Swap Line Dollar Supply

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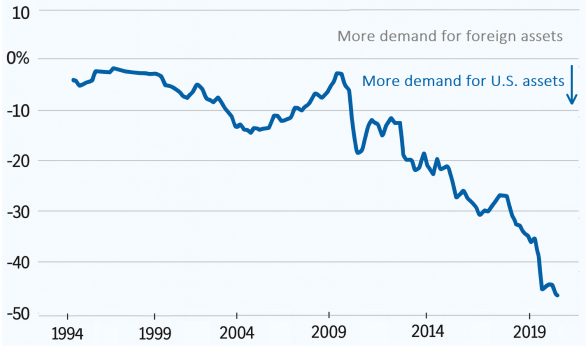
Investors globally are long U.S. safe assets, but hedge the FX risk



- Costs in U.S. Treasuries are well-studied (convenience yields $ 50 bn p.a.).
- Less is known about the cost of FX hedging ($ 150 bn p.a.).

Introduction

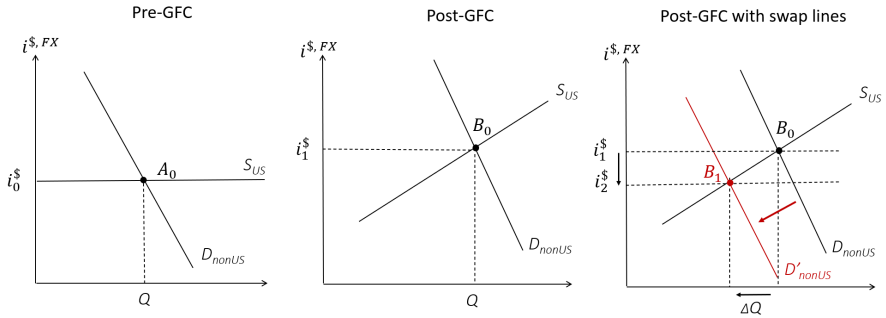
- How do intermediaries price FX hedges when investors are long U.S. dollar?
  - High costs distort investors from optimal portfolios.
- I use Fed swap lines as a laboratory to study intermediary constraints.
  - Traditional view: Fed swap lines ⇒ non-U.S. banks ("foreign relief").
  - **This paper**: Fed swap lines ⇒ non-U.S. banks ⇒ U.S. banks ("domestic relief").

Introduction (cont.)

- I find that swap lines:
  - reduce hedging costs via narrower U.S. bank bid-ask spreads in FX swaps ($\approx 10\%$).
  - expand U.S. bank lending capacity in FX swaps by creating natural hedges.
- Identification relies on swap line operational details set by the Fed:
  - **Availability.** Unlike other Fed facilities, swap lines are *not* a standing facility.
  - **Eligibility.** Swap lines are only available in (i) maturities up to 3M and (ii) to banks.

Literature on U.S. safe assets

- **Hypothesis.** *When swap lines are on, non-U.S. banks reduce long dollar position in FX swaps.*
- **Hypothesis.** *Lower long dollar position improves bid-ask spreads that U.S. dealers charge.*



Literature

- **Swap lines**: Rose and Spiegel (2012), Goldberg and Ravazzolo (2021), Choi and Ravazzolo (2021), Yun (2021), Bahaj and Reis (2021), Ferrara et al. (2022), Kekre and Lenel (2025)

  → **Contribution:** First study of $ quantities *globally* in FX swaps in response to swap lines.

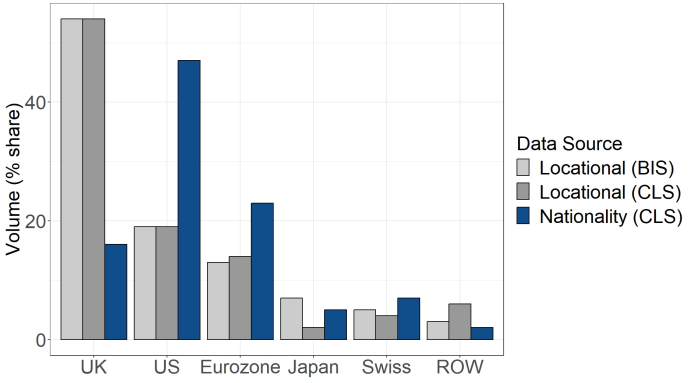
- **Liquidity provision in FX markets**: Hasbrouck and Levich (2021), Ranaldo and Somogyi (2021), Cespa et al. (2022), Krohn and Sushko (2021), Kloks et al. (2023)

  → **Contribution:** First to study the effective transaction costs charged by U.S. banks.

