



Segmented Money Markets and CIP Arbitrage

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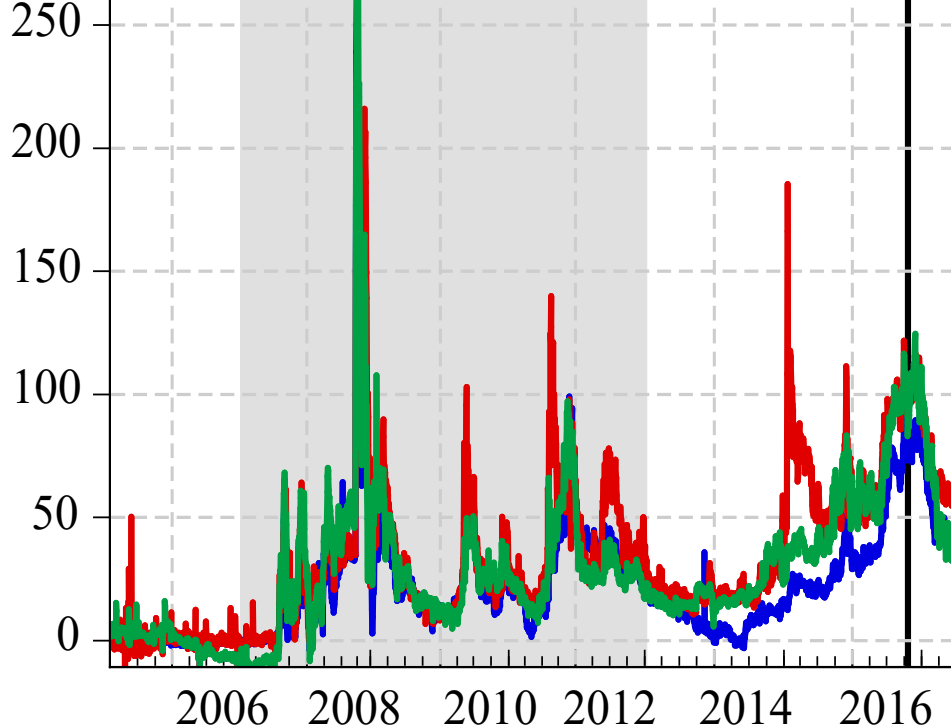
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ECB Money Market Workshop

*Disclaimer: Any views presented here are those of the authors
and do not necessarily reflect those of the BIS or Norges Bank*



Crucial in study of CIP

Get the **ARBITRAGE** right!

- **WHO** are the main arbitrageurs?
- **WHAT** are the main strategies?
 - ▶ Risk-less round-trip
 - ▶ Relative value
- **HOW** is it done?

BANKS!

