Segmented Money Markets and CIP Arbitrage

Dagfinn Rime[*]   Andreas Schrimpf[†]   Olav Syrstad[‡]
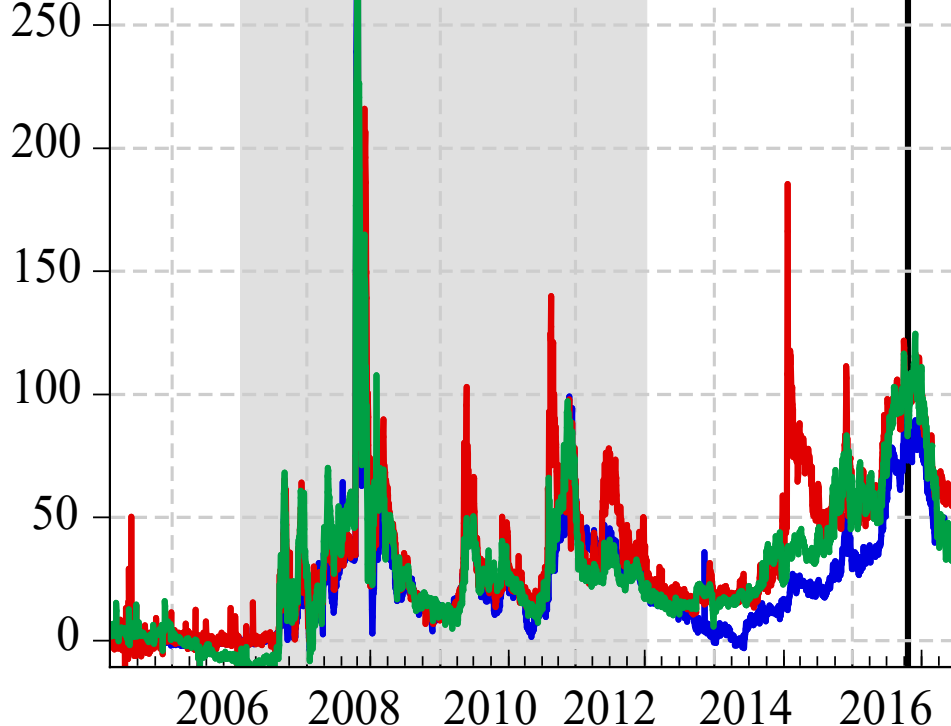
[*]BI   [†]BIS & CEPR   [‡]Norges Bank

ECB Money Market Workshop

Crucial in study of CIP

Get the ARBITRAGE right!

- **WHO** are the main arbitrageurs?   **BANKS!**
- **WHAT** are the main strategies?
  - ► Risk-less round-trip   **CIP**
  - ► Relative value   **LOOP**
- **HOW** is it done?

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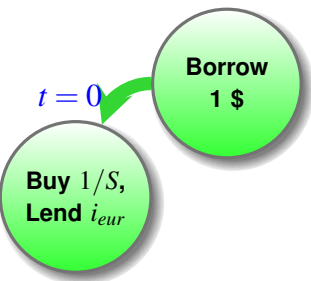- **HOW** is it done?

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$t = 0$

Borrow 1 \$

Buy $1/S$, **Lend** i_{eur}

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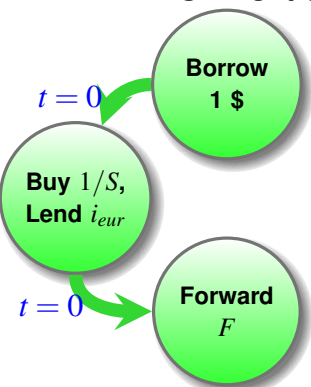
$t = 0$ **Forward** F

Crucial in study of CIP

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Buy $1/S$, **Lend** i_{eur}

$t = 0$

Forward F

Repay $1 + i_{\$}$

$t = 1$

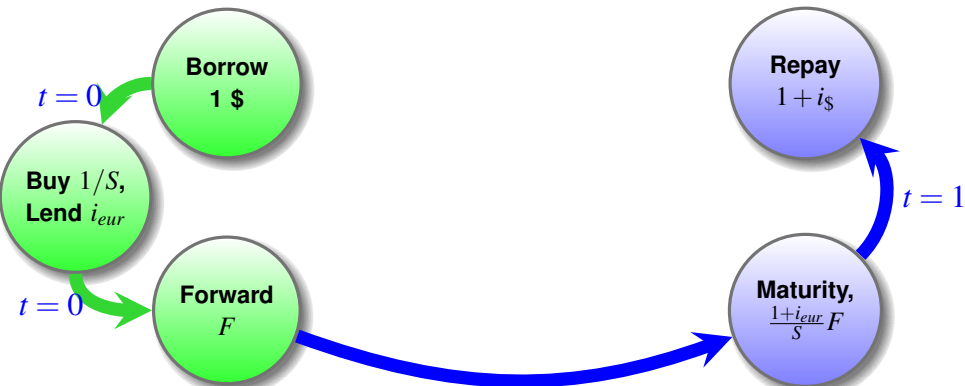**Maturity,** $\frac{1+i_{eur}}{S} F$

Crucial in study of CIP

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- **HOW** is it done?

No Arbitrage (CIP)

$$\frac{F}{S}\left(1 + i_{eur}\right) - \left(1 + i_{\$}\right) = 0$$

$t = 0$ — **Borrow 1 \$**

Buy $1/S$, **Lend** i_{eur}

$t = 0$ — **Forward** F

Repay $1 + i_{\$}$
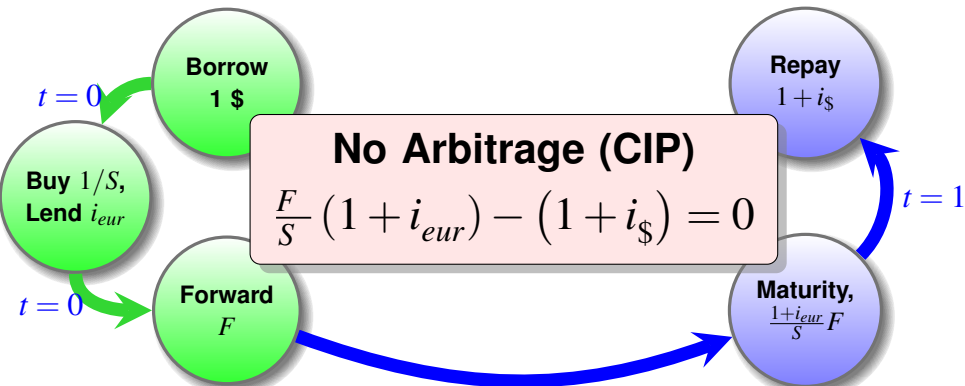
$t = 1$

Maturity, $\frac{1+i_{eur}}{S}F$

Crucial in study of CIP

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$t = 0$ **Borrow 1 \$**

Buy $1/S$, **Lend** i_{eur}

$t = 0$ **Forward** F

Repay $1 + i_{\$}$

$t = 1$

Maturity, $\frac{1 + i_{eur}}{S} F$

No Arbitrage (CIP)