- **Global dollar funding**: Ivashina et al. (2015), Aldasoro et al. (2019), Correa et al. (2021), Du and Huber (2023), Kloks et al. (2024)

  → **Contribution:** U.S. banks behave as market-makers, not just $ lenders.

Supply of the dollar: U.S. banks



- U.S. banks are the largest dollar lenders in FX swaps.
- Correlation with U.S. net *portfolio* investment position: 0.32 (in quarterly changes).

Why would the dollar supply of U.S. banks be upward sloping?

- An FX swap does not hurt the Leverage Ratio but storing dollar cash on-balance sheet does.

Bonds 100 $	200 $ Equity
Cash 100 $	
Assets 200 $	200 $ Liabilities

(a) Before FX swap

Bond 100 $	200 $ Equity
Cash 100 €	
Assets 200 $	200 $ Liabilities

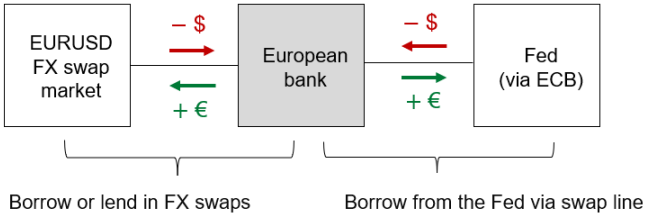
Off-balance sheet

FX receivables	100 $	100 €	FX payables

(b) After FX swap

Demand for the dollar

- For non-U.S. banks, swap lines offer the only close substitute to FX swap dollar funding.



Measuring transaction costs from settlement data

- I observe FX swap points, $F - S$, per trade direction.
- I proxy the effective bid-ask spread at day-currency-tenor-cparty level:

$$Spread_{t,i,j,k} = (F - S)^{L}_{t,i,j,k} - (F - S)^{B}_{t,i,j,k}$$

- where L and B refer to \$ borrowing vs. lending.
- At the median, realized effective spread = 72% of Bloomberg bid-ask. Summary statistics

Instrumental Variables

- Two regimes: swap line auction days vs. non-auction days.
  - Calendar pre-set by the Federal Reserve.
- Instrument: dummy if auction at $t + 1$ (Baba and Packer, 2009).
  - Calendar is anticipated, but daily dollar needs are not.
  - Suitable for studying temporary balance-sheet effects, not information surprises.
- Exclusion restriction: swap lines affect U.S. bank bid-ask spreads only via customer volume.

Instrumental Variables

- 2SLS First stage:

$$Net_{t,i,j,k} = \pi_1 \cdot z_{t+1,k} + \pi_2 \cdot BAS_{t,i,k} + \pi_3 \cdot VIX_t + \alpha_i + \gamma_j + \tau_k + \varepsilon_{t,i,j,k}.$$

- 2SLS Second stage:

$$Spread_{t,i,j,k} = \beta_1 \cdot \widehat{Net}_{t,i,j,k} + \beta_2 \cdot BAS_{t,i,k} + \beta_3 \cdot VIX_t + \alpha_i + \gamma_j + \tau_k + \varepsilon_{t,i,j,k}.$$

- Baseline: Non-U.S. bank net $ borrowing up to 3 months.
  - **Eligibility**. Swap lines NOT available (i) for maturities >3M and (ii) for non-banks.