**CIP
LOOP**

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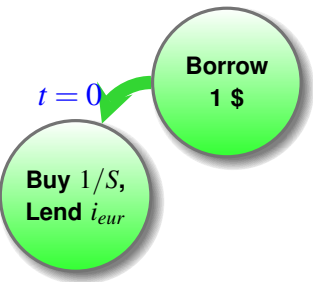
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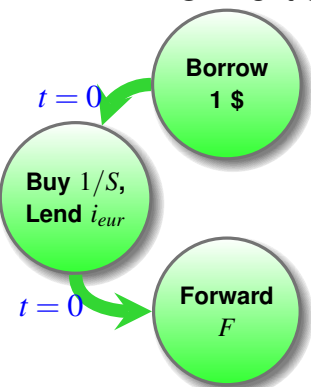
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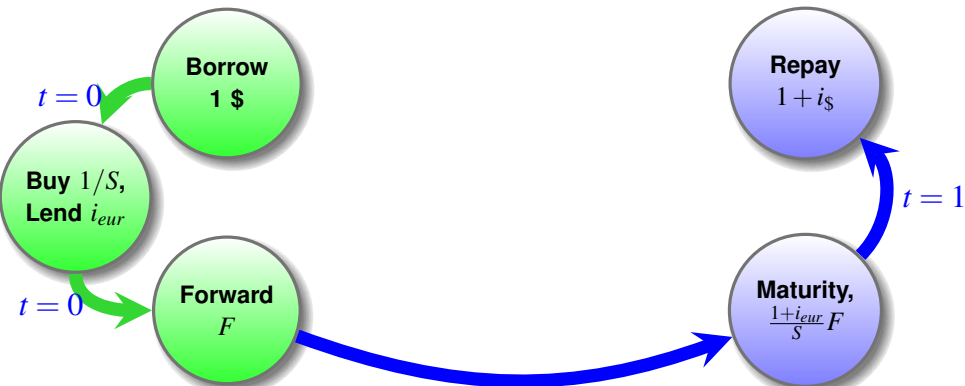
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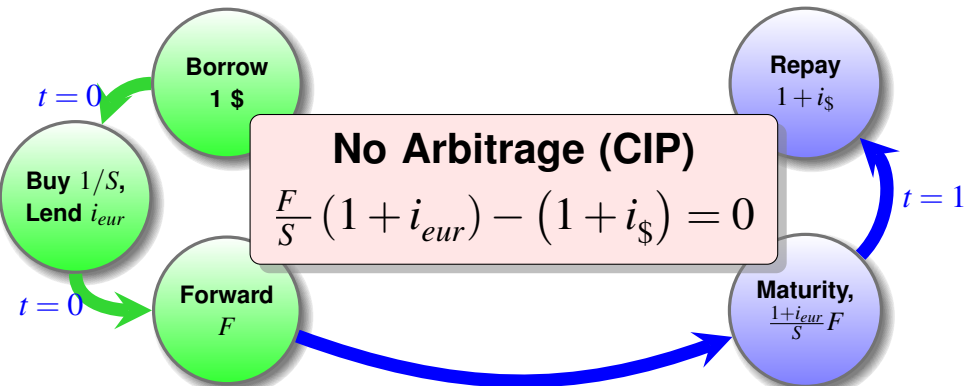
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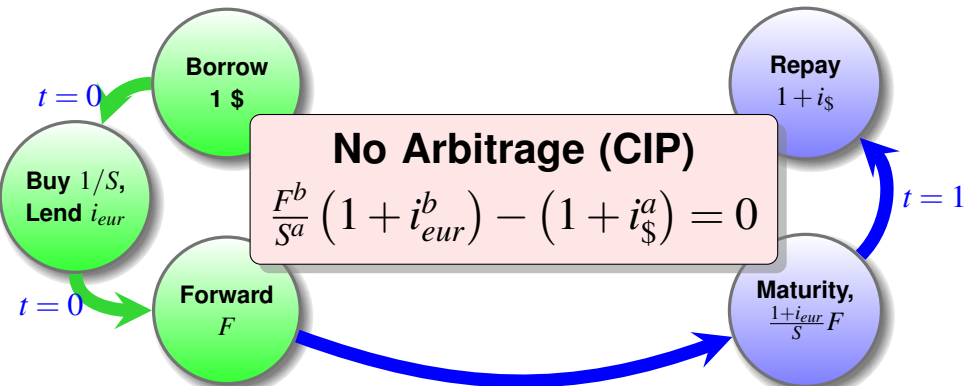
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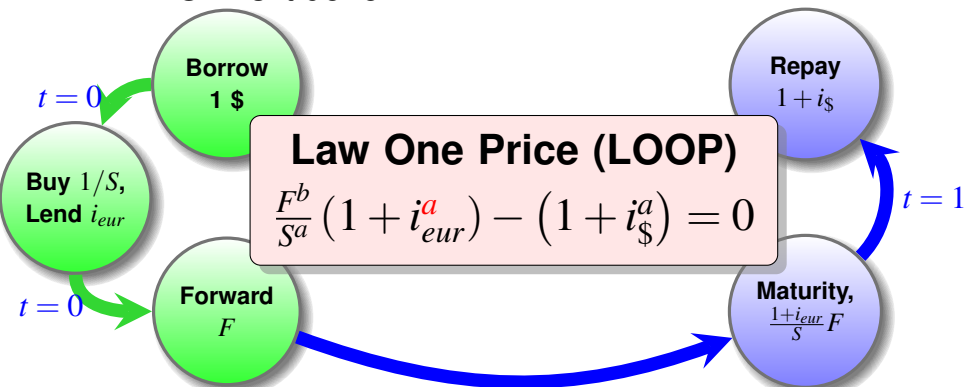
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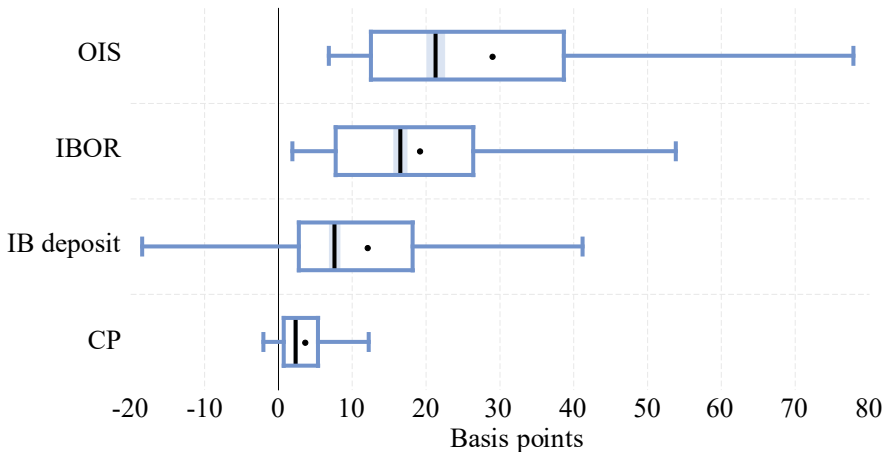
**CIP
LOOP**



Importance of different interest rates

LOOP-deviation. Average across EUR, GBP, JPY.