$$\frac{F^b}{S^a} \left(1 + i^b_{eur}\right) - \left(1 + i^a_{\$}\right) = 0$$
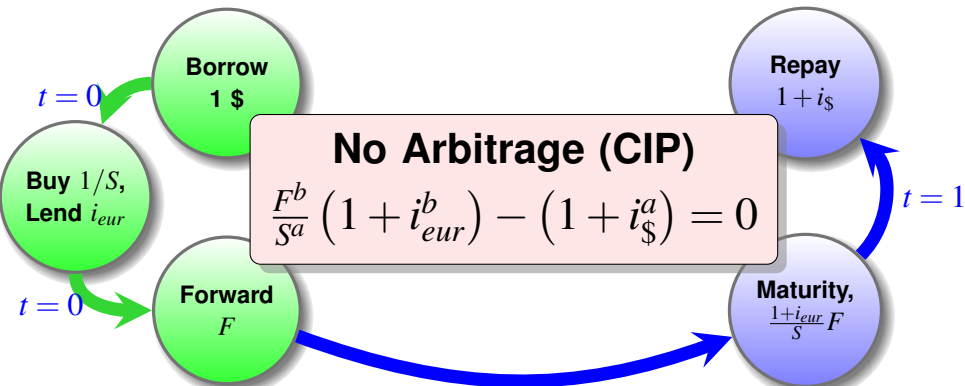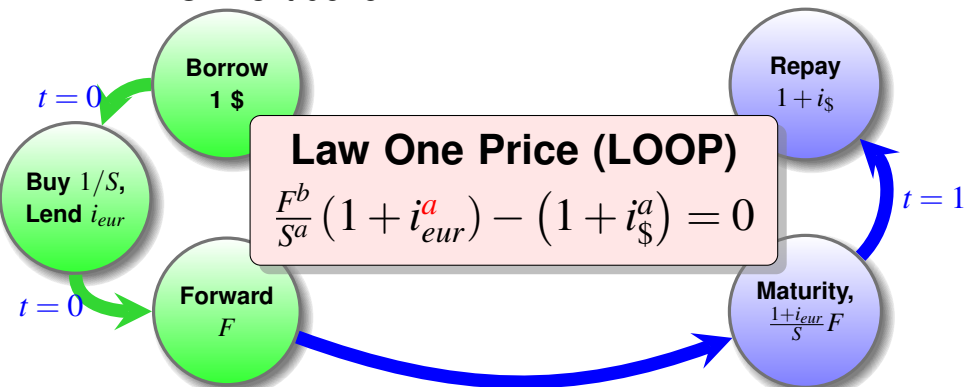
Crucial in study of CIP

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- **HOW** is it done?

Borrow 1 \$

$t = 0$

Buy $1/S$, **Lend** i_{eur}

$t = 0$

Forward F

Law One Price (LOOP)

$$\frac{F^b}{S^a}\left(1 + i^{a}_{eur}\right) - \left(1 + i^{a}_{\$}\right) = 0$$

Repay $1 + i_{\$}$

$t = 1$

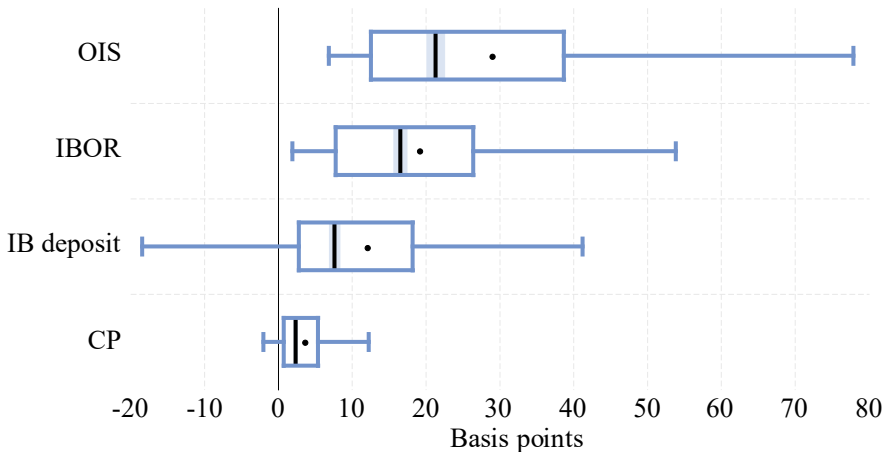**Maturity,** $\frac{1 + i_{eur}}{S} F$

Importance of different interest rates

LOOP-deviation. Average across EUR, GBP, JPY.   (2013-2016q1)

DR/AS/OS
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Activity in US interbank markets

DR/AS/OS
CIP

True CIP Arb   (Post-crisis)

Funded via USD CP and investing in T-bills   **(basis points)**

	Low rating (A-2/P-2)		Good rating (A-1/P-1)		Top rating (A-1+/P-1)	
	Median	(%D)	Median	(%D)	Median	(%D)
AUD	**-47.7**	0%	**-34.5**	0%	**-28.7**	8%
CAD	**-29.5**	0%	**-16.1**	1%	**-9.9**	3%
CHF	**-12.8**	14%	**0.6**	53%	**6.5**	80%
EUR	**-15.7**	5%	**-1.4**	42%	**4.4**	65%
GBP	**-32.0**	0%	**-18.7**	2%	**-13.0**	8%
JPY	**-4.9**	32%	**6.0**	90%	**12.2**	100%

True CIP Arb (Post-crisis)

Funded via USD CP and placing funds with foreign CB (basis points)

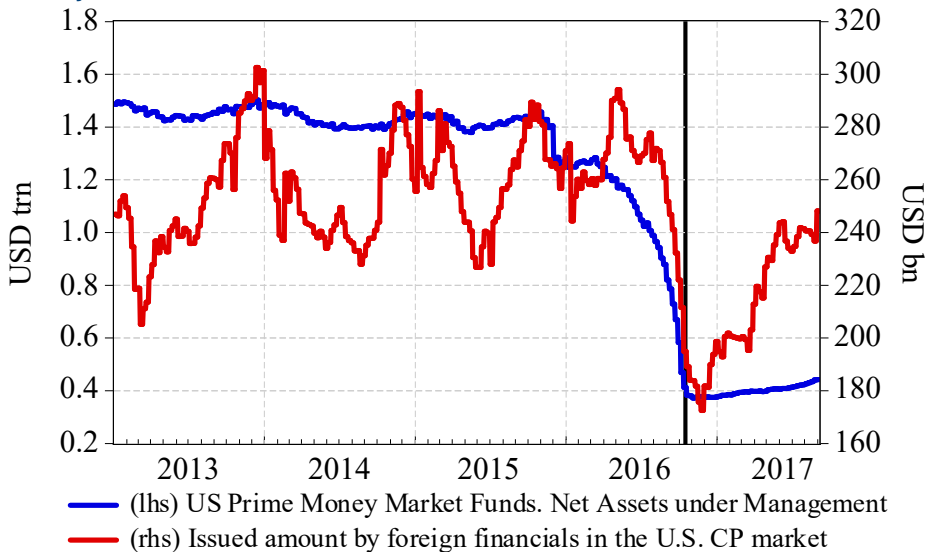|	Low rating (A-2/P-2)		Good rating (A-1/P-1)		Top rating (A-1+/P-1)	
	Median	(%D)	Median	(%D)	Median	(%D)
AUD	**-54.8**	0%	**-43.8**	0%	**-37.7**	0%
CAD	**-20.2**	0%	**-7.7**	14%	**-1.2**	35%
CHF	**1.4**	56%	**14.2**	100%	**19.8**	100%
EUR	**-22.0**	7%	**-6.8**	34%	**-1.3**	49%
GBP	**-14.1**	1%	**-0.3**	47%	**6.6**	96%
JPY	**4.6**	68%	**14.2**	100%	**19.9**	100%

US Money Market Funds

Money Market Fund reform and Asset Contraction

- (lhs) US Prime Money Market Funds. Net Assets under Management
- (rhs) Issued amount by foreign financials in the U.S. CP market

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True CIP Arb   (Asset contraction)

Funded via USD CP and investing in T-bills   (basis points)

