The failure of covered interest parity: FX hedging demand and costly balance sheets

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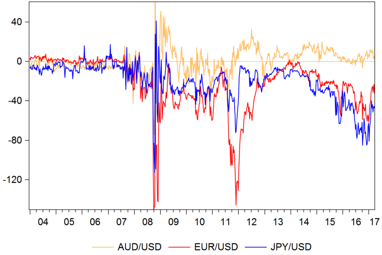
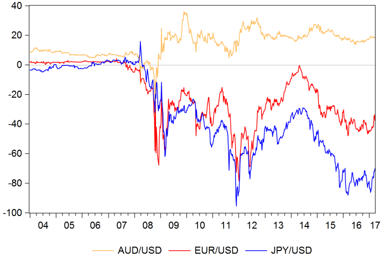
Motivation



3-month basis: b_{3m}



3-year basis: b_{3y}

- $F_t \neq S_t \left(\frac{1+r_t}{1+r_t^*}\right)$ Using different r & r^*
- Why CIP continues to fail despite low volatility and risk premia?
- Why the regime shift following the 2008-12 crisis period?

Recall: Covered interest parity

- Law of one price:
  - Interest rates used to discount cash flows in two different currencies, typically Libor or OIS rates, must be equal once currency hedging cost is taken into account
    $(1+r) = \frac{F}{S}(1+r^*)$; S and F are in dollars per foreign currency (*)

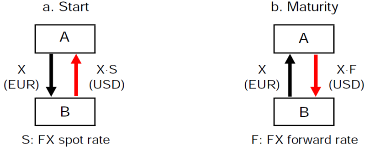
- No arbitrage condition:
  - Not possible to earn a profit by borrowing in one currency and lending in another currency while covering FX risk through a forward contract of equal maturity

    $(1+r^A) = \frac{F^A}{S^B}(1+r^{*,B})$

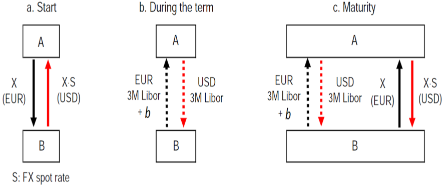
- Whether CIP holds depends crucially on F/S, which is determined in markets for currency forwards, FX swaps, and XCCY swaps

Pricing relationship between FX swaps and XCCY swaps

FX swap cash flows:



XCCY basis swap cash flows:



For a hypothetical 1-period term, the no-arbitrage relation between FX swap points and XCCY basis, b_t, can be expressed as:

$$F_{t,1} - S_t = S_t \times \frac{1 + r_{t,1} + b_{t,1}}{1 + r^*_{t,1}} - S_t$$

in logs:

$$b_t = f_t - s_t - (r_t - r^*_t)$$

$$-b_t = r_t - (f_t - s_t - r^*_t)$$

FX swap dealers: swap points, $(F_t - S_t)$

XCCY swap dealers: basis, b_t .

Source: Baba, Packer,Nagano (2008): "The spillover of money market turbulence to FX swap and cross-currency swap markets," *BIS QR* .

Related literature

CIP no-arbitrage

Frenkel / Levich (1975, 1977, 1981); Taylor (1987); Fletcher / Taylor (1996); Juhl, Miles, Weidenmier (2006) Akram, Rime, Sarno, (2008)

CIP failure due to bank credit risks & funding strains

Hanajiri (1999); Baba, McCauley, Ramaswamy (2009); Coffey, Hrung, Sarkar (2009); McGuire / von Peter (2012); Baba / Packer (2009); Cetorelli / Goldberg (2011,2012); Mancini Griffoli, Ranaldo (2012); Bottazzi, Luque, Pascoa, Sundaresan (2012); Ivashina, Scharfstein, Stein (2015)

CIP in the post-crisis period

Du, Tepper, Verdelhan (2017); Pinnington / Shamloo (2016); Iida, Kimura, Sudo (2016); Liao (2016); Wong, Ng, Leung (2016); Wong / Zhang (2017); Borio, McCauley, McGuire, Sushko (2016); Arai, Makabe, Okawara, Nagano (2016); Avdjiev, Du, Koch, Shin (2016); Rime, Schrimpf, Syrstad (2016)

This paper

Theoretically:

1. CIP fails because $(F - S)$ price-in a premia for shadow balance sheet costs
2. Small counterparty & market risks in FX swaps & XCCY swaps affect prices when scaled by the size of the positions ▸ Market size
3. Model FX swap positions as risky; results consistent with banks' P&L calculations, treatment under Basel III
   $\rightarrow$ Upward-sloping supply curve for FX swaps & XCCY swaps post-GFC

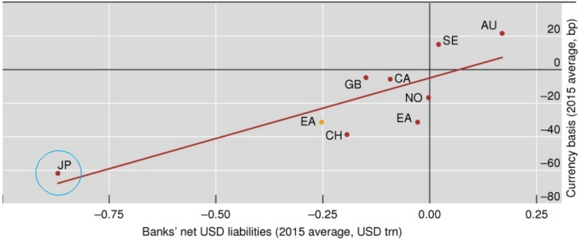
Empirically:

1. FX hedging imbalances: exogenous proxy for B/S exposure to do CIP arb.
   $\rightarrow$ Positioning of banking systems key
2. Long-run relationship between currency basis and FX hedging positions
   $\rightarrow$ CIP no-arbitrage bounds endogenous to the size of B/S risk exposure
3. Support for risk exposure premia; controlling for funding & market liquidity
4. Time-series and panel evidence, some nuance for short vs long maturities

Key: whether the banking system is positioned to provide FX hedges

Currency hedging demand and three-year basis

Banks' consolidated net USD liabilities (plus EUR reverse yankee liabilities)



AU = Australia; CA = Canada; CH = Switzerland; EA = euro area; GB = United Kingdom; JP = Japan; NO = Norway; SE = Sweden.

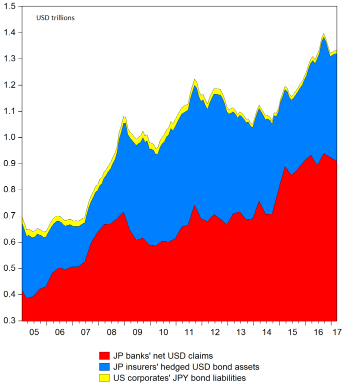
For Sweden, net euro liabilities (horizontal axis) and the SEK/EUR basis (vertical axis).

Sources: Bloomberg; BIS international banking statistics and debt securities statistics; authors' calculations.

Bank hedging of US dollar assets via FX swaps estimated as the difference between gross consolidated US dollar assets and liabilities of BIS reporting banks in each currency jurisdiction; corporate hedging demand proxied by outstanding debt securities liabilities denominated in the respective currencies issued by non-financial corporates headquartered in the US (reverse yankee bonds).