(2013-2016q1)



Activity in US interbank markets



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
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Median (%D)

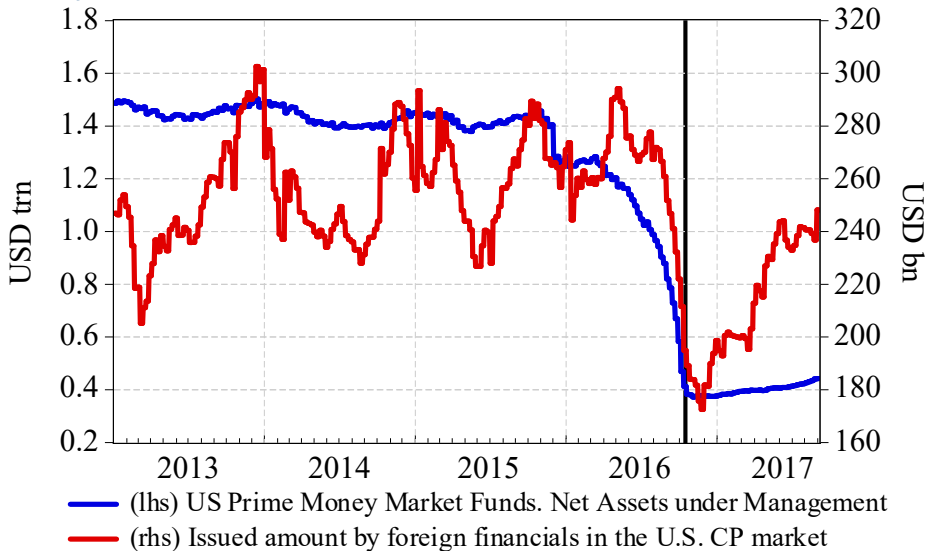
Median (%D)

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



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**

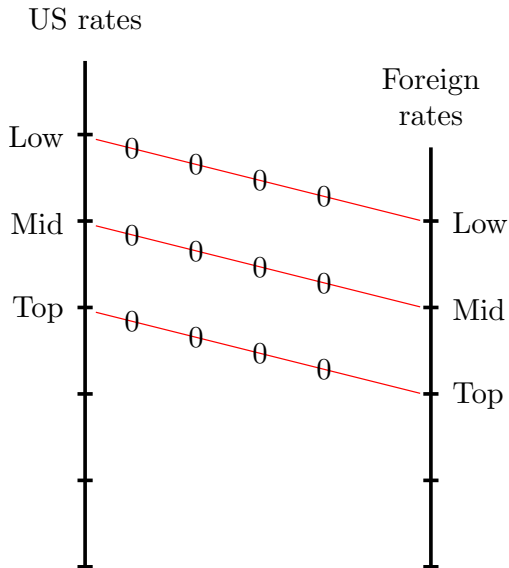
(basis points)

