Central Bank Swap Lines: Micro-Level Evidence

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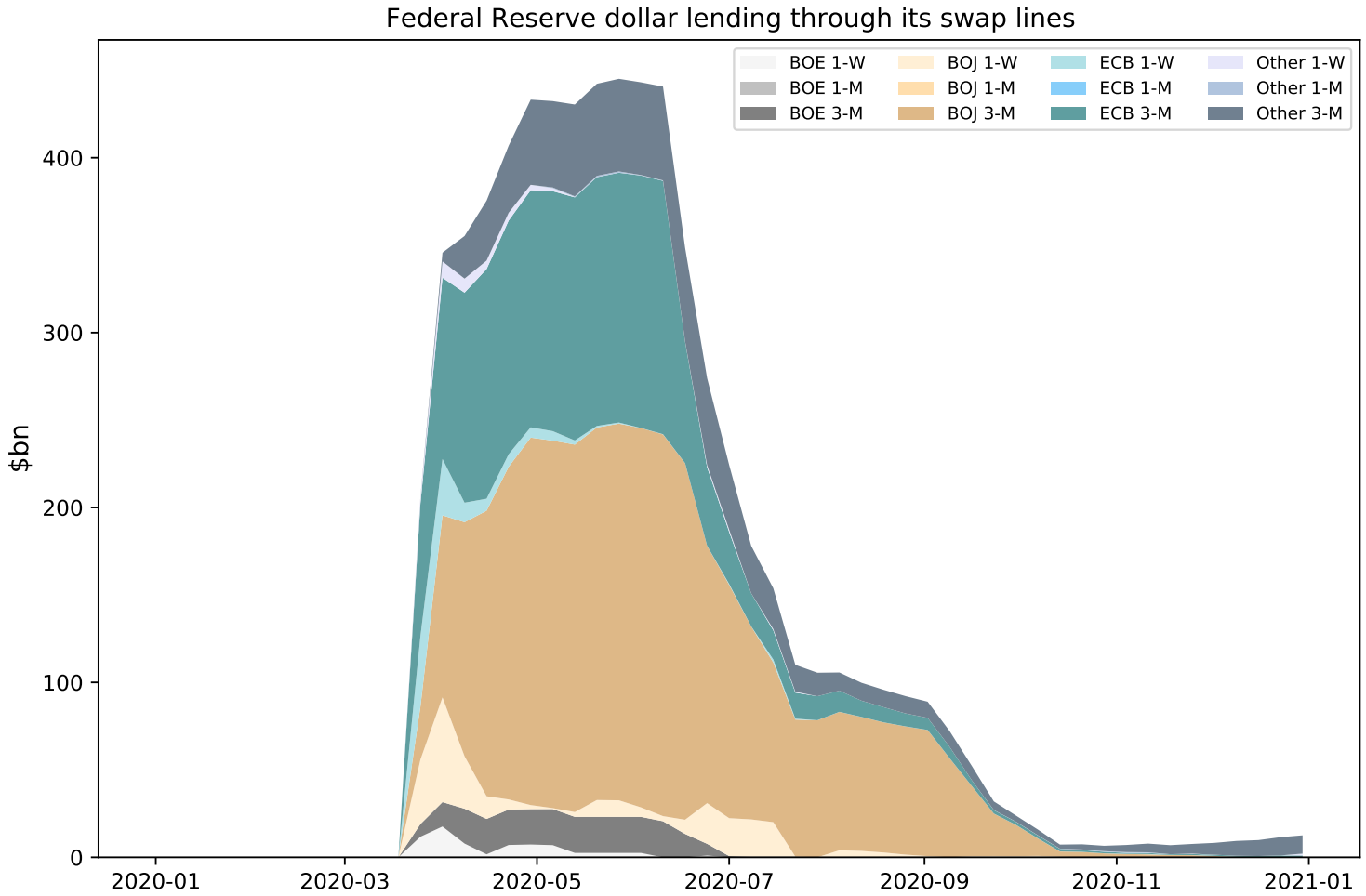
Research Questions

- What are the effects of central bank swap lines?
  - Prices?
  - FX Exposures?
  - Real Economy Effects?
- Do banks that receive swap lines change their exposures in the FX swap market?

Central Bank Swap Lines During the Pandemic



Motivation-Swap Line Effects

Price effects

- Bahaj and Reis (2020) show that swap lines enforce a ceiling on CIP deviations, which measure the difference between direct and synthetic dollar borrowing costs.
- If synthetic dollar costs are too high, arbitrageurs have an incentive to borrow dollars at the swap line rate and lend them in the FX swap market.