	Low rating (A-2/P-2)		Good rating (A-1/P-1)		Top rating (A-1+/P-1)	
	Median	(%D)	Median	(%D)	Median	(%D)
AUD	**-54.2**	0%	**-33.6**	0%	**-21.7**	0%
CAD	**-30.5**	0%	**-14.9**	0%	**-3.7**	26%
CHF	**4.8**	72%	**22.6**	100%	**34.7**	100%
EUR	**-11.6**	5%	**4.4**	74%	**16.1**	98%
GBP	**-24.7**	0%	**-7.4**	15%	**3.9**	73%
JPY	**15.2**	89%	**31.6**	97%	**40.6**	97%

True CIP Arb (Asset contraction)

Funded via USD CP and placing funds with foreign CB   **(basis points)**

|	Low rating (A-2/P-2)		Good rating (A-1/P-1)		Top rating (A-1+/P-1)	
	Median	(%D)	Median	(%D)	Median	(%D)
AUD	**-67.6**	0%	**-49.6**	0%	**-38.9**	0%
CAD	**-30.0**	0%	**-14.6**	0%	**-2.1**	33%
CHF	**21.5**	97%	**38.8**	100%	**51.5**	100%
EUR	**4.3**	60%	**21.8**	100%	**31.9**	100%
GBP	**-10.9**	18%	**5.2**	71%	**18.3**	100%
JPY	**30.4**	100%	**49.6**	100%	**59.1**	100%

FX Swap Market

(a) "Normal" situation: Equilibrium, No Arb, No Flow imbalance
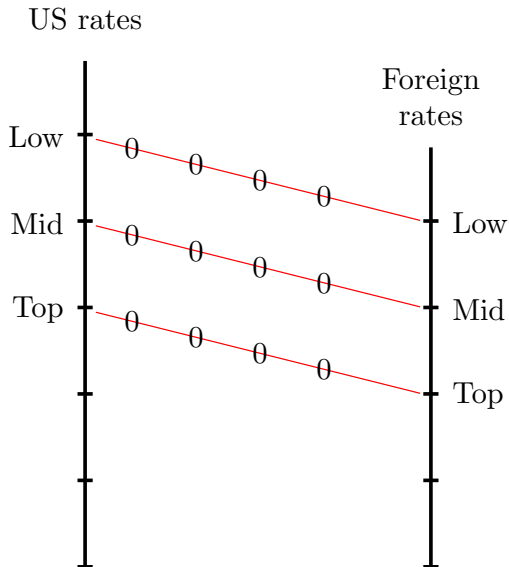
Deposit inflow in wake of ECB-QE

Billions euro

Legend:
- Total assets (left)
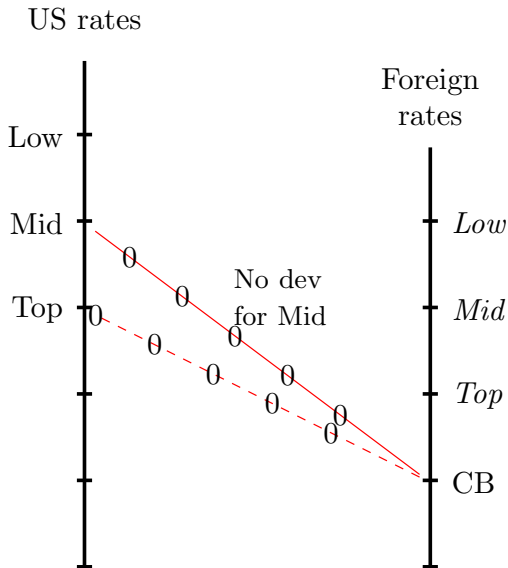- Deposits from Euro-area residents (right)
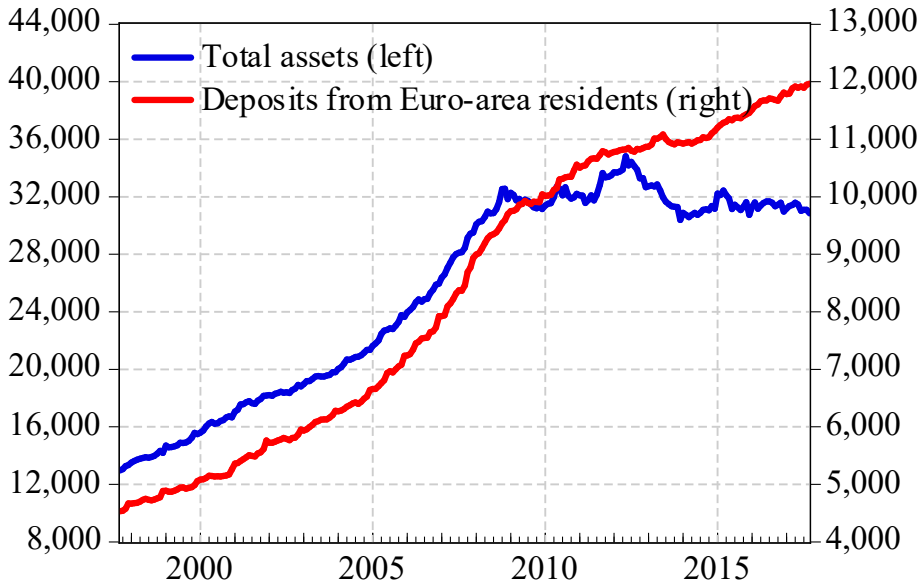
FX Swap Market

(b) Example of no equilibrium with excess liquidity
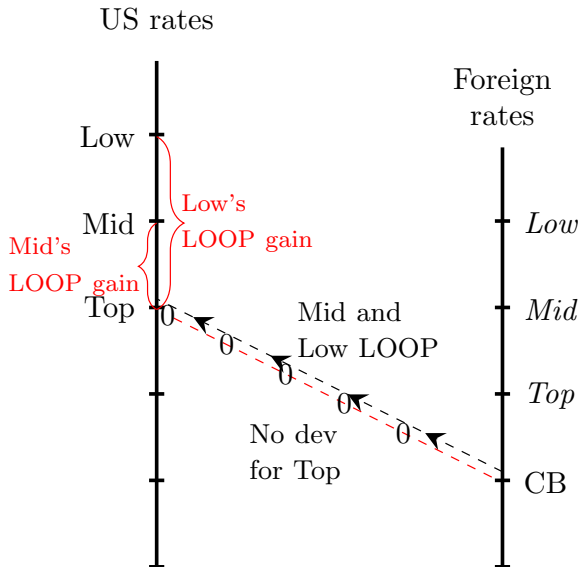
FX Swap Market

(c) Excess liquidity: Equilibrium swap rate

FX Swap Market

(d) Excess liquidity: Equilibrium flows
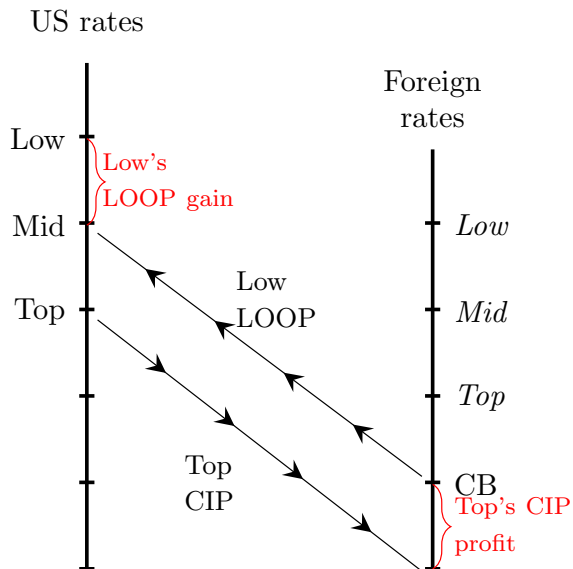
EUR CIP deviations