2SLS: First stage

Dep. variable:	Net volume, $Net_{t,i,j,k}$ (bn of USD)					
	Non-U.S. banks Affected maturities		Non-U.S. banks Unaffected maturities		Non-banks Affected maturities	
	(1)	(2)	(3)	(4)	(5)	(6)
$z_{t+1,k}$	–0.0861***	–0.0872***	0.0447	0.0453	0.0121	0.0168
	(0.0104)	(0.0022)	(0.0440)	(0.0404)	0.0327	0.0266
$BAS_{t,i,k}$		–0.0567*		0.0608		–0.0218
		(0.0276)		(0.0753)		0.0453
VXY_t		0.1566		–0.1679		-0.1529
		(0.0925)		0.2966		0.2654
FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	45,686	45,686	2,035	2,035	21,807	21,807
KP F-statistic	13.5	13.8				
Note:					*p<0.1; **p<0.05; ***p<0.01	

2SLS regressions of daily U.S. bank buy-sell spreads, $x_{t,i,j,k}$, on the instrumented net U.S. dollar borrowing by U.S. banks' customers, $Net_{t,i,j,k}$. Standard errors are clustered by time and counterparty.

2SLS: Second stage

Dep. variable:	$Spread_{t,i,j,k}$ (bps, log)			
	IV1	IV2	OLS1	OLS2
	(1)	(2)	(3)	(4)
$\widehat{Net}_{t,i,j,k}$	0.8758*	1.2093***		
	(0.3989)	(0.3305)		
$Net_{t,i,j,k}$			0.0067	0.0077
			(0.0061)	(0.0058)
$BAS_{t,i,k}$		0.4504***		0.3809***
		(0.0490)		(0.0495)
VXY_t		0.2895*		0.4407**
		(0.1384)		(0.1433)
FE	Yes	Yes	Yes	Yes
Observations	45,686	45,686	45,686	45,686
Note:				*p<0.1; **p<0.05; ***p<0.01

2SLS regressions of daily U.S. bank buy-sell spreads, $x_{t,i,j,k}$, on the instrumented net U.S. dollar borrowing by U.S. banks' customers, $Net_{t,i,j,k}$. Standard errors are clustered by time and counterparty.

Additional results

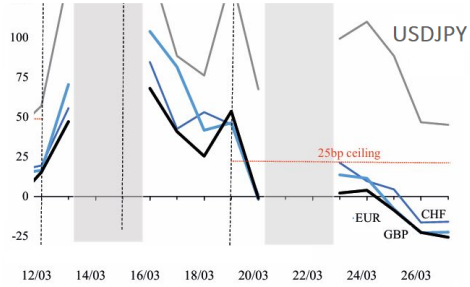
- U.S. banks' bid-ask spreads respond more strongly to customer volume when:
  - Balance sheet constraints are more binding. Dealer constraints
  - Ability to unwind reserve balances is limited, as proxied by repo-IOR spreads. Reserves

What mechanisms drive the swap line "domestic relief" of U.S. banks?

- Various channels can drive the observed effect:
  - e.g. net $\downarrow$ = borrowing $\downarrow$ – lending (substitution effects) (Ferrara et al., 2022).
- I show evidence for an additional channel: swap lines can lead to \$ lending $\uparrow$.
  - Distinguish between CIP arbitrage vs. precautionary hoarding.

COVID-19

- In 2020, CIP swap line arbitrage opportunities persisted longer in dollar-yen.

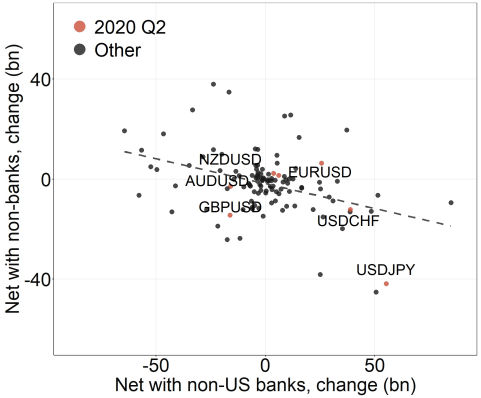


- Construct a dummy *IsViolated*: 1 if arbitrage profitable (Bahaj and Reis, 2021).
- $Volume_{i,k,t} = \beta_1 SwapLines_t + \beta_2 IsViolated_k + \beta_{DD} \cdot SwapLines_t \cdot IsViolated_{k+\gamma}\mathbf{x}+u_{i,k,t}$

