BANK FOR INTERNATIONAL SETTLEMENTS

What drives the cross-currency basis?

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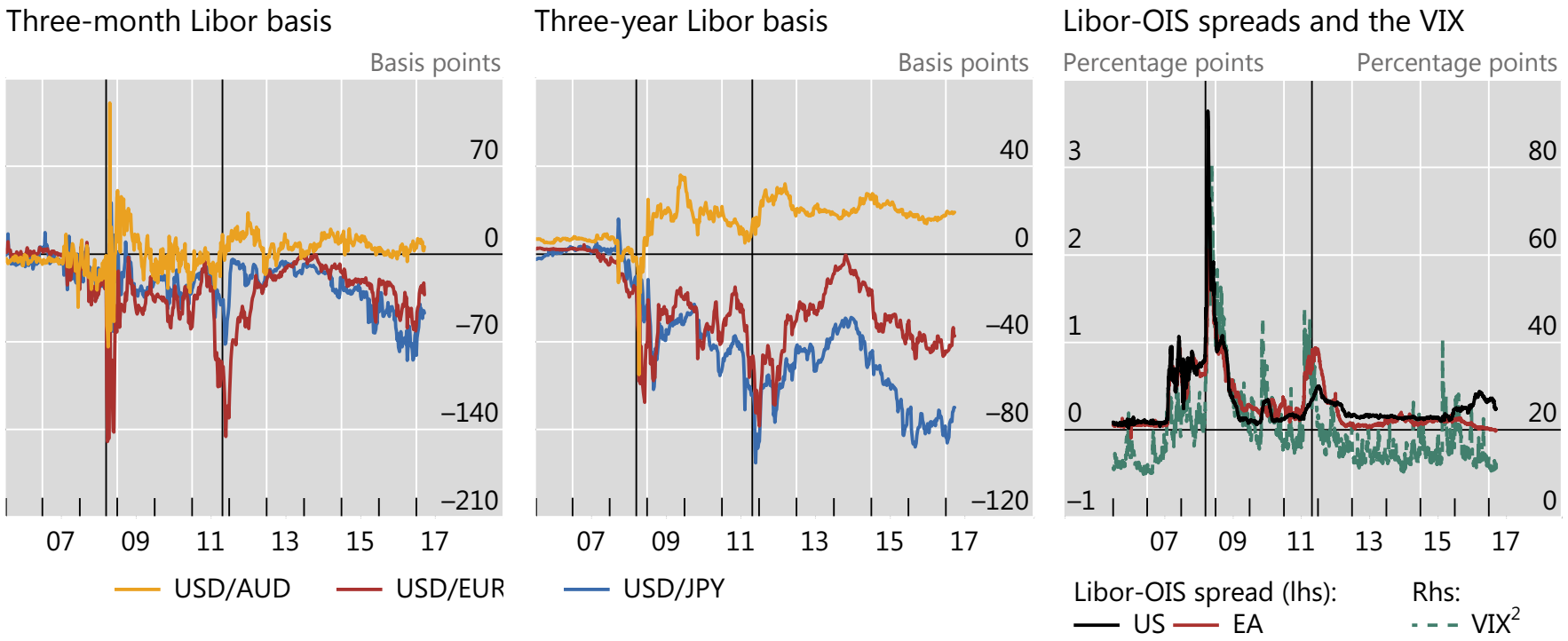
* Economist, CGFS and Markets Committee

Cross-currency basis has been wide despite absence of an obvious crisis trigger[1]

Cross-currency basis against the US dollar, interbank credit risk and market risk[1]



[1] The vertical lines indicate 15 September 2008 (Lehman Brothers file for Chapter 11 bankruptcy protection) and 26 October 2011 (euro area authorities agree on debt relief for Greece, leveraging of the European Financial Stability Facility and the recapitalisation of banks). [2] Chicago Board Options Exchange S&P 500 implied volatility index; standard deviation, in percentage points per annum.

Sources: Bloomberg; authors' calculations.