OIS and CP-based 3m deviations   **(basis points)**
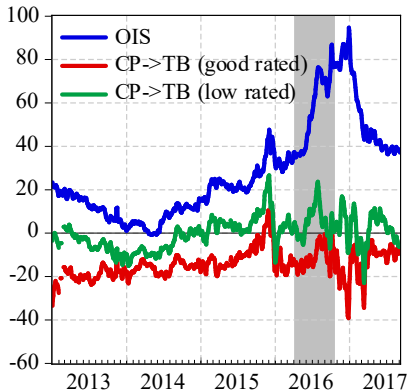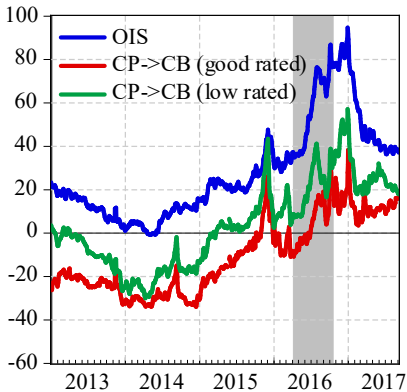
(a) OIS & CP-TB   **(b)** OIS & CP-CB

FX Swap Market

(d) Excess liquidity: Equilibrium flows

US rates

Low

Low's
LOOP gain

Mid

Top

Foreign
rates

Low

Mid

Top

Low
LOOP

Top
CIP

CB
Top's CIP
profit

DR/AS/OS
CIP
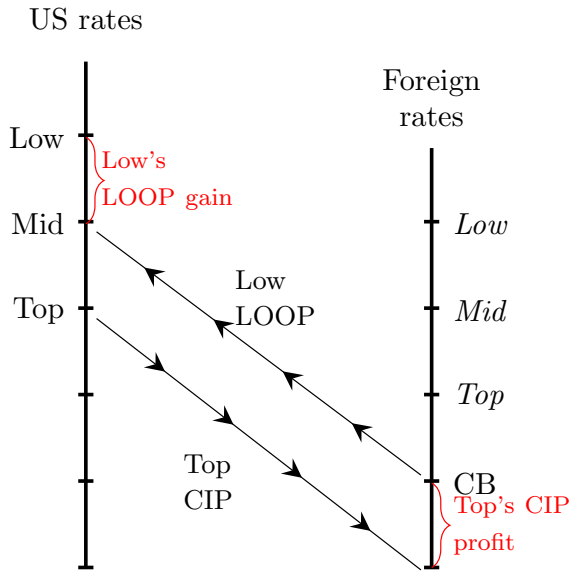
CIP arb and Swap Order Flow

Panel regression   **(CrossX FE, CrossX clustering)**

$$\Delta CIP_{i,t}^{dev} = \alpha_i + \gamma \cdot CIP_{i,t-1}^{dev}$$
$$+ D_{i,t} \cdot \beta_i \cdot OF_{i,t}^{swap} + Controls + \varepsilon_{i,t}$$

- OF_{swap}: measures demand pressure to raise USD through swaps   (*standardized*)

- Lagged dependent variable: "error-correction"

- 2 regimes, deviation-dummy: $\beta_i = \left[\beta_i^{Dev}, \beta_i^{NoDev} \right]$

▸ More

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Order flow regressions

	A-2/P-2 (1)	A-1/P-1 (2)	A-1/P-1 (3)
Deviation, level lagged	-0.04 (-2.31)	-0.07 (-4.62)	-0.07 (-6.69)
Swap OF, both dev			2.75 (2.70)
Swap OF, dev	3.26 (3.09)	0.75 (2.45)	0.65 (4.42)
Swap OF, no dev	0.91 (2.87)	0.49 (2.41)	0.26 (1.97)

Additonal controls . . . (see Appendix)

Order flow regressions

	A-2/P-2 (1)	A-1/P-1 (2)	A-1/P-1 (3)
Deviation, level lagged	-0.04	-0.07	-0.07
	(-2.31)	(-4.62)	(-6.69)
Swap OF, both dev			**2.75**
			(2.70)
Swap OF, dev	**3.26**	**0.75**	**0.65**
	(3.09)	**(2.45)**	**(4.42)**
Swap OF, no dev	0.91	0.49	0.26
	(2.87)	(2.41)	(1.97)

Additonal controls . . . (see Appendix)

Yen CIP Arbitrage

Cash deposits of foreign' banks with Bank of Japan
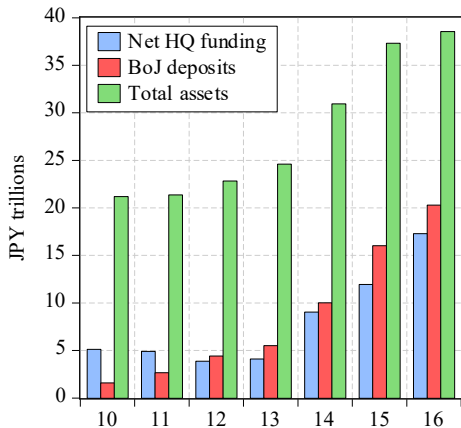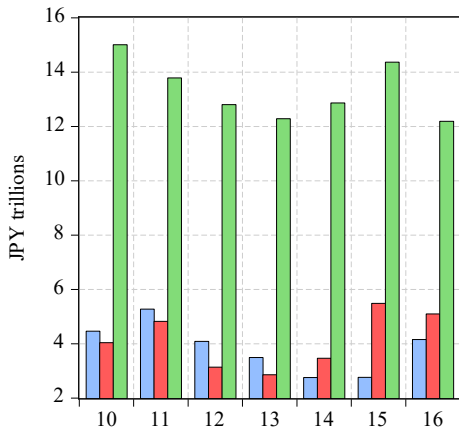
(a) Top-rated banks   **(b)** Lower-rated banks

Top Banks Arb Flows are Bounded

Dispersion in top-rated banks USD funding costs   **(USD CD issuance)**
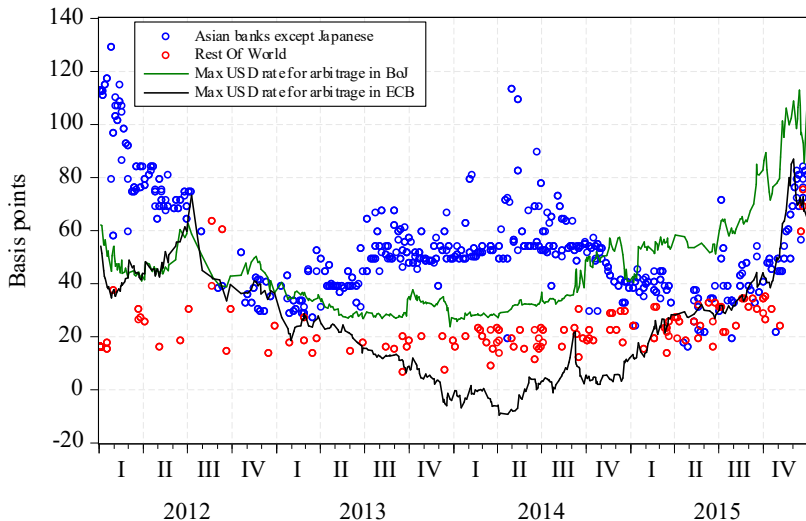
Excess liquidity and the "new LOOP"

Some evidence from the ECB's Asset Purchase Program

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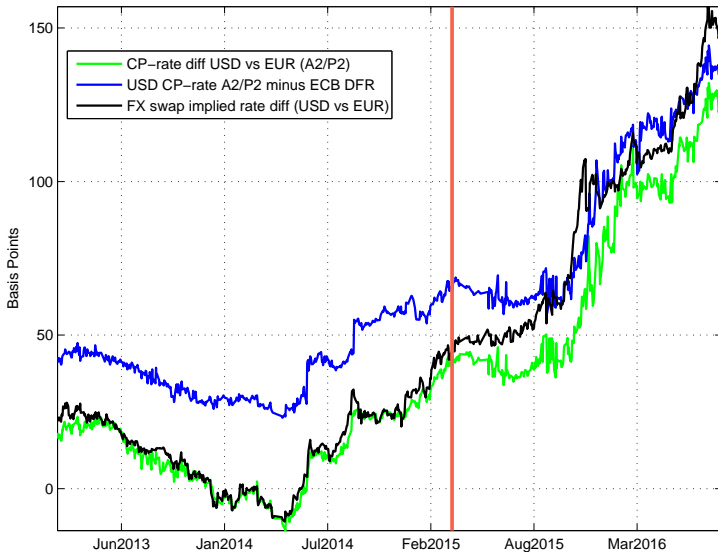
Conclusions