Difference-in-differences

	Affected tenors				*Unaffected tenors*	
	Volume, log		Market share, %		Market share, %	
	Lend (log)	Borr. (log)	Lend (%)	Borr. (%)	Lend (%)	Borr. (%)
SwapLines	0.50***	−0.57***	0.03***	−0.01***	0.003	0.004
	(0.07)	(0.08)	(0.003)	(0.001)	(0.002)	(0.003)
IsViolated	0.002	−0.0000	−0.001	0.0003	−0.004***	−0.005**
	(0.03)	(0.04)	(0.001)	(0.001)	(0.001)	(0.002)
SwapLines:IsViolated	−0.16	0.14	−0.01*	0.002	0.0002	0.0003
	(0.10)	(0.14)	(0.01)	(0.002)	(0.004)	(0.01)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,665	1,665	1,665	1,665	879	879
Adjusted R^2	0.23	0.15	0.20	0.14	0.03	0.02

Natural hedges for U.S. banks



- Either mechanism creates natural hedges for U.S. banks in times of stress.
- But the lending channel enables leverage.

Conclusion

- Even if U.S. banks have access to $, their intermediation is still affected by swap lines.
- This is because swap lines affect dealers' customer $ borrowing and $ lending in FX swaps.
- Policy implication: non-bank access to swap lines.

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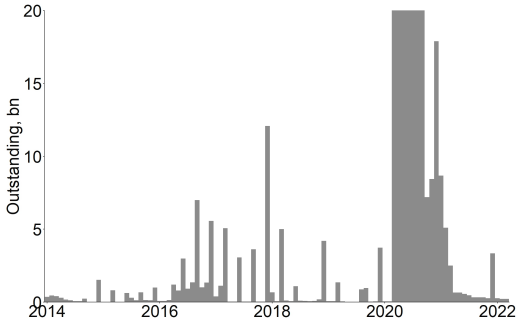
Who trades FX globally?

Rank	Name	HQ
1	JP Morgan Chase	US
2	UBS	Non-US
3	Deutsche Bank	Non-US
4	Citi	US
5	Goldman Sachs	US
6	Bank of America	US
7	State Street	US
8	HSBC	Non-US
9	Morgan Stanley	US
10	BNP Paribas	Non-US

*This table reports the ranking of the top 10 FX dealer banks per market share according to Euromoney FX survey, 2021.

Federal Reserve swap line take up



Federal Reserve swap line take up. Data is monthly for a sample from 2014 to 2022.

Federal Reserve swap line take up

	COVID-19 (peak)	GFC 2008 (peak)
Total	**449**	**583**
Major advanced economies	**403**	**501**
Japan	226	138
ECB	143	302
UK	23	34
Switzerland	10	27
Canada	0	0
Other nine economies	**46**	**81**

Source: Fed

Measuring transaction costs from settlement data

Summary statistics of U.S. bank effective spreads

		In basis points				As % of Bloomberg BAS			
		1W	1M	3M	1Y	1W	1M	3M	1Y
EURUSD	Median	0.08	0.21	0.23	0.84	67	102	72	46
	10pct	0.01	0.02	0.04	0.19	8	11	12	11
	90pct	0.64	1.49	1.52	3.51	492	730	432	182
USDJPY	Median	0.09	0.24	0.35	0.75	44	66	71	40
	10pct	0.01	0.03	0.05	0.14	6	8	10	8
	90pct	0.72	1.88	2.49	3.41	327	480	512	198

- At the median, effective spread = 72% of Bloomberg bid-ask. Return

Transaction costs, order flow and reserves

	US bank effective spread (log)			
	GCF-IOER spread:		SOFR-IOER spread:	
	$\leqslant 0$	> 0	$\leqslant 0$	> 0
Net volume (bn)	0.01***	0.02***	0.01***	0.02***
	(0.004)	(0.004)	(0.004)	(0.01)
BAS (log)	0.28***	0.38***	0.45***	0.36***
	(0.03)	(0.06)	(0.05)	(0.08)
VXY	0.81***	0.36*	0.42**	0.98***
	(0.23)	(0.25)	(0.20)	(0.35)
Controls	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes
Obs	59,879	49,744	44,483	18,238
Adjusted R^2	0.27	0.25	0.28	0.25

Ordinary Least Squares panel regressions of the effective spread on net order flow split by the sign of the repo-IOR spread. Standard errors are clustered by time. Return