Recall: Covered interest parity

- Law of one price:
  - Interest rates on two otherwise identical assets in two different currencies must be equal once currency hedging costs is taken into acount

$$(1 + r_d) = \frac{F}{S}(1 + r_f)$$; *S* and *F* are in units of *d* per *f*

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

$$\left(1 + r_d^A\right) = \frac{F^A}{S^B}\left(1 + r_f^B\right)$$

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

Variety of users across instruments and maturities

	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		

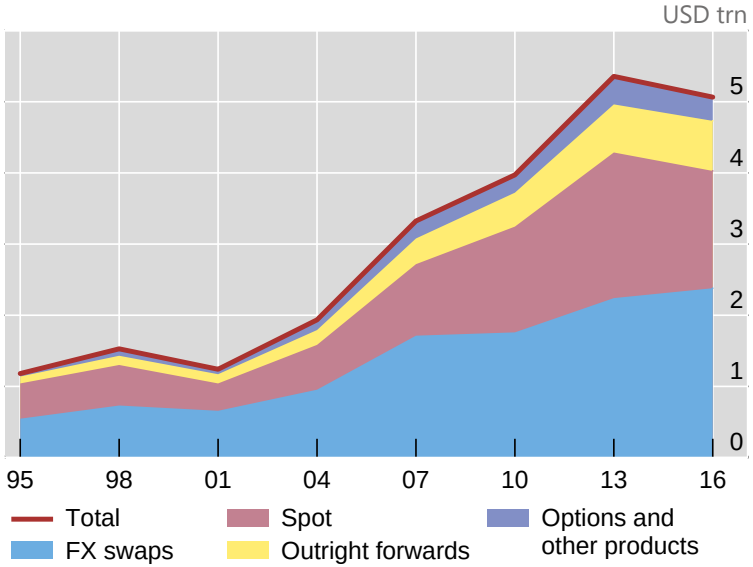
	Bank IRS desks		CB		Asset managers		HF	
	Market share	Product	Market share	Product	Market share	Product	Market share	Product
0-3 month			++	Fx Sw	+++	Fx Sw		
3mo-1yr			++	Fx Sw	++	Fx Sw	++	XCCY
1y1y							++	XCCY
2y10y	+	XCCY					+	XCCY
>10y	+++	XCCY						

Source: FX/XCCY Swap market overview, BNP Paribas Fixed Income, 9 September, 2014

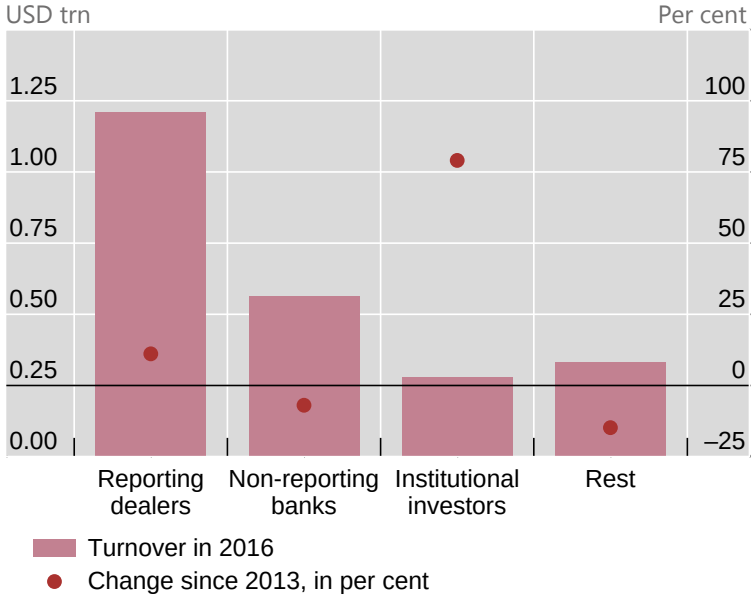
Talking about pricing relationships in *most* of the FX market

- FX swaps are the *modal* instrument: accounted for 47% of global FX turnover in April 2016
- + forwards and XCCY swaps, trading in the instruments pricing *F/S* accounted for 63%
- XCCY swaps notional amount about $20 trillion, forwards and FX swaps about $30 trillion
- Trading in FX swaps with institutional investors rose 79% since 2013!