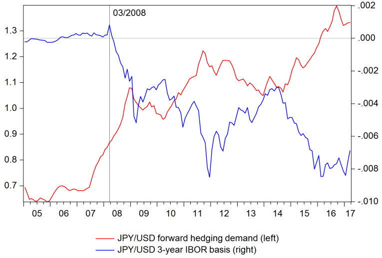
Source: Borio et al (2016): "Covered interest parity lost: understanding the cross-currency basis," *BIS Quarterly Review* , September

Yen-dollar: USD forward hedging demand out of JPY (D^{XC})

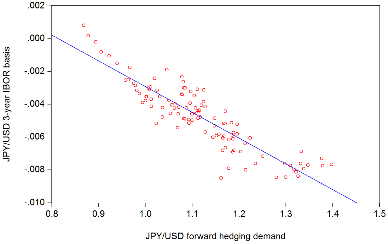


Sector & activity: Source:	Proxy
Banks' use of FX swaps to fund USD lending	BIS banks' USD funding gap (Bank^{XC})
Sources:	*BIS IBS (consolidated)* Details
Insurers' use of FX swaps to hedge USD bonds portfolio	USD bond holdings × hedge ratio (Inst^{XC})
Sources:	*MoF, SEIHO, Barclays* Details
US firms' use of FX swaps to convert JPY funding	US corporates' FX bonds outstanding (Corp^{XC})
Sources:	*BIS IDS*

FX hedging demand and the yen-dollar basis



Demand for USD forward hedge:
$D_t^{XC} = Bank_t^{XC} + Corp_t^{XC} + Inst_t^{XC}$



Scatter plot of $b_{t,3y}$ and D_t^{XC} (post-Mar 2008)

▸ Not reflected in bid-ask spreads

Test	Null Hypothesis:	Obs.	F-Stat.	Prob.
Granger-causality	$\Delta D_t^{XC} \nrightarrow \Delta b_{t,3y}^{JPY}$	109	3.233	0.043
	$\Delta b_{t,3y}^{JPY} \nrightarrow \Delta D_t^{XC}$		1.716	0.185
Cointegration	$\epsilon_t = b_{t,3y} - a - cD_t^{XC}$ is $I(1)$	109	8.730	0.000

CIP arbitrageur's problem ▸ Diagram

Chose $$ to supply via FX swaps, $x_{t,f}$:

$$\max_{x_{t,f}} \; -E_t\left[exp\left(-\rho W_{t+1}\right)\right]$$

s.t. $E_t[W_{t+1}] = W_t + (W_t - x_{t,f})r_t + [1-\theta_t]x_{t,f}(f_t^B + r_t^* - s_t^A) + \theta_t x_{t,f}(E_t[s_{t+1}^B] + r_t^* - s_t^A)$

Counterparties not 100% riskless ($\theta_t > 0$), so market risk (s_{t+1} vs f_t) relevant: ▸ CVA ▸ PFE

$\theta_t \in [0,1]$ and $E_t[s_{t+1}] \sim N(f_t, \sigma_{s,t}^2)$. ▸ Proxies

$$\Rightarrow \max_{x_{t,f}} \; W_t(1+r_t) + x_{t,f}(\underbrace{f_t^B - s_t^A}_{\text{FX points}} + r_t^* - r_t) - \underbrace{\frac{\rho}{2}\theta_t\sigma_{s,t}^2 x_{t,f}^2}_{\text{B/S cost}}$$

$\frac{\rho}{2}\theta_t\sigma_{s,t}^2 x_{t,f}^2$: MtM risks, counterparty risks, CVA charges, initial margins for XCCY basis swaps, B/S management under VaR constraint (see, eg Shin (2010))

Market-clearing FX forward rate & the endogenous no-arbitrage bounds:

$$\Rightarrow f_t^B = s_t^A + r_t - r_t^* + \underbrace{\rho\theta_t\sigma_{s,t}^2 D_t^{XC}}_{\text{B/S cost of risk}}, \text{ where } x_{t,f} = D_t^{XC} \text{ by market clearing}$$

D_t^{XC}: FX hedging demand imbalances
$\rho\theta_t\sigma_{s,t}^2$: marginal cost of B/S exposure to FX hedges

Fraction c of CIP arbitrageurs liquidity constrained/operates via repo markets, r_t^{REPO}:

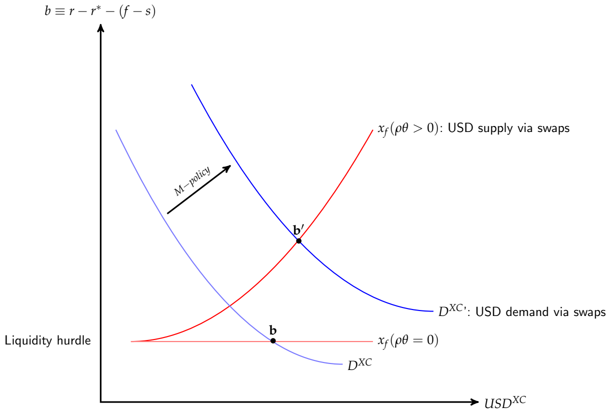
$$f_t^B = s_t^A + r_t - r_t^* + \rho\theta_t\sigma_{s,t}^2 D_t^{XC} + \underbrace{c[(r_t^{REPO} - r_t) - (r_t^{*,REPO} - r_t^*)]}_{\text{Funding liquidity}}$$

Derivation

Expressing in terms of mid-rates $((f_t - s_t) \equiv 1/2 \times [(f_t^B - s_t^A) + (f_t^A - s_t^B)])$:

$$f_t = s_t + r_t - r_t^* + \underbrace{\rho\theta_t\sigma_{s,t}^2 D_t^{XC} + c[(r_t^{REPO} - r_t) - (r_t^{*,REPO} - r_t^*)] + \underbrace{[(f_t^B - s_t^A) - (f_t^A - s_t^B)]/2}_{\text{FX market liquidity}}}_{\text{Currency basis/no-arbitrage bounds}}$$

Market-clearing currency basis: b



$$-b = \underbrace{\rho\theta\sigma_s^2 D^{XC}}_{} + \text{Liquidity hurdle}$$

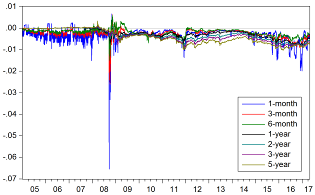
▸ Capital/collateral against potential losses

JPY/USD time series

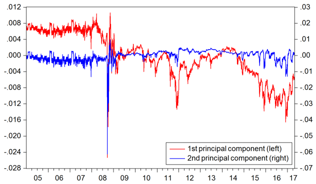
Yen-dollar IBOR basis PCA: *risk exposure factor* & *liquidity factor*