Transaction costs, order flow and balance sheet constraints

	US bank effective spread (log)				
	λ^{Q1}	λ^{Q2}	λ^{Q3}	λ^{Q4}	λ^{Q5}
	(1)	(2)	(3)	(4)	(5)
Net volume (bn)	0.01**	0.01*	0.02**	0.03***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
BAS (log)	0.05*	0.05*	0.19***	0.28***	0.19***
	(0.05)	(0.06)	(0.05)	(0.04)	(0.04)
Controls	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes
Obs	26,629	26,585	26,751	26,611	26,654
Adjusted R^2	0.25	0.27	0.27	0.26	0.27
Note:					*p<0.1; **p<0.05; ***p<0.01

Quantile regressions based on dealer capacity utilization as measured by He, Kelly, and Manela (2017). Controls include the bid-ask spread, VXY, and TED spreads. Standard errors are clustered at the date level. Return

Swap lines dollar supply: diff-in-diff around COVID-19

- Separate Net into Buy vs. Sell volumes.
- Bank of Japan during COVID-19 as a case study.
- Diff-in-diff: treatment at the maturity level.

$$Sell_{i,k,t} = \beta_1 SwapLines_t + \beta_2 Affected_k + \beta_{DD} \cdot SwapLines_t \cdot Affected_k + \gamma \mathbf{X} + u_{i,k,t}$$

  - *SwapLines* equal 1 for 12 weeks after March 23, 2020.
  - *Affected* equals 1 for maturities where swap lines were available (under 3M).

Swap lines and COVID

	Dollar vs. Non-Dollar Pairs				*Affected vs. Unaffected maturities*			
	Affected maturities		*Unaffected maturities*		*Bn of USD*		*Share*	
	Sell	Buy	Sell	Buy	Sell	Buy	Sell (%)	Buy (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
β_{DD}	0.57***	−0.06	0.18	−0.34***				
	(0.11)	(0.14)	(0.17)	(0.13)				
β_{DD}					0.19***	-0.28***	0.06***	-0.02***
					(0.04)	(0.08)	(0.02)	(0.01)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Currencies	4	4	4	4	1	1	1	1
Obs.	4,397	4,256	4,072	3,758	158	158	158	158
Adj. R^2	0.77	0.59	0.61	0.69	0.82	0.96	0.82	0.93

Difference-in-difference estimates. Data is daily. Standard errors are clustered by time where applicable. The superscripts $***$, $**$ and $*$ indicate significance at 1%, 5% and 10% significance level respectively.

Domestic banks in the FX swap market

	Δ Buy (bn) (1)	Δ Sell (bn) (2)	Δ Net (bn) (3)
Δ BoJ (bn)	0.02	0.22**	−0.19*
	(0.03)	(0.10)	(0.10)
Constant	0.11	0.14	−0.03
	(0.11)	(0.44)	(0.41)
Constant	Yes	Yes	Yes
Obs.	62	62	62
Adj. R^2	0.01	0.05	0.04

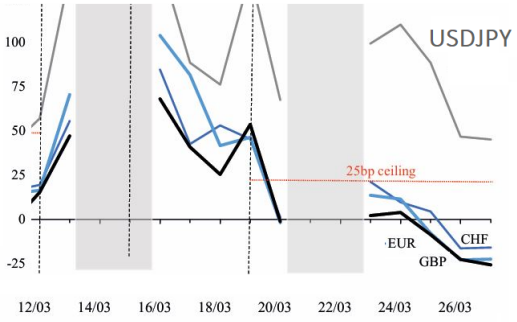
Bank of Japan swap line drawings and JP bank FX swap positions. All values are measured in differences of billions of USD. Data is daily. The superscripts $***$, $**$ and $*$ indicate significance at 1%, 5% and 10% significance level respectively.