Balance sheet effects

- Prior work has documented balance sheet effects, such as an increase in inter-office flows to offshore affiliates (Aldasora et al, 2021), and an increase in investment in dollar bonds (Bahaj and Reis, 2020)

Preview of Findings

- **Price effects**: Consistent with empirical evidence on 2008-2010 swap lines, we find the 2020 swap lines reduced both the level and volatility of CIP deviations.
- Using a Difference-in-Difference (DiD) design, we test for the effects of swap lines on dealers that borrow dollars via BOE Repos.
  1. **Gross Exposure Effects**: A reduction in dealer demand for dollars through FX forward and spot contracts in transactions with counterparty commercial banks.
  2. **Real Economy Effects**: Increase in net supply of dollars in the forward market to non-financial institutions, supporting increased funding demands by corporations during the pandemic.

Related Literature

Our contribution: Understand how central bank swap lines affect FX exposures by combining bank level drawings with the UK EMIR trade repository data.

- **CIP**: Counterparty risk Baba and Packer (2008) and Balance sheet constraints Du, Tepper and Verdelhan (2018) Strength of dollar Avdjiev, Du, Koch, and Shin 2016 Monetary Policy Borio, McCauley, McGuire, and Sushko 2016; Dedola, Georgiadis, Gräb, and Mehl 2017) and others.
- **Swap Lines**: Price effects Bahaj and Reis (2020a), Goldberg et al (2011) Theory Eguren Martin (2020) Emerging markets Bahaj and Reis (2021) Pandemic swap lines Bahaj and Reis (2020b), Aldasoro et al (2020), Eren et al (2020).
- **FX swap Market** Quarter ends Abassi and Brauning Leverage Rule Cenedese, Della Corte and Wang (2020) Order flow Syrstad and Viswanath-Natraj and Rime, Schrimpf and Syrstad (2020) Hedging channel Liao and Zhang (2020).

Data and Definitions

Institutional Details

- Swap line auctions by the Federal Reserve to a series of advanced economy central banks (ECB, BOJ, SNB, BOC and BOE) were made in March 2020.
- Major changes to the Covid swap lines
  1. Addition of auctions for swaps at a 3 month maturity, catering for longer-term hedging demands of counterparties.
  2. The reduction of the swap line rate from OIS+50bp to OIS+25bp.
  3. Increase in frequency of swap central bank auctions to daily frequency.

Swap Line Mechanics

- Steps in swap line distribution:
  1. Federal Reserve and Bank of England swap USD and GBP at a specified exchange rate.
  2. Recipient central bank distributes dollars in jurisdiction. For BOE, this is through dollar repo auctions.
  3. Once Repos mature and auction terms expire, central banks re-exchange USD and GBP at the pre-specified spot rate.
- Crucially, swap lines are offered at a **penalty rate** and the recipient central bank bears the **counterparty risk**.

Data Sources

Bank of England Repo contracts

- Individual dealer-level bank drawings on dollar repos in March-June 2020.
- Details include maturity, amount, date of auction, dealer ID

Bank of England Trade Data Repository

- Records FX transactions with at least one counterparty in the UK, representing over 42% of the entire FX swap market (Cenedese, Della Corte and Wang, 2020)
- Outstanding derivative (FX swap+forward) positions at a dealer-counterparty level for major currencies (EUR/USD, JPY/USD and GBP/USD). Data is monthly from September 2019 to December 2020.
- FX intraday trades for the dates of March 17th to March 20th 2020.

Data Sources

Federal Reserve Swap Lines

- Daily data on all dollar swap allotments by the Federal Reserve with recipient central banks.
- Details include maturity, amount, date of auction, recipient central bank.

FX prices and interest rates

- Daily data on Spot rates, OIS, IBOR and forward swap points for 1w,1m,3m from Bloomberg for advanced country currencies.
- High-frequency (5 minute) tick level data on spot and forward swap points from Tick History.

Balance sheet variables

- Quarterly data on total assets, liabilities, Tier 1 Capital and Leverage Ratios, cash and risk-weighted assets from Bloomberg.
- CDS Spreads from TR Eikon.

Empirical Evidence: Benchmark Rates

Prices and Volatility

H1: *The reduction in the penalty rate of Covid swap lines from OIS+50 basis points to OIS+25 basis points lowers CIP deviations.*

- Using a DiD framework, we find CIP deviations of countries that accessed swap line arrangements (EUR, GBP, JPY, CAD) declined relative to a control group (AUD, NZD).

H2: *There is a reduction in the price dispersion of dealer quotes and a decline in the intra-day volatility of CIP deviations*

- Dealers that access the swap line can manage their inventory and FX hedging positions, and reduce price dispersion of forward rates.
- We conduct an autoregressive model for realized volatility (RV) following Corsi (2009).
- Swap lines reduced RV on the day following auction settlement.