Q-end,LR,LCR

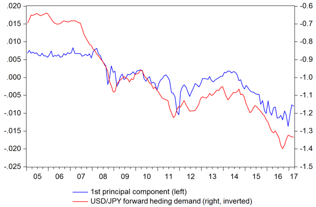
IBOR-basis, 1-month to 5-year



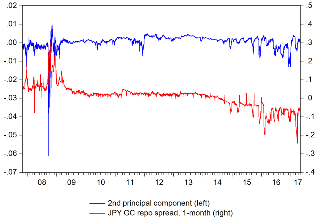
PC1 (68.2%) & PC2 (24.7%)



Risk exposure factor: PC1 & D_t^{XC}



Liquidity factor: PC2 & $(r_t^{*,REPO} - r_t^*)$



Empirical proxies

Proximate source:	Notation	Proxy
FX hedging demand:	D_t^{XC} (prices)	(OAS^{US}-OAS^{JP});
	D_t^{XC} (quantities)	Bank^{XC}+Inst^{XC}+Corp^{XC}
	ΔD_t^{XC} (quantities)	$100 \times (D_t^{XC}/D_{t-1}^{XC} - 1)$
	ΔCAB_t^{XC} (quantities, supply side)	$100 \times (CAB_t^{XC}/CAB_{t-1}^{XC} - 1)$
Bank credit risk:	θ	Libor-OIS spreads
Implied FX volatility:	$\rho\sigma_s^2$	FX option-implied volatility
Short-selling costs:	$(r_t^{REPO} - r_t) - (r_t^{*,REPO} - r_t^*)$	GC repo spreads, US minus JP
Transaction costs:	$[(f_t^B - s_t^A) - (f_t^A - s_t^B)]/2$	Spot and forward bid-ask spreads

3-year JPY/USD basis: long-run vs short-run drivers

Unit root tests, Cointegration tests

$$\Delta b_{t,3y} = \beta_0 + \sum \beta_i \Delta b_{t-i,3y} + \beta_D \Delta D^{XC}_{t-1} + \phi \hat{z}_{t-1}$$
$$+ \beta_{Repo} \Delta \left[(r^{REPO}_{t-1} - r_{t-1}) - (r^{*,REPO}_{t-1} - r^{*}_{t-1}) \right] + \sum \beta_j \Delta X_{j,t} + \epsilon_t$$
$$b_{t,3y} = \alpha_0 + \alpha_D D^{XC}_t + z_t$$

- $\hat{z}_{t-1} = b_{t-1,3y} - \hat{\alpha}_D D^{XC}_{t-1} - \hat{\alpha}_0$ denotes lagged residuals from the long-run cointegration regression
- Prediction:
  - B/S risk exposure a long-run driver: $\beta_D = 0$, $\phi < 0$, and $\alpha_D < 0$
  - Liquidity a short-run driver: $\beta_{Repo} < 0$

3-year JPY/USD basis: long-run vs short-run drivers

	Error-correction equation		Cointegrating equation	
	(1)	(2)		(3)
$\Delta b_{t-1,3y}$	0.163**	0.189***		
	(0.088)	(0.085)		
$\Delta b_{t-2,3y}$	-0.004	-0.061		
	(0.091)	(0.095)		
ΔD^{XC}_{t-1}	0.000	0.002	D^{XC}_{t}	-0.018***
	(0.003)	(0.003)		(0.001)
$\hat{z}_{t-1}$	-0.232***	-0.236***		
	(0.063)	(0.060)		
ΔRepo spread diff.$_{t-1}$	-0.003***	-0.003***		
	(0.001)	(0.001)		
$\Delta\theta_t$		0.000		
		(0.000)		
$\Delta\rho\sigma^2_{s,t}$		-0.002***		
		(0.001)		
FX bid-ask		0.227		
		(0.265)		
Constant	0.000	0.000		0.120***
	(0.000)	(0.000)		(0.006)
R-squared	0.282	0.380	R-squared	0.816
Observations	108	108	Observations	109

Monthly frequency, 03/2008 to 03/2017. Number of lags of the endogenous variable chosen based on the Schwarz (Bayes) criterion (SC). Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

JPY/USD time-series regressions, short- and long-maturities

$$\begin{aligned}
\Delta b_t &= \beta_\theta \Delta\theta_t + \beta_\sigma \Delta\rho\sigma^2_{s,t} + \beta_D \Delta D^{XC}_t + \beta_{\theta\times\sigma\times D}[\Delta\theta_t \times \Delta\rho\sigma^2_{s,t} \times \Delta D^{XC}_t] \\
&+ \beta_{Repo}\Delta\left[(r^{REPO}_{t-1} - r_{t-1}) - (r^{*,REPO}_{t-1} - r^{*}_{t-1})\right] \\
&+ \beta_{bid-ask}\Delta[(f^B_t - s^A_t) - (f^A_t - s^B_t)]/2 + \alpha + \epsilon_t
\end{aligned}$$

3-month JPY/USD IBOR-based CIP deviations

3-month JPY/USD basis	(1)	(2)	(3)	(4)
θ	-0.909***	-0.905***	0.001	-0.128
	(0.216)	(0.206)	(0.271)	(0.270)
D^{XC}		-0.150	-0.132	-0.123
		(0.107)	(0.101)	(0.114)
$\theta \times D^{XC}$			-1.138***	
			(0.340)	
$\rho\sigma_S^2 \times \theta \times D^{XC}$				-0.941***
				(0.345)
$\rho\sigma_S^2$				-0.053
				(0.108)
Repo spread diff.	-0.255*	-0.270*	-0.388***	-0.429***
	(0.149)	(0.154)	(0.118)	(0.151)
FX bid-ask	0.397***	0.430***	0.380***	0.408***
	(0.136)	(0.128)	(0.096)	(0.112)
Constant	-0.315***	-0.249**	-0.227***	-0.214***
	(0.100)	(0.100)	(0.083)	(0.079)
Observations	72	67	67	67
R-squared	0.679	0.725	0.794	0.776

The table reports coefficients based on regressions using standardized variables (zero mean, unit variance). Monthly frequency, 12/2007 to 04/2016. AR(1) not significant in first differences. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

2-year JPY/USD cross-currency swap basis

2-year JPY/USD basis	(1)	(2)	(3)	(4)
θ	-0.463***	-0.480***	-0.296	-0.382***
	(0.172)	(0.127)	(0.386)	(0.109)
D^{XC}		-0.292**	-0.281**	-0.221*
		(0.125)	(0.123)	(0.120)
$\theta \times D^{XC}$			-0.228	
			(0.454)	
$\rho\sigma_S^2 \times \theta \times D^{XC}$				-0.228*
				(0.132)
$\rho\sigma_S^2$				0.104
				(0.164)
Repo spread diff.	-0.759***	-0.839***	-0.857***	-0.709***
	(0.201)	(0.194)	(0.192)	(0.254)
FX bid-ask	-0.381	-0.714	-0.588	-0.372
	(0.970)	(0.936)	(0.920)	(0.925)
Constant	-0.004	-0.066	-0.059	-0.047
	(0.134)	(0.131)	(0.132)	(0.126)
Observations	72	67	67	67
R-squared	0.425	0.506	0.509	0.531