Swap lines and COVID

	Dep: Net $ sales, bn USD			
	JP	EZ	Other	Total
	(1)	(2)	(3)	(4)
SwapLines	0.69	−1.32	1.18	−0.04
	(0.66)	(1.14)	(0.83)	(0.33)
SwapLines:USDJPY	−15.08***	−1.86*	0.21	−2.28
	(0.09)	(1.03)	(0.60)	(2.99)
Time FE	Yes	Yes	Yes	Yes
Entity FE	Yes	Yes	Yes	Yes
Clustered s.e.	Yes	Yes	Yes	Yes
Obs (in m)	0.112	0.112	0.112	0.563
Adjusted R^2	0.48	0.07	0.22	0.02
Note:	*p<0.1; **p<0.05; ***p<0.01			

Evidence from COVID-19

- Near-arbitrage opportunities persisted in dollar-yen longer than in other major dollar pairs *after the peak of* COVID-19 Bahaj and Reis (2021).



Swap line arbitrage trade

- **Cost of swap line** (Bahaj and Reis, 2021). JP bank — BoJ — Fed (swap $ for ¥ for 1W).

$$c_t^{k/\$} = \underbrace{i_t^{\$}}_{\text{OIS + 25 bp}} - \underbrace{(i_t - i_t^{v*} + i^{p*})}_{\text{Net trade funding cost}}$$

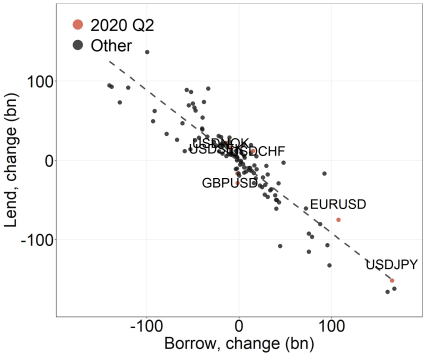
- **Revenue from FX swap**. JP bank — FX market (swap $ for ¥ for 1W).

$$\chi_t^{k/\$} = \underbrace{i_t^{k} - \rho_t^{k\$}}_{\text{FX swap market dollar rate}} - \underbrace{i_t^{\$}}_{\text{Cash market dollar rate}}$$

- *IsViolated*: 1 (0) when the basis exceeds (does not exceed) the no-arbitrage ceiling.
- **Hypothesis (swap line arbitrage).** *Swap line borrowers exhibit behavior consistent with arbitrage activity if their U.S. dollar lending responds positively when the return on lending exceeds the swap line borrowing cost.*

U.S. banks benefit a lot from natural hedges

- U.S. banks are the largest net dollar lenders worldwide.
- But they benefit from natural hedges: gross/net = 33:1.



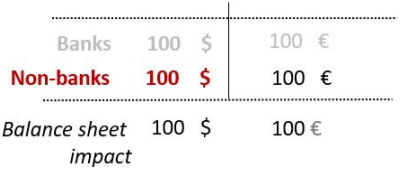
U.S. banks' leverage in FX swaps

	Dep: Δ Net$_{NonUS\ Banks}$, U.S. bank net position with foreign banks						
	Panel of G7 currencies			*Per Currency*			
	Daily	Weekly	Monthly	EUR	GBP	CHF	JPY
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Net$_{NonBanks}$	−0.12***	−0.32***	−0.31***	−0.33***	−0.23***	−0.26***	−0.31***
	(0.01)	(0.03)	(0.05)	(0.04)	(0.05)	(0.07)	(0.07)
Constant				0.32**	0.02	0.16***	0.41***
				(0.14)	(0.09)	(0.05)	(0.12)
Constant	No	No	No	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,127	2,784	540	557	557	557	556
Adjusted R^2	0.03	0.09	0.11	0.12	0.07	0.04	0.07

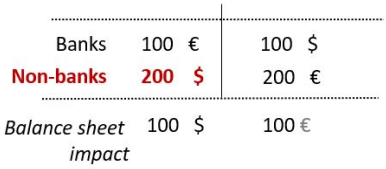
Columns (1) to (3) report the results of a panel regression across the G7 currencies whereas (4) to (7) conduct the same regression on the four largest currencies individually. All variables are in changes. Standard errors are clustered by time for the panel regressions and Newey-West otherwise. The superscripts ∗ ∗ ∗, ∗∗ and ∗ indicate significance at 1%, 5% and 10% level respectively. Return to main slide

Swap line lending channel matters for total credit available to non-banks

- For a U.S. dealer, a swap line lending channel creates natural hedges between bank and non-bank customers.



(a) Naive intuition: $ borrowing ↓



(b) This paper: also $ lending ↑