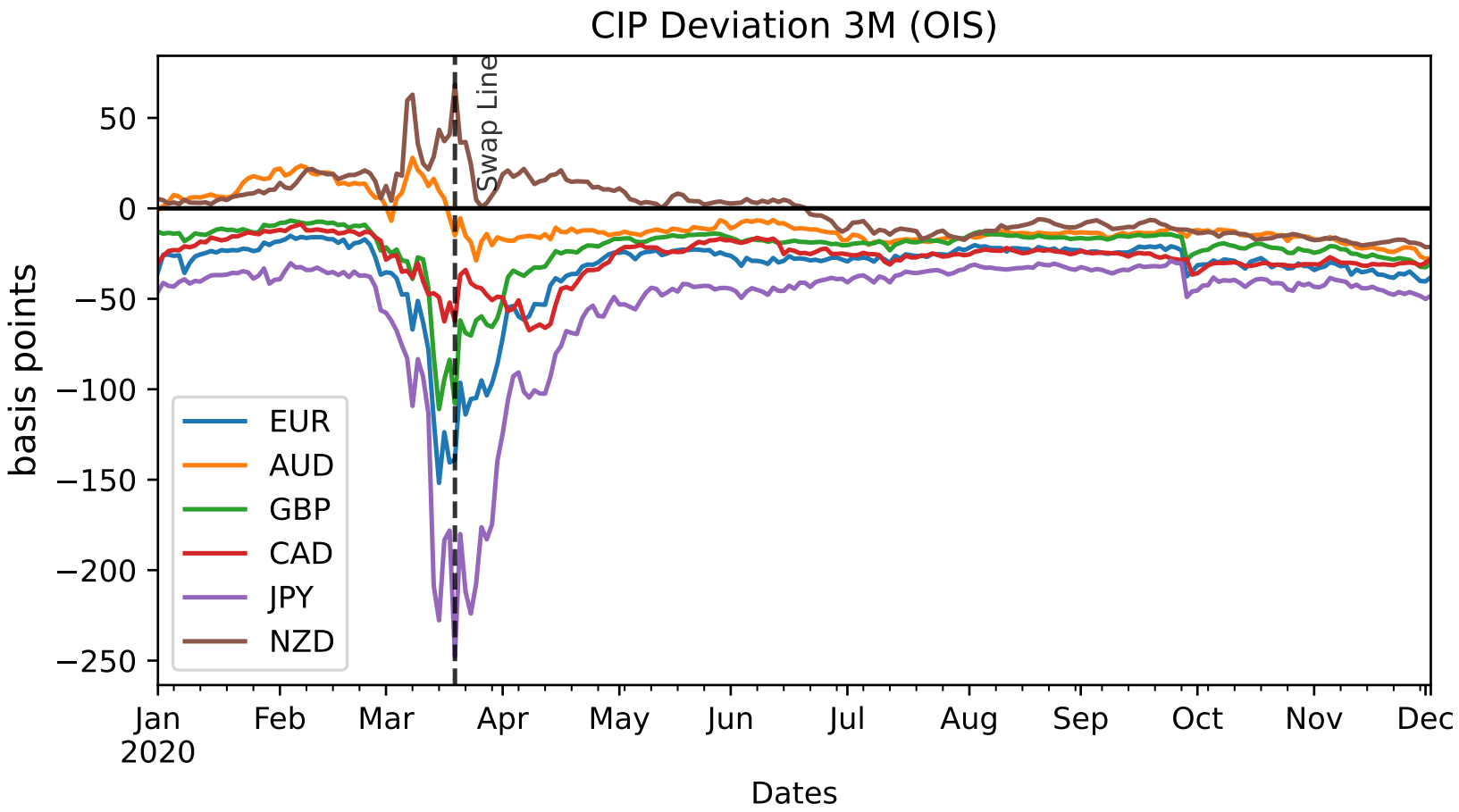
Prices

- Our measure of CIP deviations $x_{\$,d}$ is expressed as the difference between the local dollar borrowing rate less the synthetic dollar borrowing rate, where $r^f_\$$ is the US interest rate, r^f_d is the base interest rate (eg. GBP).

$$x_{\$,d} = \underbrace{1 + r^f_\$}_{\text{direct}} - \underbrace{\frac{F}{S}(1 + r^f_d)}_{\text{synthetic}}$$