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%

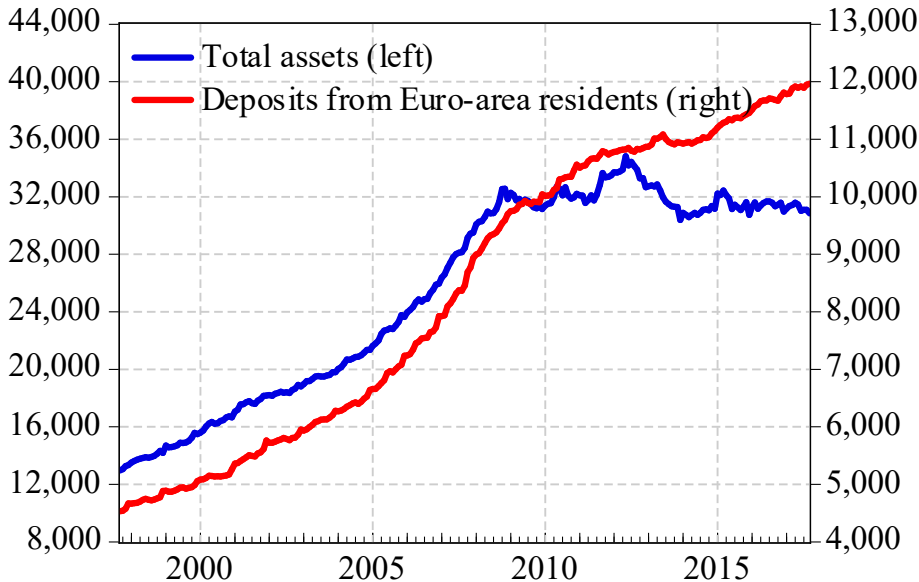
FX Swap Market

(a) “Normal” situation: Equilibrium, No Arb, No Flow imbalance



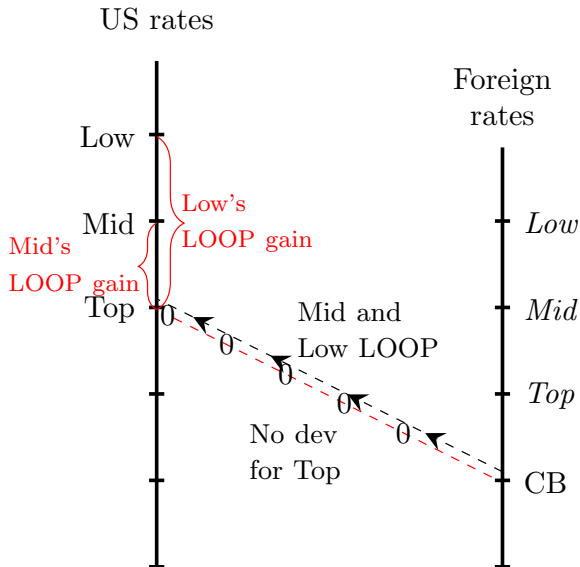
Deposit inflow in wake of ECB-QE

Billions euro



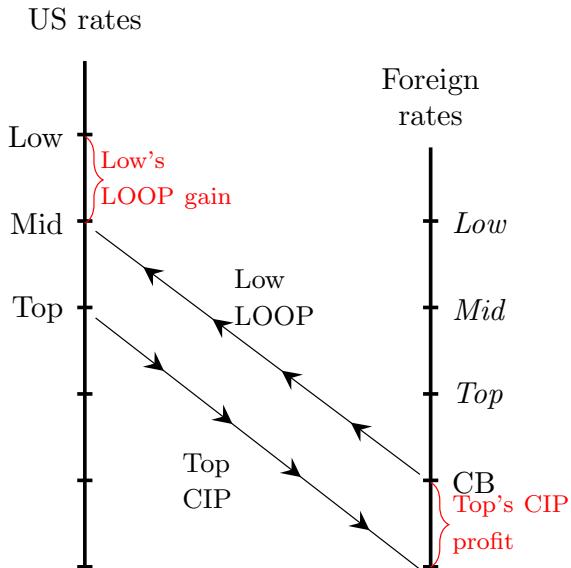
FX Swap Market

(b) Example of no equilibrium with excess liquidity



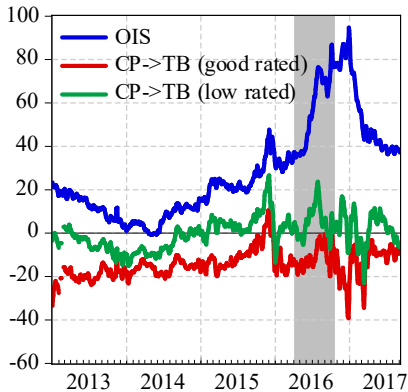
FX Swap Market

(d) Excess liquidity: Equilibrium flows



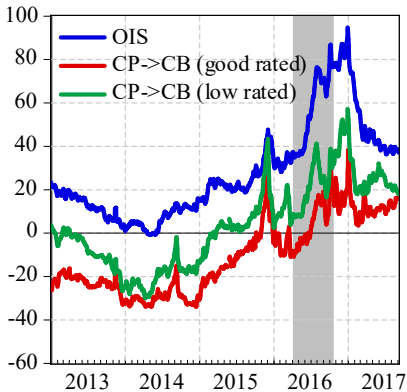
EUR CIP deviations

OIS and CP-based 3m deviations



(a) OIS & CP-TB

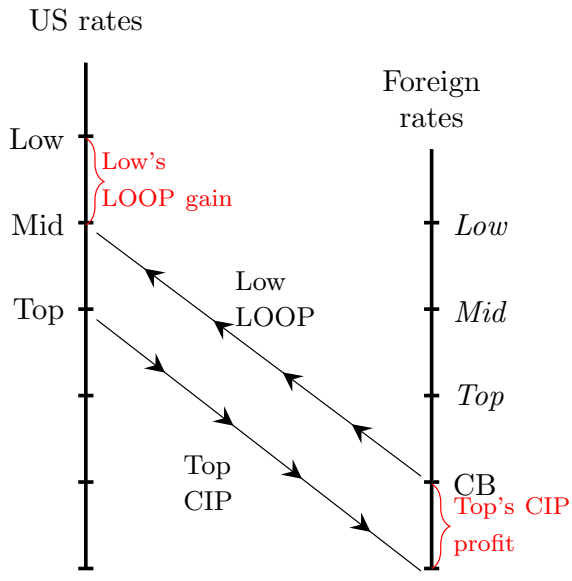
(basis points)



(b) OIS & CP-CB

FX Swap Market

(d) Excess liquidity: Equilibrium flows



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: $\beta_i = [\beta_i^{Dev}, \beta_i^{NoDev}]$

▶ More

Order flow regressions

	A-2/P-2	A-1/P-1	A-1/P-1
	(1)	(2)	(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)

Additional controls ... (see Appendix)

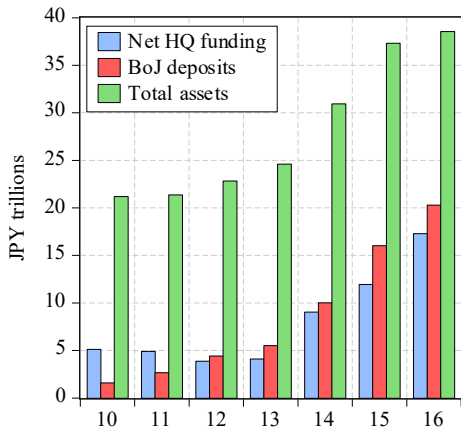
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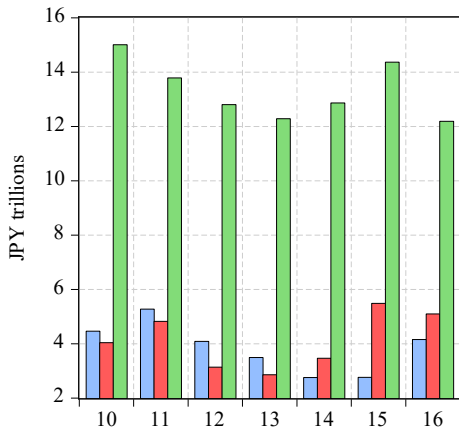
Additional controls ... (see Appendix)