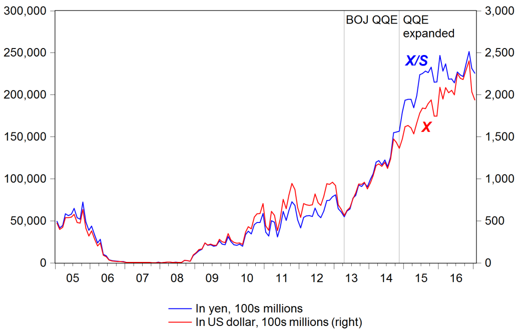
The table reports coefficients based on regressions using standardized variables (zero mean, unit variance). Monthly frequency, 12/2007 to 04/2016. AR(1) not significant in first differences. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

▸ Using price-based proxies

Using changes in arbitrageur positioning $x_{t,f}$

Global banks utilize their access to CB deposit facilities to park JPY when providing USD via FX swaps. $x_{t,f}$ is an endogenous proxy for D_t^{XC}.

Excess current account balances of foreign banks at the Bank of Japan



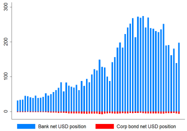
JPY/USD CIP deviations, using foreign bank excess reserves as a proxy for x_f

3-month JPY/USD basis	(1)	(2)	(3)
θ	-0.909***	-0.759***	-0.037
	(0.216)	(0.133)	(0.096)
x_f		-0.473***	0.042
		(0.116)	(0.088)
$\rho\sigma_s^2 \times \theta \times x_f$			-1.035***
			(0.116)
$\rho\sigma_s^2$			0.105*
			(0.060)
Repo spread diff.	-0.255*	-0.433***	-0.183***
	(0.149)	(0.141)	(0.061)
FX bid-ask	0.397***	0.145	0.157**
	(0.136)	(0.092)	(0.063)
Constant	-0.315***	-0.210**	-0.230***
	(0.100)	(0.088)	(0.075)
Observations	72	72	72
R-squared	0.679	0.733	0.844

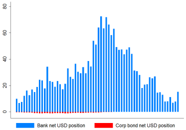
The table reports coefficients based on regressions using standardized variables (zero mean, unit variance). Monthly frequency, 12/2007 to 04/2016. AR(1) not significant in first differences. Robust standard errors in parentheses: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Panel of currencies: AUD, CAD, CHF, DKK, EUR, GBP, JPY, NOK, and SEK

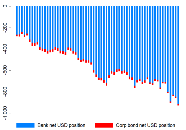
Australia ▸ AUD



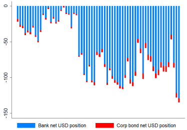
Denmark (DKK)



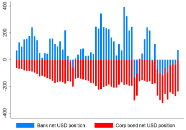
Japan ▸ JPY



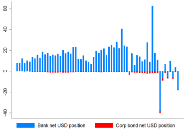
Canada (CAD)



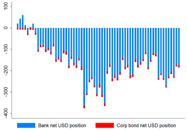
Euro area ▸ EUR



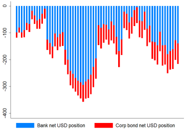
Norway (NOK)



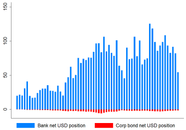
Switzerland ▸ CHF



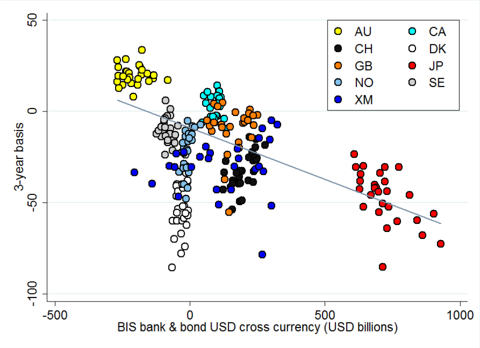
United Kingdom (GBP)



Sweden (SEK)



Panel of currencies: AUD, CAD, CHF, DKK, EUR, GBP, JPY, NOK, and SEK



$b_{t,3y}$ and $D_t^{XC} \equiv Bank_t^{XC} + Bond_t^{XC}$

AU = Australia, CA = Canada, CH = Switzerland, DK = Denmark, GB = United Kingdom, JP = Japan, NO = Norway, SE = Sweden, XM = Euro area. ▸ Price-based proxy

Fixed effects panel regressions:

$$\begin{aligned}
\Delta\hat{b}_{t,i} &= \beta_\theta \times \Delta\theta_{t,i} + \beta_\sigma \times \Delta\rho\sigma^2_{s,t,i} + \beta_D \times \Delta D^{XC}_{t,i} \\
&+ \beta_{\theta\times\sigma\times D} \times [\Delta\theta_{t,i} \times \Delta\rho\sigma^2_{s,t,i} \times \Delta D^{XC}_{t,i}] \\
&+ \beta_{Repo} \times \Delta\left[(r^{REPO}_{t,i} - r_t) - (r^{*,REPO}_{t-1,i} - r^*_{t-1,i})\right] \\
&+ \beta_{bid-ask} \times \Delta[(f^B_{t,i} - s^A_{t,i}) - (f^A_{t,i} - s^B_{t,i})]/2 + \alpha_i + \epsilon_{t,i}
\end{aligned}$$

Panel regressions: AUD, CAD, CHF, DKK, EUR, GBP, JPY, and SEK

3-month currency basis	(1)	(2)
θ	-0.406***	-0.408***
	(0.058)	(0.073)
D^{XC}		0.038
		(0.036)
$\rho\sigma_s^2 \times \theta \times D^{XC}$		-0.091***
		(0.024)
$\rho\sigma_s^2$		-0.240**
		(0.084)
Repo spread diff.	-0.215**	-0.230**
	(0.073)	(0.077)
FX bid-ask	0.322***	0.314***
	(0.068)	(0.057)
Constant	-0.014**	-0.018**
	(0.006)	(0.007)
Observations	312	303
R-squared	0.293	0.358
Currency pairs	8	8
Fixed effects	yes	yes
Clustered standard errors	yes	yes

The table reports coefficients based on regressions using standardized variables (zero mean, unit variance). Quarterly frequency, Q1/2000 to Q4/2015. AR(1) not significant. Clustered robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Panel regressions: AUD, CAD, CHF, DKK, EUR, GBP, JPY, and SEK

2-year currency basis	(1)	(2)
θ	-0.373**	-0.229*
	(0.135)	(0.104)
D^{XC}		0.029
		(0.046)
$\rho\sigma_S^2 \times \theta \times D^{XC}$		-0.160**
		(0.054)
$\rho\sigma_S^2$		-0.337**
		(0.110)
Repo spread diff.	0.006	-0.111
	(0.128)	(0.122)
FX bid-ask	0.229*	0.497**
	(0.110)	(0.179)
Constant	-0.019***	-0.014**
	(0.002)	(0.005)
Observations	294	222
R-squared	0.177	0.291
Currency pairs	8	8
Fixed effects	yes	yes
Clustered standard errors	yes	yes