1. **No CIP Arb profits (for most)** when using actual marginal *funding cost* and *riskfree lending*
2. **Risk-free CIP Arb for top-rated** banks emerge as *equilibrium outcome*

Main forces for recent market "dislocation":

★ **Funding liquidity risk in USD money markets**

- **Heterogeneity** in USD money markets
- **Excess liquidity** + **Segmentation** in non-USD
- ⇒ **Funding Liquidity Premia** differences

Part II

Additional material

Literature

Classics and pre-crisis evidence
Branson (1969), Frenkel and Levich (1975, 1977): large deviations
Taylor (1987), Akram, Rime, and Sarno (2008) : tiny dev   (when data are sampled correctly)

CIP and the global financial crisis
e.g. Baba, Packer, and Nagano (2008); Baba and Packer (2009); Coffey, Hrung, Nguyen, and Sarkar (2009); Goldberg, Kennedy, and Miu (2011); Griffoli and Ranaldo (2009); McGuire and von Peter (2012); Bottazzi, Luque, Pascoa, and Sundaresan (2012); Syrstad (2014)

The CIP puzzle in the post-GFC period
e.g. Du, Tepper, and Verdelhan (2016); Sushko, Borio, McCauley, and McGuire (2016); Avdjiev, Du, Koch, and Shin (2016); Iida, Kimura, and Sudo (2016)

$\Rightarrow$ Large & persistent deviations, yet **no turmoil!**

Borrow 1 USD

$t = 0$

Buy $1/S$, Lend at rate i_{EUR}

$t = 0$

Forward contract F

No Arbitrage
$$F = S\frac{1+i_{USD}}{1+i_{EUR}}$$

Repay debt
$1 + i_{USD}$

$t = 1$

Receive at maturity,
$\frac{1+i_{EUR}}{S}F$

▸ Back
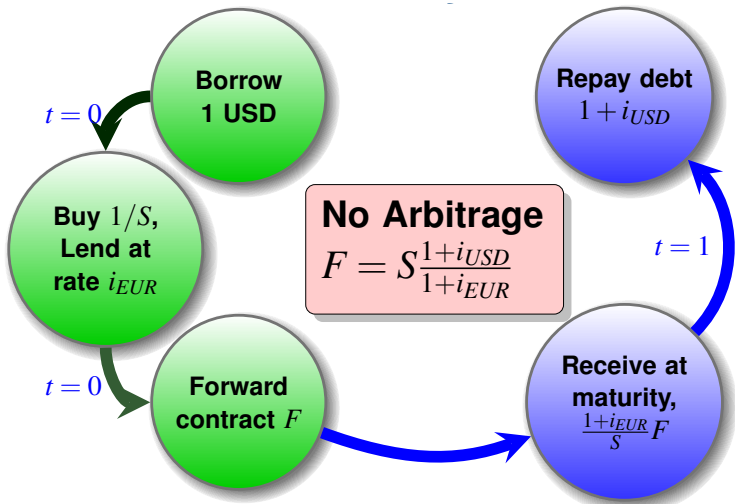
CIP (LOOP) with bid-ask spreads

CIP arbitrage is *not* profitable ...

$$(1 + r_d^a) \geqslant \frac{F^b}{S^a}(1 + r_f^b) \qquad (1)$$

$$(1 + r_f^a) \geqslant \frac{S^b}{F^a}(1 + r_d^b) \qquad (2)$$

1. Borrowing rate (ask) in domestic currency has to be equal or higher than implied lending rate (bid) measured in domestic currency

2. LOOP: same price for both interest rates (weaker)

Market conventions and the cross-currency basis

$$Dev_{CIP}^b = -i_d^a + \left[\frac{S^a + \overline{F^b - S^a}/10^4}{S^a} \left(100 + i_f^b \frac{D}{360} \right) - 100 \right] \frac{360}{D},$$

$$Dev_{CIP}^a = -i_f^a - \left[\frac{S^b}{S^b + \overline{F^a - S^b}/10^4} \left(100 + i_d^b \frac{D}{360} \right) - 100 \right] \frac{360}{D}.$$

- Swap, represented by $\overline{F^b - S^a}$ (here at bid), not forward
- D – days to maturity and 10^4 – factor scaling the swap since it is quoted in "swap points"
- CIP deviation as the cross-currency basis

Part III

Data and Funding cost heterogeneity

Funding cost heterogeneity

US money market spreads (3-mth)
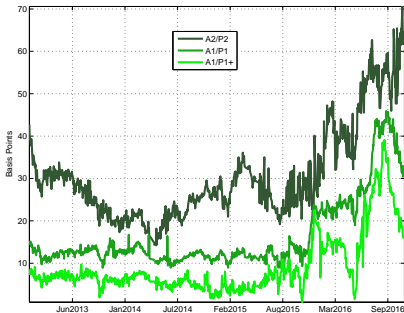
(a) USD commercial paper
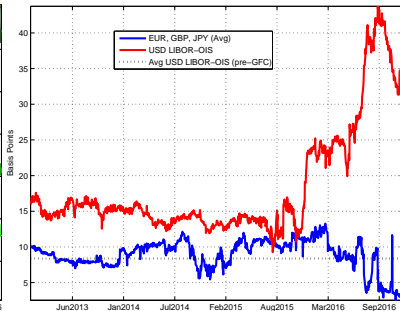
(b) USD LIBOR-OIS vs other currencies

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Heterogenous funding costs

Evidence from the LIBOR panel
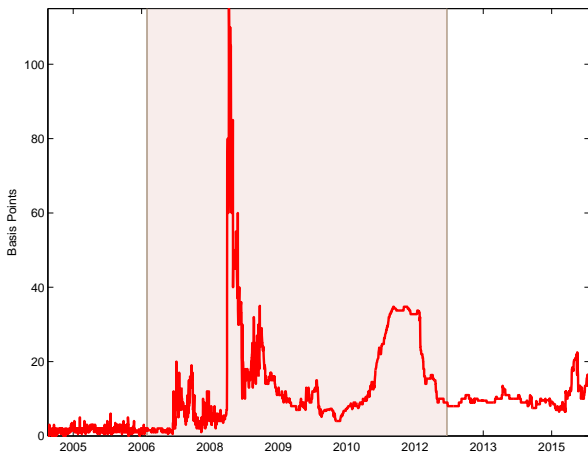
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CIP

Data overview

FX

	Tradeable	Risk-free	High-freq	Tenors Tenors	Currencies
Spot (D2)	Y	–	Y	–	AUD, CAD, CHF, EUR, GBP, JPY
FX Swaps	N	–	Y	1W-3M	AUD, CAD, CHF, EUR, GBP, JPY
FX Swaps (D3)	Y	–	Y	1W-3W	AUD, CAD, CHF, EUR, GBP, JPY