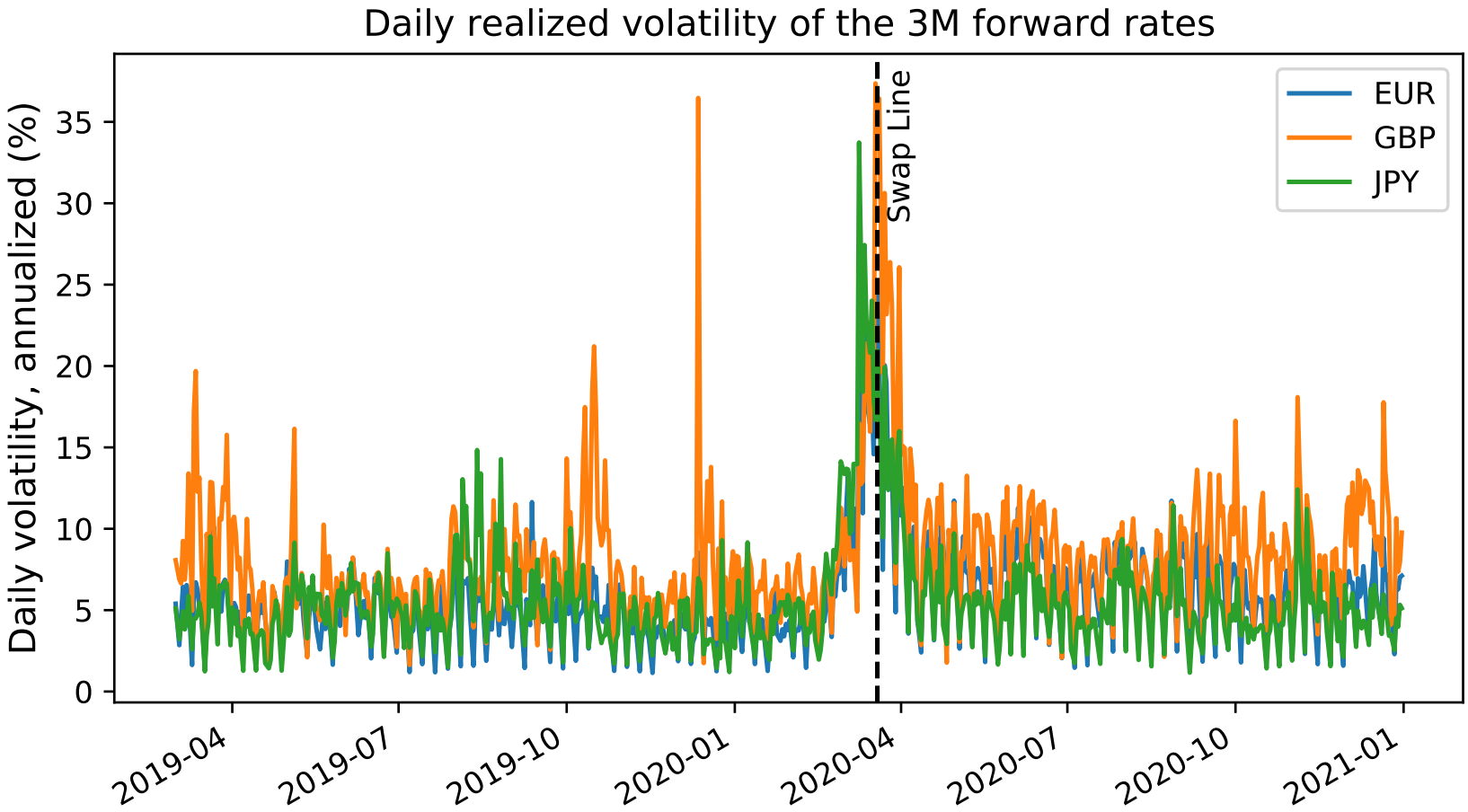
- S is the spot rate and F is the forward rate, calculated as the mid-point using bid and ask quotes.
- A negative $x_{\$,d}$ indicates that synthetic dollar borrowing costs exceed local borrowing costs
- Forward premium $\frac{F}{S}$ to annualised percentage points in order to construct a measure of 1-week/1m/3m CIP deviations in annualised terms.

Price Effects



Volatility Effects

Intra-day volatility of forward rate calculated by taking standard deviation of 5 minute returns over the trading day.



Empirical Evidence: BOE Repository

Research Hypothesis

H3: *Dealers that indirectly receive swap line funding charge lower forward premia and have a larger decline in dispersion of quotes, relative to a control group of dealers that did not receive swap line funding.*

- Dealers that access the swap line now have additional dollar liquidity at their disposal to provide customers in forward and FX swap contracts
- All else equal, the spread between the synthetic and direct dollar borrowing rate, which is captured by the CIP deviation, should fall for treated dealers relative to control dealers

Transaction Level CIP

- For a dealer i and counterparty j, we calculate a transaction-level CIP deviation.

$$x_{\$,d,i,j} = 1 + r^f_{\$} - \frac{F_{i,j}}{S}(1 + r^f_d)$$

- We construct CIP deviations from March 17th to March 20th, where March 19th was first settlement day of auctions during pandemic.
- We subdivide our sample into a control and treated group, where treated dealers receive dollar repos from the BOE.