Yen CIP Arbitrage

Cash deposits of foreign' banks with Bank of Japan



(a) Top-rated banks

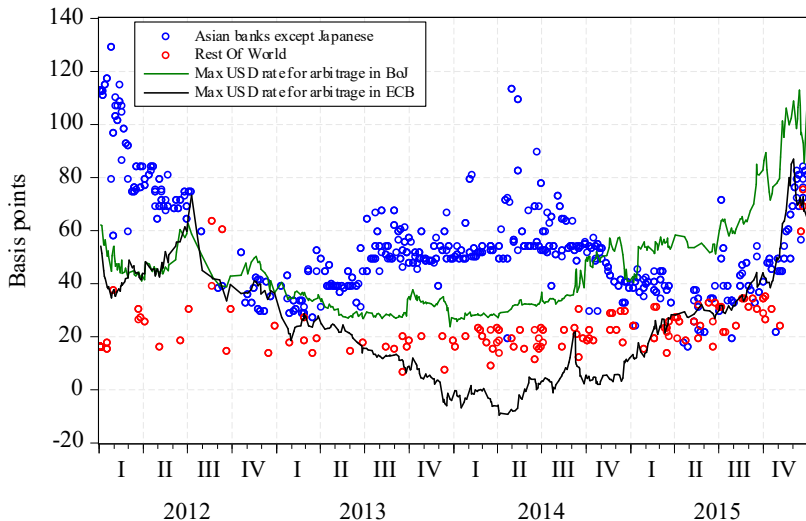


(b) Lower-rated banks

Top Banks Arb Flows are Bounded

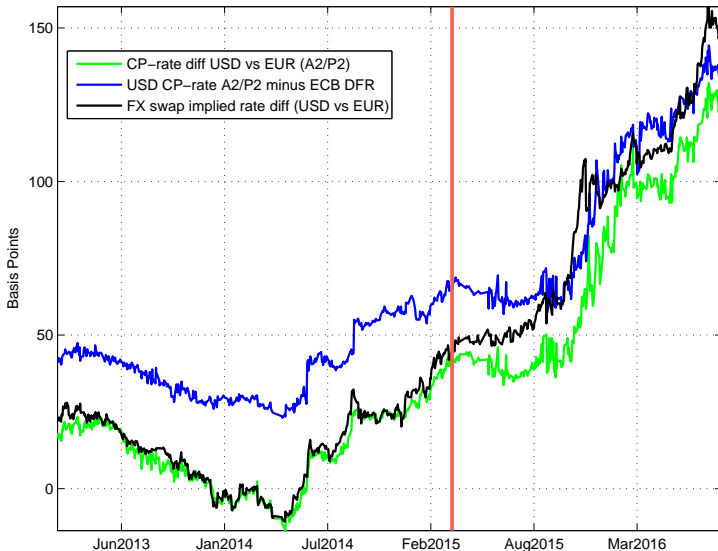
Dispersion in top-rated banks USD funding costs

(USD CD issuance)



Excess liquidity and the “new LOOP”

Some evidence from the ECB’s Asset Purchase Program



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)

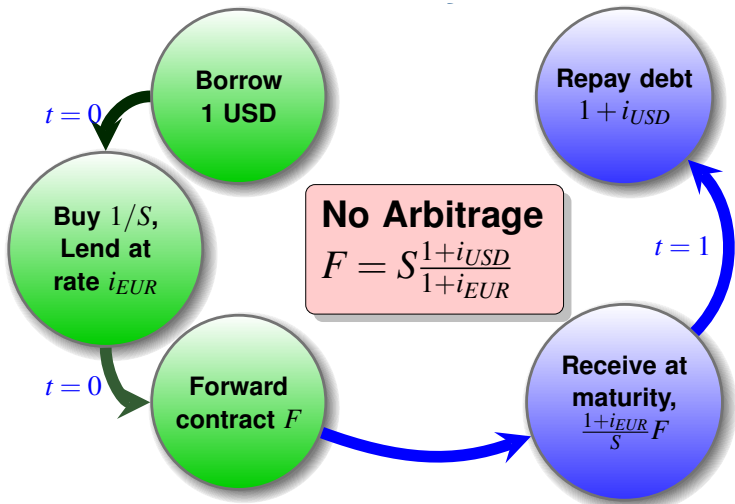
CIP and the global financial crisis

e.g. Baba, Packer, and Nagano (2008); Baba and Packer (2009); Coffey, Hrung, Nguyen, and Sarkar (2009); Goldberg, Kennedy, and Miu (2011); Griffoli and Rinaldo (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)

⇒ Large & persistent deviations, yet **no turmoil!**



CIP (LOOP) with bid-ask spreads

CIP arbitrage is *not* profitable ...