The table reports coefficients based on regressions using standardized variables (zero mean, unit variance). Quarterly frequency, Q1/2000 to Q4/2015. AR(1) not significant. Clustered robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Conclusion

Main drivers of CIP failure:

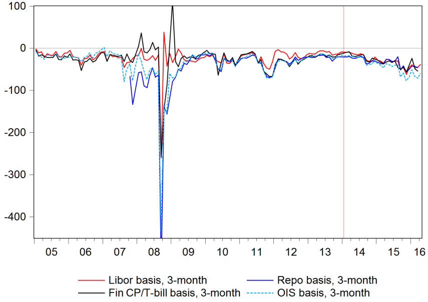
1. **Imbalances in FX hedging positions**
   - Banks' FX funding models key to how well FX hedging markets clear
2. **Re-pricing of balance sheet capacity** + clearing FX hedging imbalances

   → Mkt-clearing $(F - S)$ includes a premia for counterparty & mkt risk

   → "Dislocations" in FX swap markets when exposures are large
3. New normal:
   - Banks' risk-management, P&L calculations, and regulations account for *potential losses* on FX swaps/XCCY swaps
   - CIP arbitrage / trading against FX hedging imbalances translates into "risky exposures"
   - CIP no-arb bounds endogenous to imbalances in FX hedging mkts

Swap points out of line with money market rates

- Libor-basis narrower than OIS basis because accounts for bank liquidity credit risk
- Post-2014, Libor, Repo, and CP/T-bill basis line-up
- Swap points out of line with money market rates, regardless of which rates are used
- So, focus on $(F - S)$



Note: To be exact, T-day CIP deviations in basis points calculated as: $CIP_T^{Dev} = 10^4 \times \left(1 + \frac{r_T}{100} - (1 + \frac{r_T^*}{100}) \times \frac{F_T}{S}^{360/T}\right)$

Swap market size and users across instruments & maturities

Back

- FX swaps are the modal instrument, $2.4 trn/day: accounted for 47% of global FX turnover in April 2016 (+ forwards XCCY swaps, 63%)
- US dollar is on one side of 91% of FX swap transactions
- Trading in FX swaps with institutional investors rose 79% since 2013
- XCCY swaps notional about $20 trn, forwards and FX swaps about $30 trn

	Bank treasuries/ALM		**Corporates**		**Supras/Agencies**		**Pension funds**	
	Market share	Product	Market share	Product	Market share	Product	Market share	Product
0-3 month	++	Fx Sw	+	Fx Sw+ Out	+	Fx Sw	+++	Fx Sw
3mo-1yr	+++	Fx Sw	+	FX Out			+	Fx Sw
1y1y	++	Fx Sw, XCCY	+	FX Out				
2y10y	+++	XCCY	+++	FX Out<5 XCCY>5	++++	XCCY	+	XCCY
>10y	+++	XCCY	+++	XCCY	++++	XCCY		

	Bank IRS desks		**CB**		**Asset managers**		**HF**	
	Market share	Product	Market share	Product	Market share	Product	Market share	Product
0-3 month			++	Fx Sw	+++	Fx Sw		
3mo-1yr			++	Fx Sw	++	Fx Sw	++	XCCY
1y1y							++	XCCY
2y10y	+	XCCY					+	XCCY
>10y	+++	XCCY						

Sources: FX/XCCY Swap market overview, BNP Paribas Fixed Income, 9 September, 2014; BIS data.

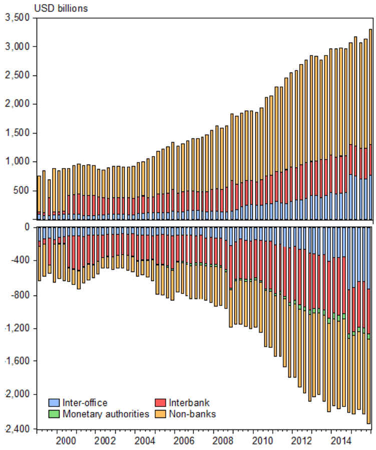
During the financial crisis, banks suffered significant counterparty credit risk (CCR) losses on their OTC derivatives portfolios. **The majority of these losses came not from counterparty defaults but from fair value adjustments on derivatives.** *The value of outstanding derivative assets was written down as it became apparent that counterparties were less likely than expected to meet their obligations.*

Basel Committee on Banking Supervision, Consultative Document, July 2015

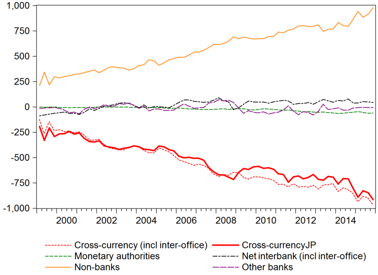
Banks seem to have progressively converged in reflecting the cost of the credit risk of their counterparties in the fair value of derivatives *[...]. This convergence is the result of industry practice, as well as a consequence of the implementation in the EU of IFRS 13 and the Basel CVA framework.*

European Banking Authority Report on CVA, February 2015 Back

USD cross-currency position of JP banks: $Bank_t^{XC}$



Net USD foreign positions by counterparty

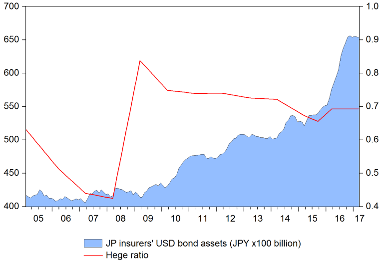


- BIS consolidated statistics (immediate borrower basis)
- BIS locational statistics by nationality
- Implied cross-currency funding (ie FX swaps) equates gross US dollar assets and liabilities

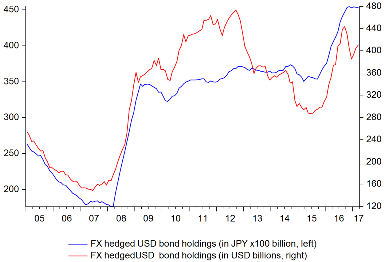
Back

For details, see McGuire, P and G von Peter (2009) "The US dollar shortage in global banking", *BIS Quarterly Review*, March

USD forward hedges of JP life insurers: $Inst_t^{XC}$



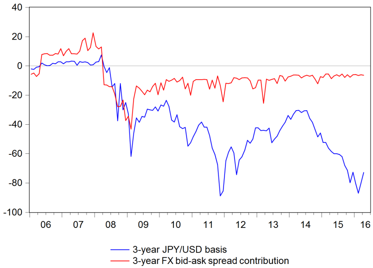
Stock of FX bonds & hedge ratio



FX hedged bond holdings

- Stock benchmarked from The Life Insurance Association of Japan reports
- Monthly flows based on reports of insurance sector purchases and sales of foreign long-term debt securities by residence (MoF tables)
- Hedge ratios sourced from Barclays Back