Transaction Level CIP - DiD Specification

$$Y_{i,j,t} = \alpha_{i,j} + \alpha_{j,t} + \sum_{j=1}^{3} \delta_j D_{03/17+j} \times D_{treatment,i} + \epsilon_{i,j,t} \quad (1)$$

- Granularity of data allows for counterparties with multiple dealers.
- Fixed effects at dealer-counterparty and counterparty-time following Khawja and Mian (2008).
- Outcome variables include transaction level CIP for the currency pairs of EUR/USD, GBP/USD and JPY/USD
- D_{treat} is a dummy variable for dealers that activated the BoE dollar repo. $D_{03/18}$, $D_{03/19}$ and $D_{03/20}$ are dummy variables for the 18th, 19th and 20th of March respectively.

Transaction Level CIP - All counterparties

- CIP deviation ↑ on 03/19 (the settlement day) for Dealers that received a swap line

	I Panel	II EUR 3M	III GBP 3M	IV JPY 3M
$D_{treat} \times D_{03/18}$	-27.3376*	-29.2257**	-4.6552	-8.9691
	(10.8271)	(5.7671)	(18.1059)	(7.2881)
$D_{treat} \times D_{03/19}$	-3.3794	-13.1570**	46.1210*	28.5460**
	(6.7608)	(3.6286)	(16.3555)	(8.9291)
$D_{treat} \times D_{03/20}$	-18.7965	-20.5335*	67.3384	-5.3686
	(11.0745)	(7.9440)	(31.5169)	(2.8132)
constant	-132.5710***	-118.4106***	-134.5626***	-193.5048***
	(5.1419)	(3.0842)	(9.6533)	(0.0548)
R-sq	0.138	0.190	0.201	0.252
N	2272	992	644	630

FX Exposures

- For a dealer i and counterparty j at the end of month t, we measure the outstanding buy and sell positions of dollars at the forward leg of FX forward and swap contracts.
- Denote outstanding buy $Buy_{ijt,\$,\text{forward}}$ and outstanding sells $Sell_{ijt,\$,\text{foward}}$
- The dollar funding gap measures the net FX exposures of dealers, and we construct it as the net demand for dollars at the forward leg of FX forward and spot contracts.

$$\text{dollar funding gap}_{ijt} = Buy_{ijt,\$,\text{forward}} - Sell_{ijt,\$,\text{forward}}$$

FX Exposures

H4.1: *Dealers that receive swap line funding reduce their need for dollar liquidity through FX forward and swap contracts.*

- Dealers can access cheaper dollar funding from dollar repo
  1. dealers reduce dollar hedging demand at forward legs of FX forward contracts
  2. dealers reduce dollar demand at the spot leg of FX swap contracts
- In both cases, we expect gross FX exposures to decline

H4.2: *Dealers that receive swap line funding provide dollar liquidity to non-financial institutions.*

- Non-financial institutions cannot directly access the swap line
- Increased uncertainty during the pandemic lead to an increased demand for hedging by non-financials
- We therefore expect an increase in the supply of dollars through forward contracts

FX Exposures- DiD Specification

$$Y_{i,j,t} = \alpha_{i,j} + \alpha_{j,t} + \gamma D_{swapline,t} + \delta D_{swapline,t} \times D_{treatment,i} + \text{controls}_{i,t} + \epsilon_{i,}$$

- Granularity of data allows for counterparties with multiple dealers.
- Fixed effects at dealer-counterparty and counterparty-time following Khawja and Mian (2008).
- Outcome variables include gross Buys, Sells and dollar funding gap of dealer i and counterparty j in month t.
- $D_{swapline,t}$ takes value of 1 during months of March, April and May, 2020. $D_{treatment,i}$ takes value of 1 for dealers that draw on the 3 month BOE dollar repo line.