▸ Back

Data overview

Interest rates

	Trade-able	Risk-free	High-freq	Tenors Tenors	Currencies
Secured					
OIS	Y	Y	Y	1W-3M	USD, EUR, GBP*, JPY*
			Y	1M-3M	AUD, CAD, CHF
Repo (GC)	Y	Y	D	1M, 3M	USD, EUR
T-bills	Y	Y	D	1M, 3M	USD, AUD, CAD, CHF, EUR, GBP, JPY
CB deposits	Y	Y	D	1M, 3M	USD, AUD, CAD, CHF, EUR, GBP, JPY
Unsecured					
Deposit	N	N	Y	1W-3M	USD, AUD, CAD, CHF, EUR, GBP, JPY
IBOR	N	N	D	3M	USD, AUD*, CAD, CHF, EUR, GBP, JPY
CP	Y	N	D	1M, 3M	USD, AUD, CAD, EUR, GBP, JPY

DR/**AS**/**OS**
CIP

Descriptives

Money market spreads (over OIS)

	Deposit	Repo	IBOR
Mean	0.324	-0.105	0.291
Median	0.174	-0.095	0.145
Maximum	4.776	0.341	3.663
Minimum	-0.140	-1.464	0.025
Std. Dev.	0.478	0.136	0.391
Skewness	4.334	-2.331	3.949
Kurtosis	28.453	16.746	24.023
Observations	2801	1740	2733

▸ Back

Part IV

OIS, GC Repo and FTP

Roundtrip Arb based on OIS contracts

1. Borrow funds overnight (O/N) in borrowing currency (e.g. USD)

2. Roll over O/N loan daily over preferred maturity and hedge IR risk by paying the (fixed) OIS-rate of the same maturity

3. Enter into FX swap with same maturity as OIS

4. Invest lending currency O/N (e.g. JPY)

5. Roll over O/N investment and hedge IR risk by receiving the OIS-rate in the lending currency

⇒ Rolling over short-term O/N funding allows arbitrageur to reduce funding cost

⇒ But, this comes at the cost of taking on additional *liquidity risk* in the borrowing currency ...

Roundtrip cross-currency basis arbitrage with OIS rates (I)

		GFC and EUR crisis					
				Deviation			
	Direction	Median	Std.	(%D)	(%W)	(%M)	Obs.
EUR	*FCU ⇒ USD*	-29.8	38.2	0%	0%	0%	1566
	USD ⇒ FCU	23.5	35.4	92%	91%	88%	1566
GBP	*FCU ⇒ USD*	-13.6	34.7	3%	2%	0%	1395
	USD ⇒ FCU	7.5	31.3	87%	79%	61%	1395
JPY	*FCU ⇒ USD*	-31.1	16.6	0%	0%	0%	796
	USD ⇒ FCU	25.7	16.7	100%	99%	97%	796

Round-trip arb based on OIS rates and B/A adjustment in all legs of trade sequence

"Direction" indicates if round-trip goes "*USD ⇒ FCU*" or "*FCU ⇒ USD*" at spot leg of swap

▸ More

Roundtrip cross-currency basis arbitrage with OIS rates (II)

	Direction	Post-crisis		Deviation			
		Median	Std.	(%D)	(%W)	(%M)	Obs.
EUR	*FCU ⇒ USD*	-18.8	16.0	0%	0%	0%	728
	USD ⇒ FCU	12.8	9.3	94%	92%	87%	728
GBP	*FCU ⇒ USD*	-8.1	3.7	0%	0%	0%	725
	USD ⇒ FCU	3.1	3.6	99%	97%	95%	725
JPY	*FCU ⇒ USD*	-23.8	14.4	0%	0%	0%	694
	USD ⇒ FCU	19.9	14.2	100%	100%	100%	694

Round-trip Arb based on OIS rates and B/A adjustment in all legs of trade sequence

"Direction" indicates if round-trip goes "*USD ⇒ FCU*" or "*FCU ⇒ USD*" at spot leg of swap

▸ More

Roundtrip cross-currency basis arbitrage with OIS rates (III)

	Direction	GFC and EUR crisis					Post-crisis				
		Median	Std.	(%D)	(%W)	(%M)	Median	Std.	(%D)	(%W)	(%M)
AUD	*FCU ⇒ USD*	-10.2	40.4	18%	14%	7%	6.9	9.6	64%	61%	56%
	USD ⇒ FCU	2.5	38.2	61%	52%	41%	-12.3	9.5	13%	11%	7%
CAD	*FCU ⇒ USD*	-13.0	37.3	1%	0%	0%	-7.7	4.0	1%	0%	0%
	USD ⇒ FCU	6.0	31.2	88%	79%	62%	2.4	3.8	76%	67%	47%
CHF	*FCU ⇒ USD*	-41.3	31.4	0%	0%	0%	-31.2	28.3	0%	0%	0%
	USD ⇒ FCU	32.3	27.9	100%	100%	98%	23.9	24.8	100%	100%	100%

Round-trip Arb based on OIS rates and B/A adjustment in all legs of trade sequence

"Direction" indicates if round-trip goes "*USD ⇒ FCU*" or "*FCU ⇒ USD*" at spot leg of swap

▸ Back

OIS is not Marginal Funding Rate

An Overnight-Index-Swap is a derivative, _not_ a funding instrument

- Use for CIP calculations (implicitly) assumes a complex series of trades
- Need to roll over O/N borrowing
- Arbitrageur remains exposed to **rollover** and **liquidity risks** ▸ Evidence

⇒ Fluctuations of OIS FX swap basis largely reflect relative **term funding liquidity premiums** vis-a-vis USD ...

⇒ Can't make judgement about validity of a no-Arb condition like CIP

⇒ Similar arguments apply to FX swap basis constructed from GC repo rates

▸ Arb trade sequence w OIS   ▸ Repo   ▸ Funding liquidity premia

GC repo rates in CIP calculations

Like in case of OIS, there are hidden costs when relying on GC repo rates in CIP calculations ...

- Collateral used in repo is ultimately financed unsecured
- For use in arbitrage trade, collateral needs to be unencumbered
- Otherwise, requirements of self-financing Arb trade not met

$\rightarrow$ To capture marginal funding costs for repo-based CP arbitrage, it is necessary to adjust for the (unsecured) funding cost of the collateral

How do banks price funds internally?

The principle of Funds Transfer Pricing (FTP)

- Transfer IR and liquidity risk to central location (Treasury unit)
- Immunize remaining units against these risk factors
- Treasury "buys" funds from units managing the banks' liability side
- And, it "sells" funds to units investing in banking assets
- The corresponding "prices" charged by the Treasury are related to the cost of obtaining the funds

The FTP interest rate curve

- To determine FTP, the Treasury unit constructs an IR curve, incorporating the marginal cost of using funds across maturities
- Make sure business units face net interest margin from

  1. Funding spread between deposit rates faced by banks' customers and internal price (liability side)
  2. Spread between internal price and return on the banking assets (asset side)

- Rely on interbank deposit rates $< 1y$ and IRS curve $> 1y$
- Interbank deposit rate regarded as a reasonable proxy for the marginal cost of using funds for banks

FTP: Implications

- Banks' internal pricing needs to be closely aligned with LOOP

- Otherwise, internal business units may exploit inconsistency

$\Rightarrow$ Choice of MM rates guided by banks' internal no-Arb condition across currencies ...

- Interbank deposit rates as a reasonable proxy for the internal price

- Account for term funding liquidity, credit premium and balance sheet cost of using additional funds

- TC-adjustment feasible (unlike IBOR)

$\Rightarrow$ Expect CIP to hold to a close approximation between interbank deposit rates (after TC-adjustment) ...