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

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

- 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

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

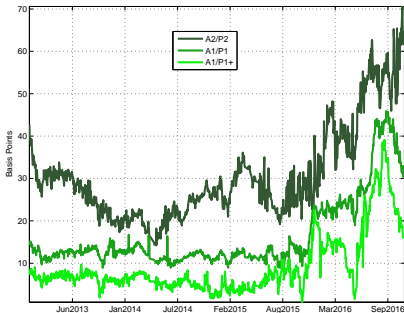
- Swap, represented by $\overline{F^b - S^a}$ (here at bid), not forward
- D – days to maturity and 10^4 – factor scaling the swap since it is quoted in “swap points”
- CIP deviation as the cross-currency basis

Part III

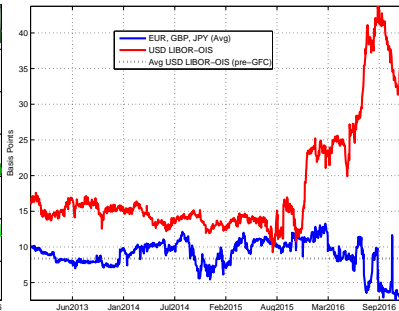
Data and Funding cost heterogeneity

Funding cost heterogeneity

US money market spreads (3-mth)



(a) USD commercial paper

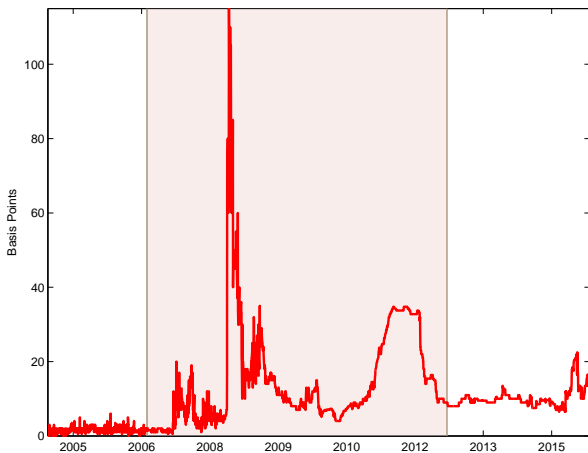


(b) USD LIBOR-OIS vs other currencies

▶ Back

Heterogenous funding costs

Evidence from the LIBOR panel



▶ Back

DR/AS/OS
CIP

Data overview

FX

	Trade-able	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
<i>Secured</i>					
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
<i>Unsecured</i>					
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

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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

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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	<i>FCU</i> \Rightarrow <i>USD</i>	-29.8	38.2	0%	0%	0%	1566
	<i>USD</i> \Rightarrow <i>FCU</i>	23.5	35.4	92%	91%	88%	1566
GBP	<i>FCU</i> \Rightarrow <i>USD</i>	-13.6	34.7	3%	2%	0%	1395
	<i>USD</i> \Rightarrow <i>FCU</i>	7.5	31.3	87%	79%	61%	1395
JPY	<i>FCU</i> \Rightarrow <i>USD</i>	-31.1	16.6	0%	0%	0%	796
	<i>USD</i> \Rightarrow <i>FCU</i>	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* \Rightarrow *FCU*" or "*FCU* \Rightarrow *USD*" at spot leg of swap

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

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

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 <i>FCU ⇒ USD</i>	-10.2	40.4	18%	14%	7%	6.9	9.6	64%	61%	56%
<i>USD ⇒ FCU</i>	2.5	38.2	61%	52%	41%	-12.3	9.5	13%	11%	7%
CAD <i>FCU ⇒ USD</i>	-13.0	37.3	1%	0%	0%	-7.7	4.0	1%	0%	0%
<i>USD ⇒ FCU</i>	6.0	31.2	88%	79%	62%	2.4	3.8	76%	67%	47%
CHF <i>FCU ⇒ USD</i>	-41.3	31.4	0%	0%	0%	-31.2	28.3	0%	0%	0%
<i>USD ⇒ FCU</i>	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

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

→ 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

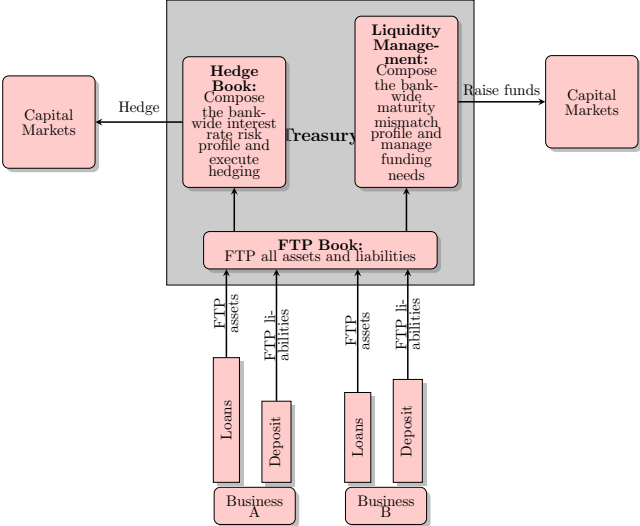
- Banks' internal pricing needs to be closely aligned with LOOP
- Otherwise, internal business units may exploit inconsistency