FX Exposures-Dealer-Commercial Banks

- Reduction in gross exposures, both Buy ↓ and Sell ↓. Suggestive of **Gross Exposure Effects**

	I Buy	II Buy	III Sell	IV Sell	V GAP	VI GAP
D_{treat}	1669.3818**	2823.7673**	1755.4510**	3275.0664**	-201.5053*	-451.2991**
	(764.4143)	(1305.3792)	(693.9651)	(1467.2981)	(115.8088)	(212.8922)
$D_{swapline} \times D_{treat}$	-585.3502**	-486.9576**	-518.6646**	-520.7244**	76.7367	33.7668
	(284.7379)	(242.1697)	(215.4139)	(229.6649)	(69.0184)	(69.6598)
$\frac{RWA}{Assets}$		5629.3553**		5743.3572*		-114.0020
		(2651.2771)		(3101.4125)		(706.8223)
$\text{distance}_{CET1Ratio}$		-17.6605		-107.1667		89.5062
		(57.1402)		(84.9530)		(60.7120)
$\text{distance}_{LeverageRatio}$		-379.4334		-487.3873		107.9539*
		(363.1662)		(395.8769)		(61.1920)
constant	1229.5924***	-511.6249	1379.5560***	547.9659	-135.8122**	-1059.5908**
	(361.8578)	(1186.6702)	(327.5546)	(897.6071)	(58.4392)	(439.2696)
R2	0.409	0.414	0.372	0.380	0.137	0.140
N	12806	12806	13331	12806	12806	12806

Note: p values in parentheses

FX Exposures-Dealer-Non-Financials

- Negative DiD coefficient for GAP $\Longrightarrow$ increase in net supply of dollar forwards to non-financials

	I Buy	II Buy	III Sell	IV Sell	V GAP	VI GAP
D_{treat}	61.9193	81.6182	28.7118	59.2571**	33.2075	22.3611
	(44.6938)	(51.0806)	(17.7492)	(28.1408)	(28.8548)	(28.3220)
$D_{swapline} \times D_{treat}$	-54.6671*	-54.9084*	-9.6300	-7.7601	-45.0371**	-47.1484**
	(31.6980)	(31.9439)	(14.3598)	(13.3359)	(20.4809)	(22.1920)
$\frac{RWA}{Assets}$		276.0417		350.8949*		-74.8532
		(172.8225)		(178.7838)		(59.6074)
$\text{distance}_{CET1Ratio}$		10.1067		14.1313		-4.0246*
		(7.8937)		(8.6039)		(2.2613)
$\text{distance}_{LeverageRatio}$		-4.2904		-21.8876**		17.5971**
		(4.8634)		(8.3679)		(7.7839)
constant	94.1765***	-102.1483	64.8724***	-168.1365	29.3040**	65.9882*
	(21.3371)	(161.0783)	(8.4565)	(144.8964)	(13.9172)	(34.4949)
R2	0.311	0.314	0.276	0.290	0.348	0.350
N	2002	2002	2002	2002	2002	2002

Note: p values in parentheses

Concluding Remarks

- This paper uses micro-level evidence on the response of currency exposures of FX swap participants to central bank swap line.
- Increased dollar liquidity reduced pricing inefficiencies in FX forward rates, with evidence swap lines reduced the level and volatility of CIP deviations.
- Combining data on BOE drawings of swap lines with the BOE trade data repository, we find that dealers reduced their gross FX exposures, and increased their net supply of dollars to non-financial institutions

Thank You!

Pricing-Panel Specification

H1: *The reduction in the penalty rate of Covid swap lines from OIS+50 basis points to OIS+25 basis points lowers CIP deviations.*

- We can compare CIP deviations of countries that accessed swap line arrangements (EUR, GBP, JPY, CAD) relative to a control group (AUD, NZD)
- $\Delta x_{\$,i,j,t}$ is first difference in CIP deviation in basis points.

$$\Delta x_{\$,i,j} = \alpha_i + \gamma_j + \delta Post_t \times D_{Swapline_i} + controls_t + \epsilon_{i,j,t}$$

- $Post_t$ is a dummy variable for from March 19, 2020, which is the first auction (settlement) day after the new swap policy announcement.
- $SwapLine_i$: is a dummy variable for whether the currency i sovereign central bank has a swap arrangement with the Federal Reserve.
- Controls: interest rates, VIX, bid-ask spreads and dealer leverage in first differences.

Pricing Results

- Results using OIS benchmark for 1w,1m and 3m maturities, find significant reduction in synthetic dollar costs following swap lines.

	I	II	III	IV
	$\Delta x_{i,j,t}$	$\Delta x_{i,j,t}$	$\Delta x_{i,j,t}$	$\Delta x_{i,j,t}$
$Swapline_i \times Post_t$	12.731***	13.581**		
	(3.295)	(6.206)		
$Allotment_{i,t} \times Post_t$			0.558***	0.526***
			(0.115)	(0.092)
$\Delta(i - i_{us})$		-6.123		-0.097
		(3.976)		(0.518)
Δbroad dollar		-1.867		-3.235***
		(1.142)		(1.218)
Δlog(vix)		-33.346***		-39.617***
		(10.53)		(12.242)
Δfwd bid-ask		0.477		-0.255
		(2.191)		(1.951)
HKM		-2.633***		-2.950***
		(0.739)		(0.773)
Constant	-4.584***	-6.356**	-0.606***	-0.068
	(1.098)	(3.04)	(0.055)	(0.413)
Observations		756		
Treatment		EUR, GBP, JPY, and CAD		
Control		AUD and NZD		