Funds Transfer Pricing

Capital Markets

Hedge

Hedge Book: Compose the bank-wide interest rate risk profile and execute hedging

Liquidity Management: Compose the bank-wide maturity mismatch profile and manage funding needs

Raise funds

Capital Markets

Treasury

FTP Book: FTP all assets and liabilities

FTP assets

FTP liabilities

FTP assets

FTP liabilities

Loans

Deposit

Loans

Deposit

Business A

Business B

Part V

LOOP

LOOP and IBOR

$$(i) \qquad y^{\$} \quad - \quad y^{FCU \to \$}$$

Direct \$-rate   Swap-implied \$-rate

$$(ii) \qquad y^{FCU} \quad - \quad y^{\$ \to FCU}$$

Direct FCU -rate   Swap-implied FCU-rate

		GFC and EUR crisis						Post-crisis					
				Deviation						Deviation			
		Median	Std.	(%D)	(%W)	(%M)	Obs.	Median	Std.	(%D)	(%W)	(%M)	Obs.
EUR	(i)	**-33.7**	33.3	11%	8%	3%	1422	**-13.7**	9.1	1%	0%	0%	711
	(ii)	**31.6**	31.4	88%	85%	77%	1422	**12.4**	8.8	98%	97%	90%	711
GBP	(i)	**-17.0**	30.3	5%	1%	0%	1422	**-2.1**	4.1	12%	7%	1%	711
	(ii)	**15.3**	27.4	91%	85%	76%	1422	**1.4**	4.0	80%	71%	53%	711
JPY	(i)	**-18.5**	20.1	11%	6%	2%	1500	**-15.4**	12.9	0%	0%	0%	729
	(ii)	**16.2**	19.0	84%	77%	68%	1500	**14.3**	12.6	100%	100%	100%	729

▸ Back

LOOP and interbank deposit

$$(i) \qquad \underbrace{y^{\$}}_{\text{Direct \$-rate}} \quad - \quad \underbrace{y^{FCU \to \$}}_{\text{Swap-implied \$-rate}}$$

$$(ii) \qquad \underbrace{y^{FCU}}_{\text{Direct FCU -rate}} \quad - \quad \underbrace{y^{\$ \to FCU}}_{\text{Swap-implied FCU-rate}}$$

		GFC and EUR crisis						Post-crisis					
				Deviation						Deviation			
		Median	Std.	(%D)	(%W)	(%M)	Obs.	Median	Std.	(%D)	(%W)	(%M)	Obs.
EUR	(i)	**-4.0**	9.9	11%	1%	0%	1488	**-0.8**	2.4	13%	0%	0%	728
	(ii)	**3.2**	9.9	81%	62%	40%	1488	**0.4**	2.4	75%	44%	17%	728
GBP	(i)	**-4.5**	7.7	21%	8%	4%	1472	**-0.8**	2.9	26%	5%	0%	725
	(ii)	**3.7**	7.2	74%	53%	32%	1472	**0.6**	2.9	65%	33%	8%	725
JPY	(i)	**-2.0**	4.7	23%	8%	1%	1417	**-2.5**	3.1	10%	0%	0%	694
	(ii)	**1.4**	4.9	68%	43%	22%	1417	**2.3**	3.0	87%	65%	38%	694

▸ Back

LOOP for CP rates (A-2/P-2)

$$(i) \qquad \underbrace{y^{\$}}_{\text{Direct \$-rate}} - \underbrace{y^{FCU \to \$}}_{\text{Swap-implied \$-rate}}$$

$$(ii) \qquad \underbrace{y^{FCU}}_{\text{Direct FCU -rate}} - \underbrace{y^{\$ \to FCU}}_{\text{Swap-implied FCU-rate}}$$

		Median	Std.	Deviation			Obs.
				(%D)	(%W)	(%M)	
EUR	(i)	**-4.2**	8.6	3%	0%	0%	716
	(ii)	**3.4**	8.4	93%	79%	54%	716
GBP	(i)	**-0.3**	4.2	44%	22%	8%	716
	(ii)	**-0.4**	4.1	43%	21%	7%	716
JPY	(i)	**-1.6**	6.4	25%	4%	0%	714
	(ii)	**0.3**	6.1	55%	28%	8%	714

Part VI

Funding Liquidity Premia

Funding liquidity premia and the basis
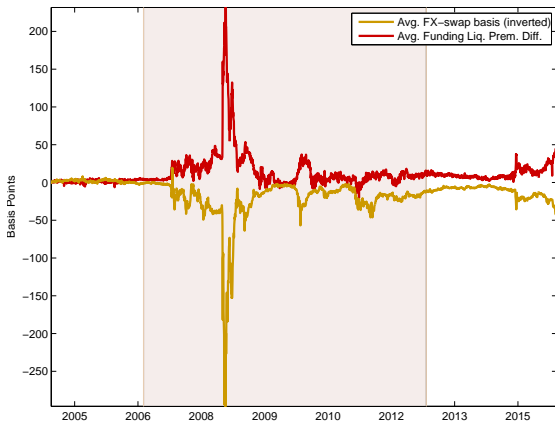
Funding liquidity premia and the basis
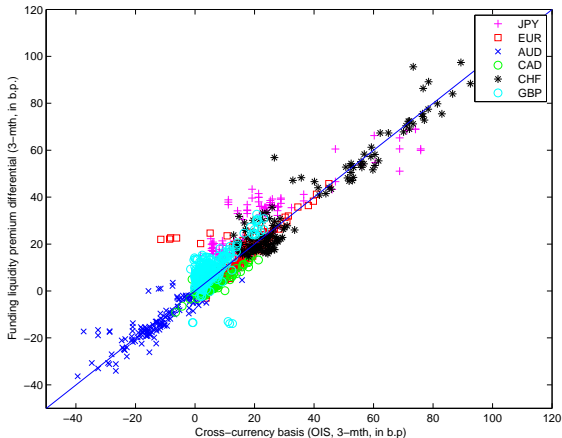
Funding liquidity premia and the basis

Commercial paper
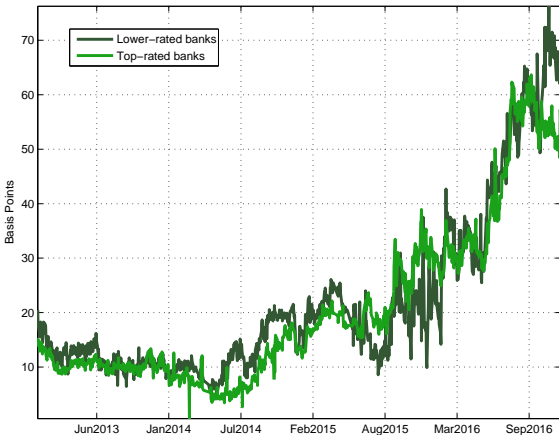
Part VII

True CIP Arbitrage

True CIP Arb   (Post-crisis)

Funded via USD CP and investing in T-Bills

Lower-rated banks (A-2/P-2)

	Median	Std.	(%D)	(%W)	(%M)	Obs.
AUD	**-38.9**	10.4	0%	0%	0%	167
CAD	**-28.6**	6.9	0%	0%	0%	691
CHF	**-13.6**	10.7	9%	6%	3%	679
EUR	**-23.2**	6.1	1%	0%	0%	713
GBP	**-25.3**	7.1	0%	0%	0%	688
JPY	**-4.8**	10.8	30%	18%	9%	497

▸ Back

True CIP Arb   (Post-crisis)

Funded via USD CP and investing in T-Bills

Top-rated banks (A-1/P-1)

	Median	Std.	(%D)	(%W)	(%M)	Obs.
AUD	**-25.9**	13.2	0%	0%	0%	167
CAD	**-15.5**	5.5	1%	0%	0%	691
CHF	**-0.2**	10.7	49%	28%	9%	679
EUR	**-9.3**	7.4	6%	3%	0%	713
GBP	**-12.5**	6.7	7%	6%	3%	688
JPY	**6.3**	10.6	95%	88%	80%	497

▸ Back

True CIP Arb   (Post-crisis)

Funded via USD CP and investing in T-Bills

Best-rated banks (A-1+/P-1)