⇒ 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)

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

Funds Transfer Pricing



Part V

LOOP

LOOP and IBOR

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

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

		GFC and EUR crisis						Post-crisis					
		Median	Std.	Deviation			Obs.	Median	Std.	Deviation			Obs.
				(%D)	(%W)	(%M)				(%D)	(%W)	(%M)	
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

LOOP and interbank deposit

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

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

		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

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

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

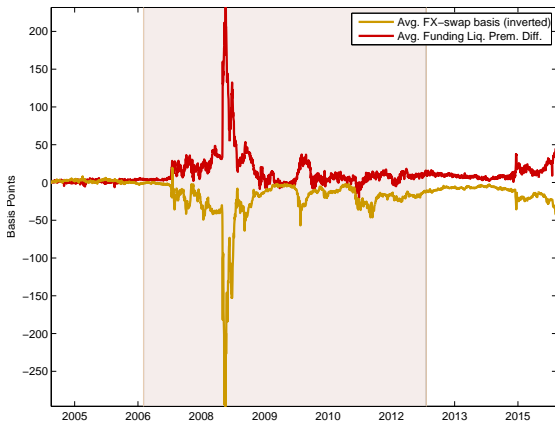
$$(ii) \quad \underbrace{y^{FCU}}_{\text{Direct FCU -rate}} - \underbrace{y^{\$ \rightarrow FCU}}_{\text{Swap-implied FCU-rate}}$$

				Deviation			
		Median	Std.	(%D)	(%W)	(%M)	Obs.
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

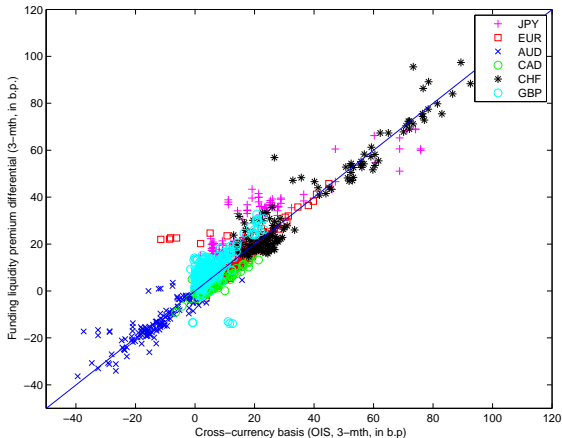
Funding Liquidity Premia

Funding liquidity premia and the basis



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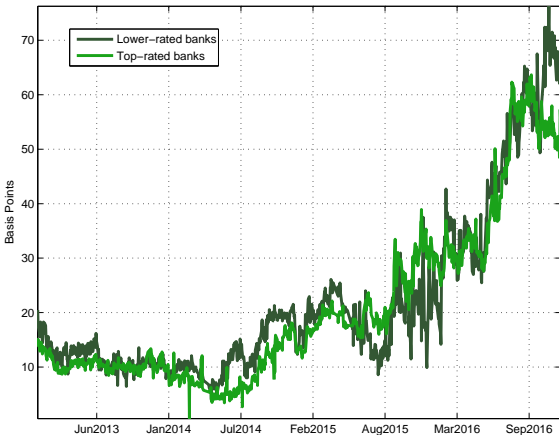
Funding liquidity premia and the basis



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Funding liquidity premia and the basis

Commercial paper



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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

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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

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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

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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

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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

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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

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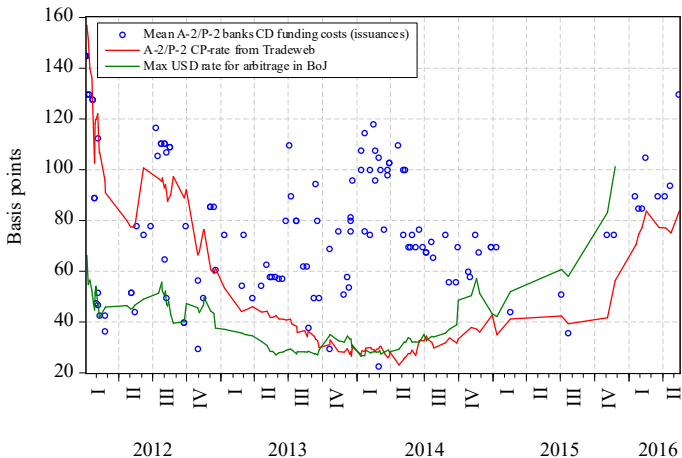
Cash deposits of foreign banks with Bank of Japan