Not a dealer intraday inventory risk problem...



$$r_t - (r_t^* + f_t^B - s_t^A) = r - (r^* + f_t - s_t) - \frac{1}{2}[(f_t^B - s_t^A) - (f_t^A - s_t^B)]$$

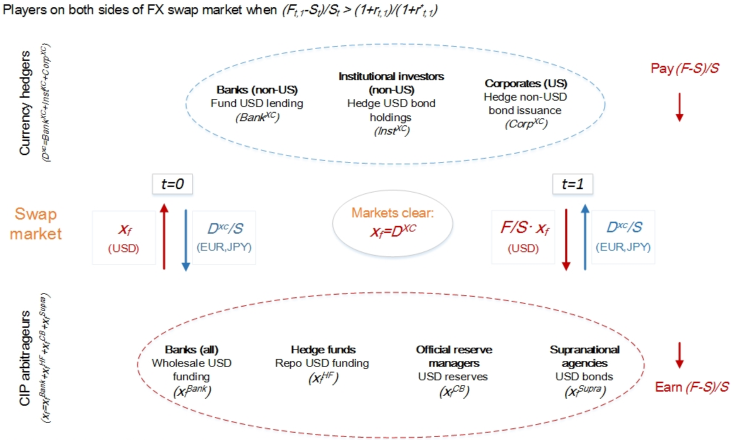
where

$$(f_t - s_t) \equiv \frac{1}{2}[(f_t^B - s_t^A) + (f_t^A - s_t^B)]$$

- D_t^{XC} NOT reflected in the contribution of swap bid-ask spreads
- Premium on the stock of B/S exposure to D_t^{XC} priced into $(f_t - s_t)$ Back

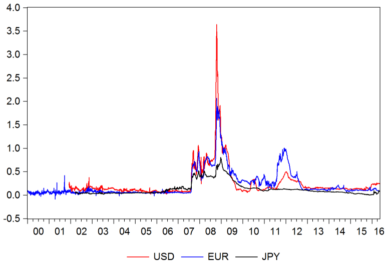
Onus on supply/demand in swap markets ▸ Back

FX swap flows when net USD forward position of FX hedgers is negative

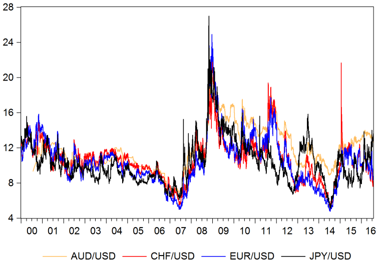


S: spot rate, in units of USD per foreign currency
F: currency forward rate, in units of USD per foreign currency
D^{XC}: total demand for USD via FX swaps $(D^{XC}=Bank^{XC}+Inst^{XC}+Corp^{XC})$
X_f: total supply of USD via FX swaps $(x_f=x_f^{Bank}+x_f^{HF}+x_f^{CB}+x_f^{Supra})$

Proxies for θ and $\rho\sigma_s^2$



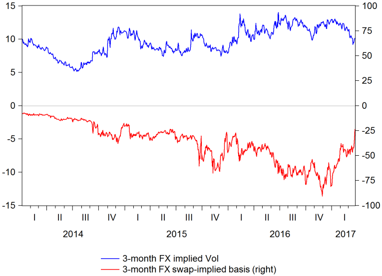
3-month Libor-OIS spreads: θ



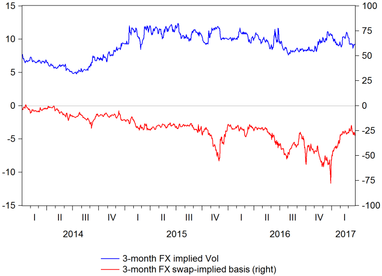
3-month FX option-implied volatility: $\rho\sigma_s^2$

▶ Back

Currency option-implied volatility, as a proxy for MtM risk, and the basis



$\rho\sigma_s^2$ and b, USD/JPY



$\rho\sigma_s^2$ and b, USD/EUR

Back

Adjusting for market risk in the presence of counterparty risk

$$
\begin{aligned}
E_t[W_{t+1}|\theta_t > 0] - E_t[W_{t+1}|\theta_t = 0] &= [1-\theta_t]x_{t,f}(f_t^B - s_t^A + r_t^* - r_t) \\
&+ \theta_t x_{t,f}(E_t[s_{t+1}^B] - s_t^A + r_t^* - r_t) \\
&- x_{t,f}(f_t^B - s_t^A + r_t^* - r_t) \\
&= \theta_t x_{t,f}(E_t[s_{t+1}^B] - f_t^B)
\end{aligned}
$$

- Credit Valuation Adjustment (CVA): adjustment to the fair value (or price) of derivative instruments to account for counterparty credit risk
- A unilateral CVA given by the product of the probability of counterparty default and the contract value at the time of default
- A bank must have a CVA desk (or a similar dedicated function). Capital requirement for CVA risk (counterparty credit risk + exposure risk) calculated for all covered transactions (BCBS, 2015)
- Risk charges managed by posting collateral (2-way CSA), subject to haricuts & additional collateral required if MtM of the swap is negative Back

Bank have to add $PFE = \gamma x_{t,f}$ adjustment to total exposure calculation in the leverate ratio, L, reporting (Basel III, US SLR). So, equity, E_t, has to satisfy:

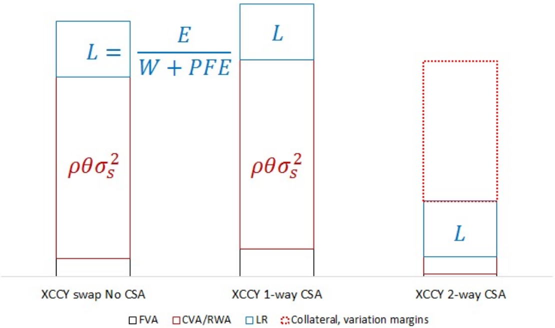
$$\begin{aligned} \frac{E_t}{W_t + PFE} &= L, \\ \Rightarrow E_t &= LW_t + L\gamma x_{t,f} \end{aligned}$$

If L was binding when $x_{t,f} = 0$, then finance $L\gamma x_{t,f}$ by raising additional capital.

γ by category:	$<$ 1-year	1-5 years	$>$ 5-year
FX and gold:	0.01	0.05	0.075
Interest rate:	0.00	0.005	0.015
Credit (IG):	0.05	0.05	0.05
Credit (HY):	0.10	0.10	0.10
Equity:	0.06	0.08	0.10

Notes: table sourced from Supplementary leverage ratio, Davis Polk Wardwell LLP, September 12, 2014. Back

Relationship to factors driving the pricing of an OTC derivative



Additional costs for a EUR/USD XCCY swap

Notes: illustration borrowed from Motte F (2015): Impacts of regulations on derivatives markets, dealers perspective, HSBC. Back

Asymmetric liquidity conditions/secured funding costs

Fraction c of CIP arbitrageurs liquidity constrained, so fund in repo markets at r_t^{REPO} (Mancini Griffoli and Ranaldo, 2012).