Note: standard errors in parentheses

Volatility Effects

H2: *There is a reduction in the price dispersion of dealer quotes and a decline in the intra-day volatility of CIP deviations*

- A common motivation for swap lines is that it reduces pricing inefficiencies in the swap market.
- For example, dealers that access the swap line can manage their inventory and FX hedging positions.
- These dealers can now charge more favorable forward rates for dollar liquidity for other customers in the market.

Volatility Specification

- Model specification follows Corsi (2009)

$$RV_t = \alpha + \beta_d RV_{t-1} + \beta_w RV_{t-1:t-6} + \beta RV_{t-1,:t-26} + \delta_1 \text{Swap line}_{set,t} + \delta_2 \text{Swap line}_{set,t-1} + \gamma_1 \text{Covid}_{t-1} + \gamma_2 \text{Covid}_{US,t-1} + \epsilon_t$$

- RV is the daily realized intra-day volatility of forward rates. $RV_{t-1:t-6}$ and $RV_{t-1,:t-26}$ indicate one-week and one-month RV.
- Swap line$_{set,t}$ takes a value of 1 on the settlement day when the corresponding central bank use the swap line.
- Covid$_{t-1}$ and Covid$_{US,t-1}$ is the change in hospitalizations with Covid-19 symptoms for corresponding country and U.S, respectively.

Volatility Results

- Estimation period: March 1, 2020, to June 30, 2020. Significant decline in volatility in the day following settlement for all pairs and maturities.

	I EUR 1W	II GBP 1W	III JPY 1W	IV EUR 1M	V GBP 1M	VI JPY 1M	VII EUR 3M	VIII GBP 3M	IX JPY 3M
Const	1.589	2.407**	1.517***	1.593	2.390**	1.513***	1.491	2.407**	1.518***
	(1.064)	(1.125)	(0.411)	(1.066)	(1.122)	(0.409)	(1.049)	(1.121)	(0.415)
RV_{t-1}	0.032	0.216**	0.314***	0.034	0.217**	0.317***	0.046	0.218**	0.307***
	(0.064)	(0.106)	(0.114)	(0.064)	(0.106)	(0.114)	(0.064)	(0.106)	(0.116)
$RV_{t-1:t-6}$	1.059***	0.818***	0.654***	1.058***	0.818***	0.650***	1.047***	0.816***	0.664***
	(0.146)	(0.155)	(0.149)	(0.145)	(0.155)	(0.148)	(0.146)	(0.156)	(0.15)
$RV_{t-1:t-26}$	-0.173	-0.252**	-0.103	-0.173	-0.250**	-0.101	-0.161	-0.252**	-0.106
	(0.154)	(0.118)	(0.099)	(0.155)	(0.119)	(0.098)	(0.151)	(0.118)	(0.099)
Swap $line_{set,t}$	0.241	0.79	-0.138	0.237	0.773	-0.137	0.211	0.769	-0.122
	(0.406)	(0.997)	(0.371)	(0.406)	(0.996)	(0.37)	(0.4)	(0.993)	(0.372)
Swap $line_{set,t-1}$	-3.048***	-2.624**	-1.744***	-3.048***	-2.625**	-1.747***	-3.055***	-2.614**	-1.739***
	(0.412)	(1.06)	(0.386)	(0.412)	(1.059)	(0.386)	(0.41)	(1.057)	(0.39)
$Covid_{t-1}$	-0.861	0.286	-0.049	-0.85	0.28	-0.047	-0.935	0.293	-0.052
	(0.689)	(0.397)	(0.368)	(0.695)	(0.397)	(0.368)	(0.686)	(0.397)	(0.366)
$Covid_{US,t-1}$	0.434**	0.204	0.185	0.431**	0.202	0.183	0.440**	0.204	0.184
	(0.189)	(0.204)	(0.121)	(0.188)	(0.204)	(0.12)	(0.187)	(0.204)	(0.121)
N	184	184	184	184	184	184	184	184	184
R2	0.6	0.6	0.74	0.6	0.6	0.74	0.61	0.6	0.74