	Median	Std.	(%D)	(%W)	(%M)	Obs.
AUD	**-21.0**	13.4	18%	11%	0%	161
CAD	**-9.3**	5	5%	2%	0%	683
CHF	**6.0**	10.6	78%	65%	45%	671
EUR	**-3.4**	7.4	32%	23%	14%	705
GBP	**-6.5**	6.7	21%	13%	5%	680
JPY	**12.5**	10.7	100%	100%	100%	492

▶ Back

True CIP Arb (Post-crisis)

Funded via USD CP and placing funds with foreign CB

Lower-rated banks (A-2/P-2)

	Median	Std.	(%D)	(%W)	(%M)	Obs.
AUD	**-53.5**	11	0%	0%	0%	639
CAD	**-20.1**	6.9	0%	0%	0%	696
CHF	**0.5**	16.9	53%	41%	31%	699
EUR	**-22.9**	11.5	7%	4%	1%	696
GBP	**-12.9**	5.2	1%	0%	0%	698
JPY	**4.0**	14.8	65%	60%	49%	699

▸ Back

True CIP Arb   (Post-crisis)

Funded via USD CP and placing funds with foreign CB

Top-rated banks (A-1/P-1)

	Median	Std.	(%D)	(%W)	(%M)	Obs.
AUD	**-42.6**	11.4	0%	0%	0%	639
CAD	**-7.5**	5.6	14%	9%	2%	696
CHF	**13.1**	17.9	100%	99%	97%	699
EUR	**-9.7**	13.1	29%	25%	19%	696
GBP	**0.6**	3.5	59%	46%	28%	698
JPY	**13.3**	14.6	100%	100%	100%	699

True CIP Arb   (Post-crisis)

Funded via USD CP and placing funds with foreign CB

Best-rated banks (A-1+/P-1)

	Median	Std.	(%D)	(%W)	(%M)	Obs.
AUD	**-35.9**	11.3	0%	0%	0%	631
CAD	**-1.5**	5.6	35%	24%	12%	688
CHF	**18.7**	18.1	100%	99%	97%	691
EUR	**-3.6**	12.9	44%	42%	37%	688
GBP	**7.4**	3.7	98%	96%	92%	690
JPY	**18.8**	14.8	100%	100%	100%	691

Cash deposits of foreign banks with Bank of Japan

Panel regression: $(BoJCash - Funding)/TotAssets$

	(1)	(2)	(3)	(4)
Rating	-0.019	-0.019	-0.018	-0.019
	(-2.44)	(-2.41)	(-2.32)	(-2.33)
CIP, top rating		0.295		0.150
		(1.83)		(1.00)
CIP, low rating			0.109	0.089
			(3.81)	(4.47)

CD issuance in US Dollars

Dispersion in USD funding costs - low-rated banks

Legend:
- ○ Mean A-2/P-2 banks CD funding costs (issuances)
- —— A-2/P-2 CP-rate from Tradeweb
- —— Max USD rate for arbitrage in BoJ

Y-axis: Basis points (20 to 160)

X-axis: quarters (I–IV) across years 2012, 2013, 2014, 2015, 2016
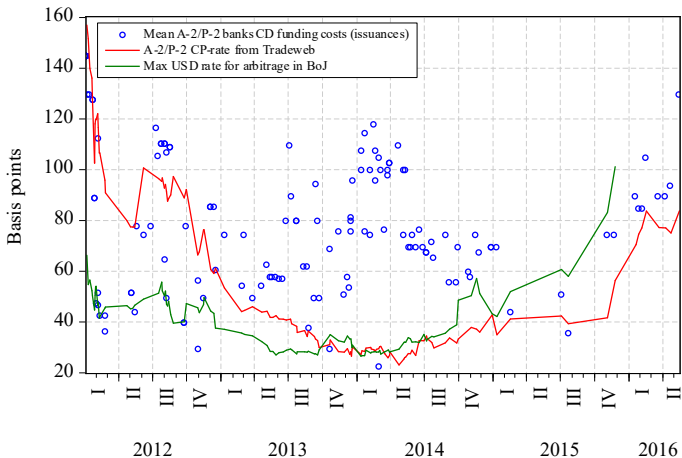
Activity in US interbank markets
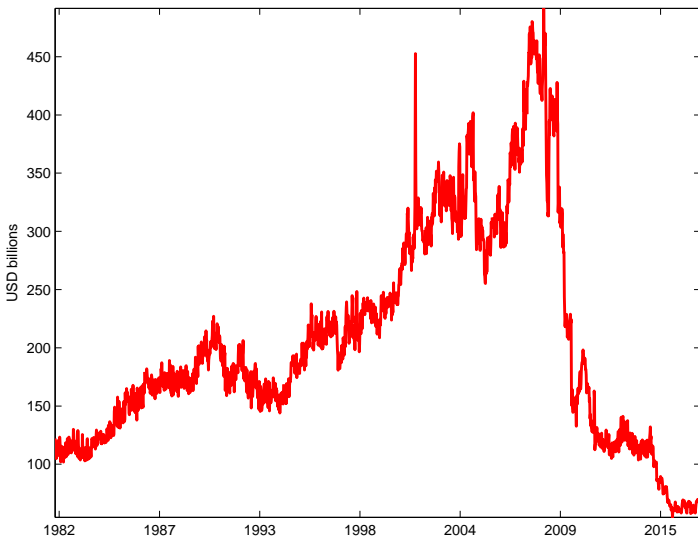
Global banks and their ratings

	Rating category			
	A-1+/P-1	A-1/P-1	A-2/P-2	Lower/No

A: Non-Asian banks, including Japanese banks				
Average size	749	861	877	310
Total size	8,990	35,301	14,907	19,519
# banks	12	41	17	63

B: Asian banks, excluding Japanese banks				
Average size	301	1,026	473	342
Total size	1,803	11,282	3,311	6,155
# banks	6	11	7	18

Part VIII

Swap Order Flow

Order flow regressions

Interpretation

- Rise in funding liquidity premia ("USD more scarce")

- Turn to swap-market for funding in USD (especially for low-tier)
  $\rightarrow$ CIP-deviations widen ...

- Reflects rising pressure (on $f - s$) as price impact of swap order flow imbalance rises

Other results:

- Similar for OIS roundtrip deviations

Order flow regressions   (Cont.)

	A2/P2 (1)	A1/P1 (2)	A1/P1 (3)
Spot return, dev	1.45	-0.60	-0.19
	(1.25)	(-1.38)	(-0.62)
Spot return, no dev	-0.54	-1.25	-0.89
	(-0.93)	(-2.15)	(-2.87)
Spot OF, dev	-0.10	-0.01	-0.04
	(-0.37)	(-0.03)	(-0.51)
Spot OF, no dev	-0.21	-0.27	-0.01
	(-1.40)	(-2.22)	(-0.11)
Liq-premia diff, dev	0.06	0.09	0.04
	(2.54)	(3.10)	(3.37)
Liq-premia diff, no dev	-0.01	-0.16	-0.07
	(-0.56)	(-2.82)	(-4.99)

OF: Robustness

	A-2/P-2		A-1/P-1	
	(1)	(2)	(3)	(4)
Swap OF, dev	1.54	1.81	0.58	0.69
	(2.37)	(2.49)	(2.38)	(9.14)
Swap OF, no dev	0.17	0.16	0.21	0.25
	(3.87)	(3.62)	(2.20)	(1.91)
Spot index, dev	1.44		0.64	
	(1.68)		(1.32)	
Spot index, no dev	0.03		-1.66	
	(0.11)		(-2.92)	
Spot, dev		1.05		0.28
		(0.92)		(2.06)
Spot, no dev		-0.64		-0.78
		(-1.56)		(-3.77)
LP diff, dev	0.13		0.16	
	(5.28)		(5.82)	
LP diff, no dev	0.06		0.01	
	(2.58)		(0.35)	

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