Then the objective function includes a short-selling costs (Gromb and Vayanos, 2010):

$$\max_{x_{t,f}} \; W_t + (W_t - x_{t,f}(1-c))r_t + x_{t,f}(f^B - s_t^A + r_t^*) - \frac{\rho}{2}\theta_t x_{t,f}^2 \sigma_s^2 - x_{t,f} r_t^{REPO} c$$

Market-clearing forward rate:

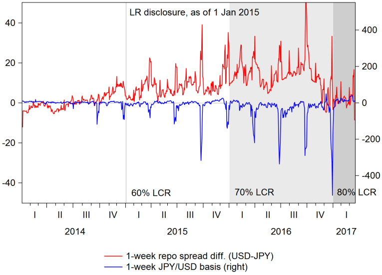
$$\Rightarrow f_t^B = s_t^A + r_t - r_t^* + \theta_t \rho \sigma_s^2 D_t^{XC} + c(r_t^{REPO} - r_t)$$

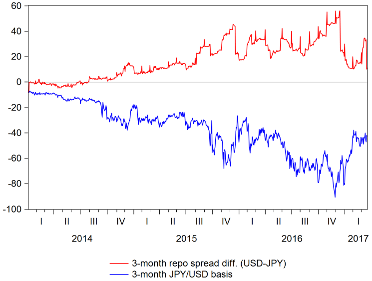
If repo used also in the investment leg, then:

$$f_t^B = s_t^A + r_t - r_t^* + \theta_t \rho \sigma_s^2 D_t^{XC} + c[(r_t^{REPO} - r_t) - (r_t^{*,REPO} - r_t^*)]$$

Back

PC2 relates to asymmetric liquidity conditions, $(r_t^{REPO} - r_t) - (r_t^{*,REPO} - r_t^*)$





- B/S management under the leverage ratio (Du et al, 2016; Arai et al, 2016)
- PFE add-on factors under Basel III and US SLR; LCR by currency
- Q-end window dressing, difficult to place JPY cash at Q-ends Back

Long-run relationship between JPY/USD currency basis & D^{XC}

- Forward points, $(F_t - S_t)$, price in *risk exposure premium*

  $\Rightarrow$ Breakdown of cointegration between F_t, S_t, r_t and r_t^*

- Cointegration recovered by accounting for D_t^{XC}.

	Cointegration		
Johansen cointegration test (H_1):	P-value	Trace stat	5% Critical value
$\epsilon_t = F_{t,3y} - a - bS_t - cr_t^* + dr_t$ is $I(0)$	0.526	33.568	47.856
$\epsilon_t = F_{t,3y} - a - bS_t - cr_t^* + dr_t - eD_t^{XC}$ is $I(0)$	0.037	71.435	69.819
$\epsilon_t = b_{t,3y} - a - cD_t^{XC}$ is $I(0)$	0.023	17.679	15.495
ARDL bounds test (H_1):	P-value	F-stat	5% Critical value
$\epsilon_t = b_{t,3y} - a - cD_t^{XC}$ is $I(0)$	0.000	8.730	5.730

Monthly frequency: 01/2005 to 03/2017. ADF test and Breakpoint unit root tests reject the null for $b_{t,3m}$, p-values 0.093 and 0.01, respectively. ADF test and Breakpoint unit root tests fail to reject the null for $b_{t,3y}$, p-values 0.730 and 0.785, respectively. ADF test and Breakpoint unit root tests fail to reject the null for D_t^{XC}, p-values 0.615 and 0.358, respectively. Back

Robustness check using $D^{XC} = OAS^{US} - OAS^{JP}$, 3-month JPY/USD basis

3-month JPY/USD basis	(1)	(2)	(3)	(4)
θ	-113.620***	-112.440***	-42.195***	-34.265*
	(26.952)	(28.476)	(13.518)	(17.186)
D^{XC}		-1.769	-3.752	-7.464
		(12.643)	(7.542)	(7.568)
$\theta \times D^{XC}$			-92.246***	
			(10.298)	
$\rho\sigma_S^2 \times \theta \times D^{XC}$				-6.687***
				(0.912)
$\rho\sigma_S^2$				1.112
				(0.716)
Repo spread diff.	-29.301*	-29.955	-42.413***	-42.537***
	(17.148)	(19.867)	(12.768)	(13.798)
FX bid-ask	2.160***	2.177***	0.835	0.978**
	(0.737)	(0.776)	(0.502)	(0.474)
Constant	-19.420***	-19.379***	-20.239***	-31.549***
	(2.535)	(2.583)	(2.376)	(7.433)
Observations	72	72	72	72
R-squared	0.679	0.679	0.815	0.818

The table reports coefficients based on regressions using standardized variables (zero mean, unit variance). Monthly frequency, 12/2007 to 04/2016. AR(1) not significant in first differences. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Robustness check using $D^{XC} = OAS^{US} - OAS^{JP}$, 2-year JPY/USD basis

2-year JPY/USD basis	(1)	(2)	(3)	(4)
θ	-15.675***	-12.316*	-0.845	-4.470
	(5.825)	(6.280)	(5.633)	(4.301)
D^{XC}		-4.745	-5.611*	-3.778
		(3.784)	(3.299)	(3.420)
$\theta \times D^{XC}$			-15.233***	
			(4.361)	
$\rho\sigma_S^2 \times \theta \times D^{XC}$				-9.940***
				(2.465)
$\rho\sigma_S^2$				0.623
				(0.763)
Repo spread diff.	-23.634***	-25.570***	-26.716***	-23.268***
	(6.252)	(6.740)	(5.823)	(6.922)
FX bid-ask	-0.093	-0.072	-0.047	-0.020
	(0.237)	(0.243)	(0.235)	(0.230)
Constant	-0.312	-0.364	0.272	0.265
	(0.776)	(0.776)	(0.765)	(0.775)
Observations	72	72	72	72
R-squared	0.425	0.446	0.506	0.505

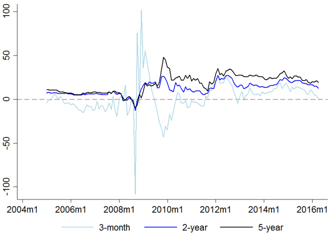
The table reports coefficients based on regressions using standardized variables (zero mean, unit variance). Monthly frequency, 12/2007 to 04/2016. AR(1) not significant in first differences. Robust standard errors in parentheses: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Back