Note: standard errors in parentheses

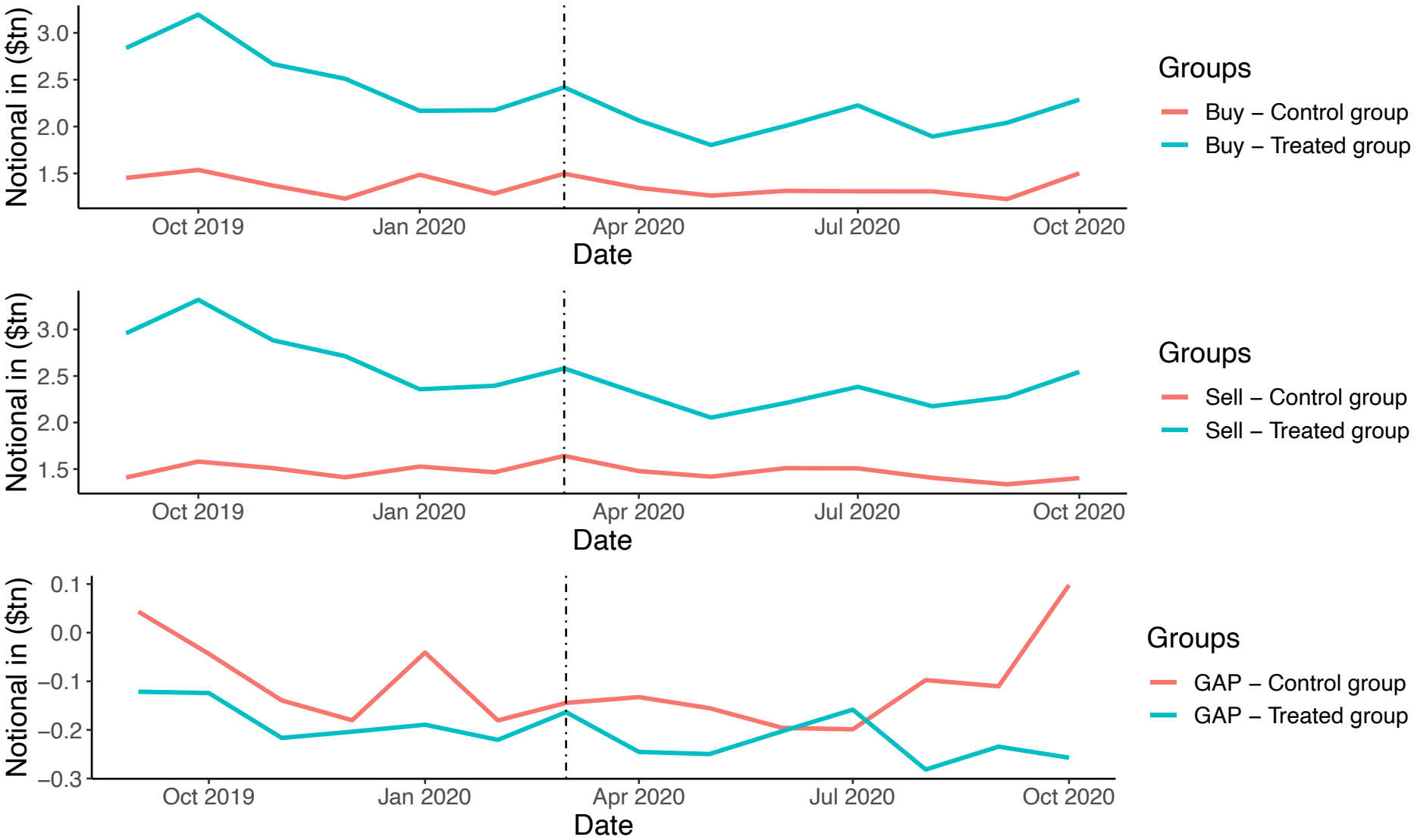
Determinants of BOE Repo Drawings

- Probit specification using balance sheet variables in February 2020.
- Interestingly, dollar repos are drawn by institutions that are more capitalized, have higher cash and lower risk weighted assets.

	I	II	III	IV	V
	$D_{swapline}$	$D_{swapline}$	$D_{swapline}$	$D_{swapline}$	$D_{swapline}$
$distance_{CET1Ratio}$	0.4571***				0.3222***
	(0.000)				(0.006)
$distance_{LeverageRatio}$		0.8735***			0.5191**
		(0.000)			(0.041)
$\frac{Cash}{Assets}$			12.4293***		7.1324**
			(0.000)		(0.046)
$\frac{RWA}{Assets}$				-5.1516***	-2.3936**
				(0.000)	(0.049)
constant	-4.2424***	-1.6408***	-1.2990***	1.5201***	-3.6937***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.003)
pseudo R-sq	0.243	0.125	0.163	0.160	0.371
N	88	88	88	88	88

Note: p values in parentheses

FX Exposures- Commercial Banks



FX Exposures- Non-Financial Institutions