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

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

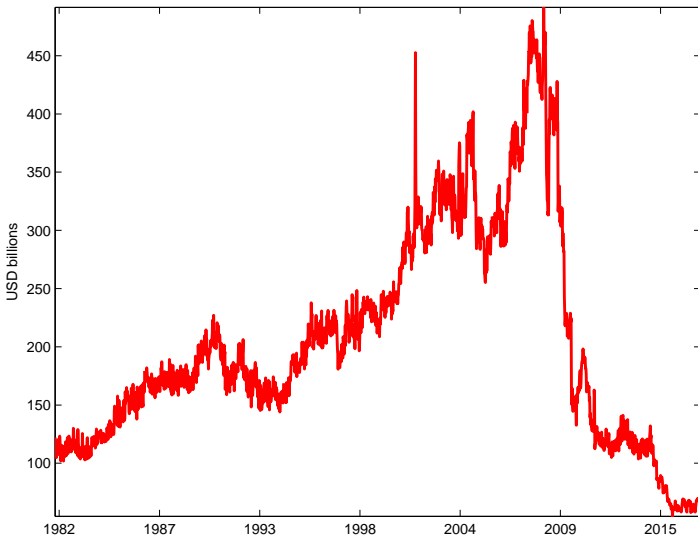
CD issuance in US Dollars

Dispersion in USD funding costs - low-rated banks



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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)
→ 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

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Order flow regressions

(Cont.)

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

OF: Robustness

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

References I

- Q. Farooq Akram, Dagfinn Rime, and Lucio Sarno. Arbitrage in the foreign exchange market: Turning on the microscope. *Journal of International Economics*, 76:237–253, 2008.
- Stefan Avdjiev, Wenxin Du, Catherine Koch, and Hyun Song Shin. The dollar, bank leverage and the deviation from covered interest parity. Working Paper 592, BIS, November 2016. URL <http://www.bis.org/publ/work592.htm>.
- Naohiko Baba and Frank Packer. Interpreting deviations from covered interest parity during the financial market turmoil of 2007-08. *Journal of Banking and Finance*, 33(11): 1953–1962, 2009. ISSN 0378-4266.

References II

- Naohiko Baba, Frank Packer, and Teppei Nagano. The spillover of money market turbulence to fx swap and cross-currency swap markets. *BIS Quarterly Review*, (1):27–42, March 2008. URL <http://ideas.repec.org/a/bis/bisqtr/1012e.html>.
- Jean-Marc Bottazzi, Jaime Luque, Mario Pascoa, and Suresh M. Sundaresan. Dollar shortage, central bank actions, and the cross currency basis. typescript, Columbia Business School, October 2012. URL <http://ssrn.com/abstract=2167716>.
- William H. Branson. The minimum covered interest differential needed for international arbitrage activity. *Journal of Political Economy*, 77(6):1028–1035, 1969.

References III

- Niall Coffey, Warren Hrung, Hoai-Luu Nguyen, and Asani Sarkar. Credit risk, liquidity risk and deviations from covered interest rate parity. Staff Report 393, Federal Reserve Bank of New York, 2009. URL https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr393.pdf.
- Wenxin Du, Alexander Tepper, and Adrien Verdelhan. Deviations from covered interest rate parity. Working paper, MIT, August 2016. URL <http://ssrn.com/abstract=2768207>.
- Jacob A. Frenkel and Richard M. Levich. Covered interest arbitrage: Unexploited profits. *Journal of Political Economy*, 83(2):325–338, 1975.
- Jacob A. Frenkel and Richard M. Levich. Transaction costs and interest arbitrage: Tranquil versus turbulent periods. *Journal of Political Economy*, 85(6):1209–1226, 1977.

References IV

- Linda S. Goldberg, Craig Kennedy, and Jason Miu. Central bank dollar swap lines and overseas dollar funding costs. *FRBNY Economic Policy Review*, pages 3–20, May 2011. URL <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.422.11&rep=rep1&type=pdf>.
- Tommaso Mancini Griffoli and Angelo Ranaldo. Deviations from covered interest parity during the crisis; a story of funding liquidity constraints. typescript, Swiss National Bank, 2009.
- Tomoyuki Iida, Takeshi Kimura, and Nao Sudo. Regulatory reforms and the dollar funding of global banks: Evidence from the impact of monetary policy divergence. Working Paper No.16-E-14, Bank of Japan, August 2016. URL https://www.boj.or.jp/en/research/wps_rev/wps_2016/data/wp16e14.pdf.

References V

- Patrick McGuire and Goetz von Peter. The dollar shortage in global banking and the international policy response. *International Finance*, 15(2):155–178, jun 2012.
- Vladyslav Sushko, Claudio Borio, Robert McCauley, and Patrick McGuire. The failure of covered interest parity: FX hedging demand and costly balance sheets. Working Paper 590, BIS, 2016. URL <http://www.bis.org/publ/work590.htm>.
- Olav Syrstad. The impact of the Term Auction Facility on the liquidity risk premium and unsecured interbank spreads. Working Paper 7/2014, Norges Bank, 2014. URL <http://www.norges-bank.no/en/Published/Papers/Working-Papers/2014/201407/>.
- Mark P. Taylor. Covered interest parity: A high-frequency, high-quality data study. *Economica*, 54(216):429–438, November 1987.