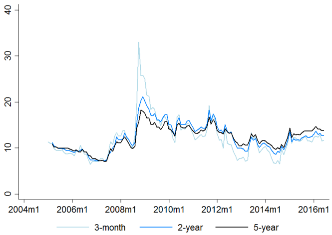
AUD/USD currency basis and option-implied volatility, compared to net USD positioning of Australian banks and AUD debt of US corporates

Back

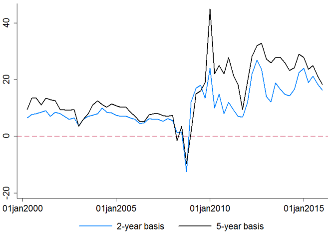
AUD/USD basis



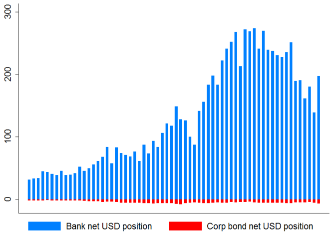
AUD/USD implied vol



AUD/USD long-term basis

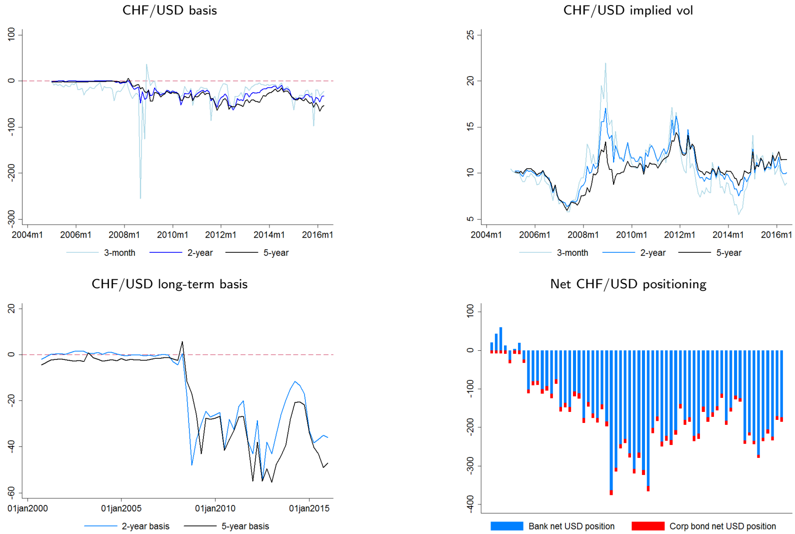


Net AUD/USD positioning



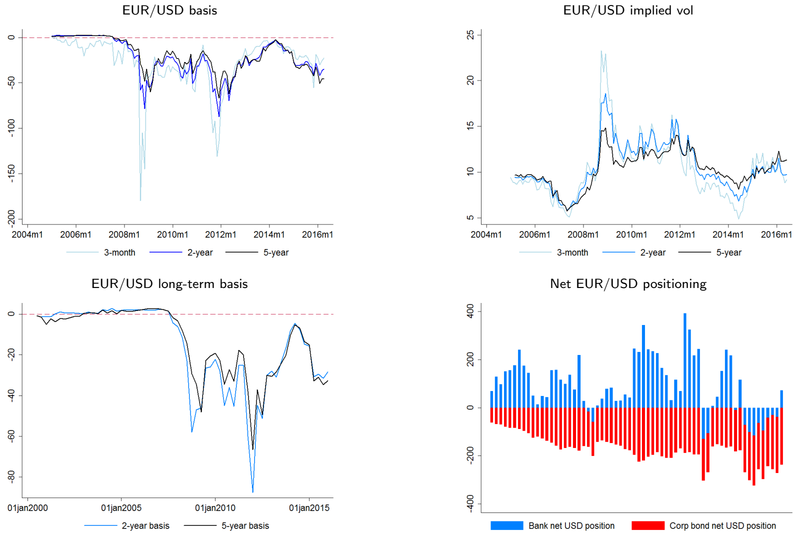
CHF/USD currency basis and option-implied volatility, compared to net USD positioning of Swiss banks and CHF debt of US corporates

Back



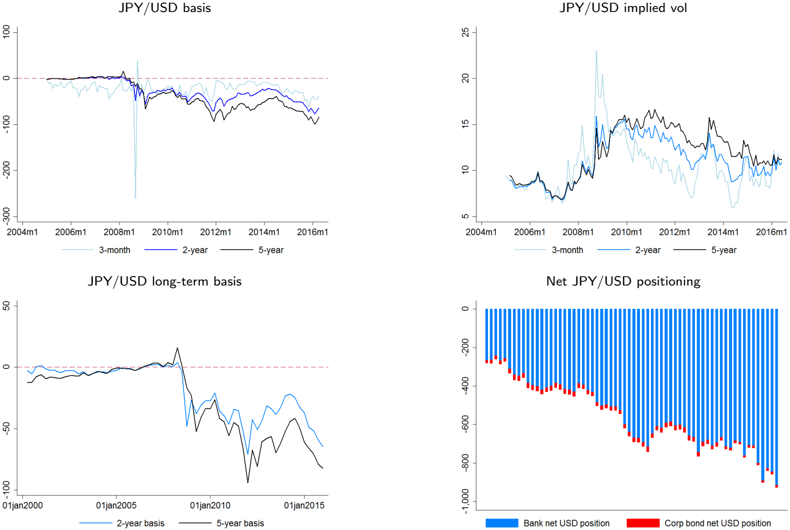
EUR/USD currency basis and option-implied volatility, compared to net USD positioning of euro area banks and EUR debt of US corporates

Back

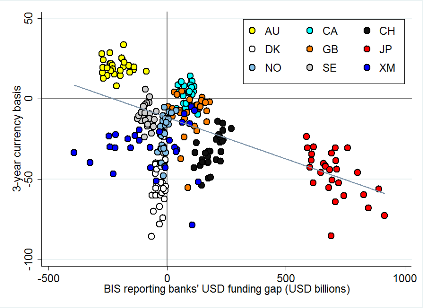


JPY/USD currency basis and option-implied volatility, compared to net USD positioning of Japanese banks and JPY debt of US corporates

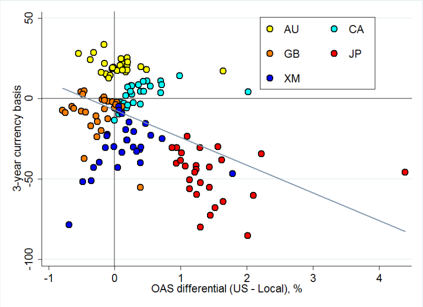
Back



Quantity vs price proxies for the direction of USD forward positions and the currency basis



Banks' USD funding gap & 3-year basis



Corporate spread differentials & 3-year basis

Sample: Q1/2009 - Q4/2015. AU = Australia, CA = Canada, CH = Switzerland, DK = Denmark, GB = United Kingdom, JP = Japan, NO = Norway, SE = Sweden, XM = Euro area. Back