}'^*
\]

Or, borrow in recipient-currency, hedge forex exposure with intermediaries

\[
i^* + s - f \quad h(.)
\]
Equilibrium

\[ G(\bar{x})\pi'(k_0^*) + (1 - G(\bar{x}))\bar{\pi}'(k_0^*) + \int_{\chi}^{\bar{x}} \pi'(k_0^*, \chi) dG(\chi) = \rho \]
Theory predictions

An exogenous decrease in the swap line rate:

1. Lowers the ceiling on CIP deviations, and so lowers the average across realizations of the funding shock;

2. Raises investment by recipient-country banks in source-currency capital;

3. Increases the expected profits of recipient-country banks that invest in source-currency capital.
Empirical strategy I: investments

• Banks in countries with access to USD via their central bank’s swap line should demand more USD-denominated assets relative to other banks and relative to non-USD bonds

• Triple difference-in-difference
  • (i) across time: swap rate change, days before and after
  • (ii) across banks: swap and non swap line across currencies
  • (iii) across investments: USD-denominated bonds versus bonds in other currencies
Diff USD-other bonds per bank
\[
n_{a,b,t} = \beta \times Post_t \times \text{SwapLine}_a \times \text{USDBond}_b + \alpha_{.,t} + \varepsilon_{k,j,t}
\]

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>baseline</td>
<td>currency, bank</td>
<td>currency, bank, bond</td>
<td>saturated</td>
</tr>
<tr>
<td>\text{Post}_t \times \text{Swap}_a \times \text{USDBond}_b</td>
<td>0.0770*</td>
<td>0.0770*</td>
<td>0.0772*</td>
<td>0.0788*</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(0.041)</td>
<td>(0.041)</td>
<td>(0.042)</td>
</tr>
<tr>
<td>\text{N}</td>
<td>205227</td>
<td>205227</td>
<td>205227</td>
<td>205227</td>
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<tr>
<td>\text{bank} \times \text{period f.e.}</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>\text{bank} \times \text{currency f.e.}</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>\text{bank} \times \text{issuer f.e.}</td>
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<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>\text{bank} \times \text{duration f.e.}</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>\text{bank} \times \text{bond f.e.}</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>\text{period} \times \text{currency f.e.}</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>\text{period} \times \text{issuer f.e.}</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>\text{period} \times \text{duration f.e.}</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>\text{period} \times \text{bond f.e.}</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes: Estimates of equation (9). The dependent variable is \(n_{a,b,t}\), bond level daily flows by bank scaled by the total absolute flow by bank. \text{Post}_t is a dummy variable taking a value of 1 if \(t\) is after 30th of November 2011. \text{Swap}_a is a dummy variable taking a value of 1 if the bank \(a\) is headquartered in swap line country. \text{USDBond}_b is a dummy variable taking a value of 1 if bond \(b\) is dollar denominated. Column (1): triple difference estimator, including \text{Swap}_a \times \text{period}, \text{USDBond}_b \times \text{period} and \text{Swap}_a \times \text{USDBond}_b fixed eﬀects. Column (2): adds bank specific and bond-currency specific fixed eﬀects. Column (3): additionally adds issuer and duration (3-year window) fixed eﬀects. Column (4): saturated regression. Column (5): includes in the sample banks who trade infrequently. Column (6): limits the sample to bonds that are rated A- and above. Column (7): limits the sample to bonds that are rated BBB+ and below. Standard errors, clustered at the bank and bond level, are in brackets. *** denotes statistical significance at the 1% level; ** 5% level; * 10% level.
Empirical strategy 2: asset prices

• Bonds that are heavily held by foreign banks should see their prices rise.

• Difference-in-difference
  • (i) across time: swap rate change, 5 days before and after
  • (ii) across USD bonds: those held by foreigners versus those that are not.
Effect on bond prices

<table>
<thead>
<tr>
<th></th>
<th>Nearest Neighbor</th>
<th>Exact Match on Euro Issuers</th>
<th>Dropping Euro-area Issuers</th>
</tr>
</thead>
<tbody>
<tr>
<td>foreignheld&lt;sub&gt;b&lt;/sub&gt;</td>
<td>-0.0860**</td>
<td>-0.1221***</td>
<td>-0.1264***</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.038)</td>
</tr>
<tr>
<td>N</td>
<td>5474</td>
<td>5474</td>
<td>5257</td>
</tr>
</tbody>
</table>

Notes: The dependent variable is the change in the average yield of the bond in the 5 trading days following the swap rate change on the 30th of November 2011, versus the 5 days before. The independent variable is a dummy for whether the bond is frequently traded by our sample of European banks. Column (1): nearest neighbor estimates, using Abadie and Imbens (2011) bias correction, that single matches on five bond characteristics: (i) credit rating, converted into a numerical scale, (ii) log residual maturity, (iii) coupon, (iv) log of the face value outstanding, and (v) average yield in the 5 days prior to 30th November. Column (2): exact matching estimators that requires the bond issuer to be located in a Euro-area country. Column (3): Drops bonds issued by Euro-area firms. Robust standard errors are in brackets. *** denotes statistical significance at the 1% level; ** 5% level; * 10% level.
Empirical strategy 3: bank value

- Banks in countries that receive dollar swap lines should have excess returns around announcements since now safer, protected from funding shocks.

- Triple difference-in-difference
  - (i) across time: swap rate change, 5 days after
  - (ii) across currencies: swap and non swap line across currencies
  - (iii) across banks: with US presence or not
Returns around swap rate line change
### Estimates and standard errors

<table>
<thead>
<tr>
<th></th>
<th>Swap Line Banks</th>
<th>US Banks</th>
<th>Other Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>US Presence</td>
<td>No US Presence</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.0265*</td>
<td>0.0087</td>
<td>0.0063</td>
</tr>
<tr>
<td></td>
<td>(0.0140)</td>
<td>(0.0068)</td>
<td>(0.0084)</td>
</tr>
<tr>
<td>Size</td>
<td>0.0251**</td>
<td>0.0281***</td>
<td>0.0290*</td>
</tr>
<tr>
<td>Weighted</td>
<td>(0.0125)</td>
<td>(0.0086)</td>
<td>(0.0154)</td>
</tr>
<tr>
<td>N</td>
<td>36</td>
<td>72</td>
<td>310</td>
</tr>
</tbody>
</table>

Notes: Excess returns are computed accumulating over 3 days using a beta-to-local market return that is estimated over the 100 days prior to 01/11/11. Swap line banks are headquartered in Canada, Euro-area, Japan, Switzerland, or the United Kingdom. U.S. presence is taken from “U.S. Agencies and Branches of Foreign Banking Organisations” dataset. Bootstrapped confidence intervals in brackets are constructed by randomly sampling event dates over the window 01/06/10-31/11/11. *** denotes statistical significance at the 1% level; ** 5% level; * 10% level.
4. Conclusion
Conclusion

• Central bank swap lines *large and here to stay.*

• Swap line is the *twin of the discount window* when foreign banks invest and borrow domestically.

• Swap line spread plus foreign difference between policy and deposit central bank rates put *ceiling on CIP deviations*, empirically there from both variations.

• Swap line encourages investment in dollar assets ex ante, prevents fire sales ex post. Empirically see *portfolio tilt* towards bonds, increase in price of USD bonds traded by foreigners, increase in share price of foreign banks.

• Overall: *eased funding pressure* in cost of hedging foreign funding, choice of investments to fund, asset prices of those investments, stock price of investors.