Global foreign exchange turnover by instrument[1]



FX swap turnover growth by counterparty and growth since 2013[2]



[1] Adjusted for local and cross-border inter-dealer double counting, ie net-net basis; daily averages in April. [2] Gross daily capital flows are estimated by dividing the annual sum of inflows and outflows by 365. [3] 2016 current, capital and financial account flows are estimated by extrapolating the average annual growth for 2014 and 2015.

Sources: BIS Triennial Central Bank Survey; BIS calculations.

Outline

- What drives the basis? Why does the "arbitrage" exist?
- How long? How long has it existed and how long could it last?
- Should central banks consider persistent CIP deviations as a cause for concern in the area of financial stability?

Recent publications by BIS economists:

- Avdjiev, S, W Du, C Koch and H Shin (2016): The dollar, bank leverage and the deviation from covered interest parity, *BIS Working Papers* no 592
- Borio, C, R McCauley, P McGuire and V Sushko (2016): Covered interest parity lost: understanding the cross-currency basis, *BIS Quarterly Review*, September.
- Rime, D, A Schrimpf and O Syrstad (2016): "Segmented money markets and covered interest parity arbitrage", Available at SSRN.
- Sushko, V, C Borio, R McCauley and P McGuire (2016): The failure of covered interest parity: FX hedging demand and costly balance sheets, *BIS Working Papers,* no 590, October.

(See Slide 25 for a more comprehensive publications list)

Why does the basis exist?

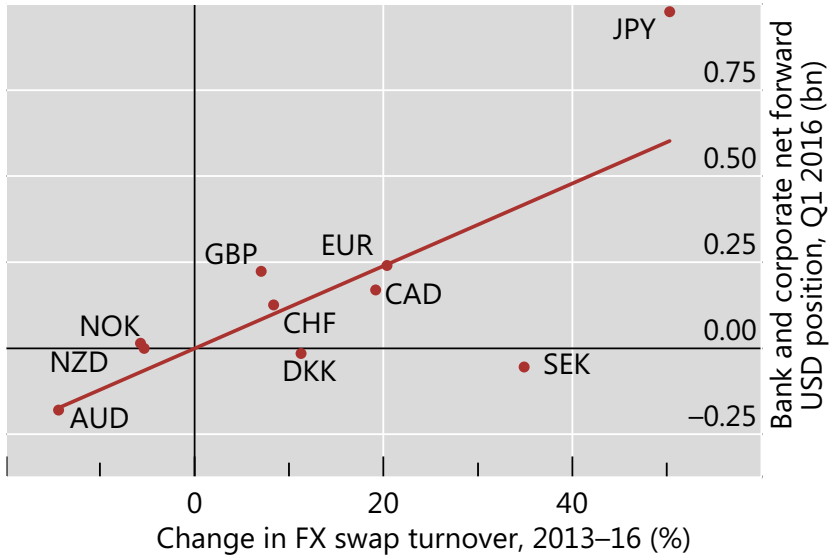
- **Supply/demand imbalances (cyclical)**
  - High demand to hedge EUR or JPY funding for USD investment, but low demand to do the opposite
  - **Divergent monetary policies**
    - Excess liquidity+ term spread compression + credit spread compression
  - Investors **demand for FX hedges/FX funding**
  - Banks taking imbalances onto balance sheet because client flows not offsetting
  - Possible constraints on **supply of safe assets** for arbitrageurs to "park the $$"

- **Repricing of balance sheet capacity (structural)**
  - Flow-driven model obsolete (eg "death of the flow monster"?)
  - **Leverage constraints + capital costs & funding costs**
    - Counterparty & market risk priced-in at all times
    - Funding costs & liquidity risk
  - MM segmentation: greater heterogeneity in banks' funding costs, access to CB deposit facilities
  - Risk & exposure limits (both banks and wholesale funding courses, eg MMFs)

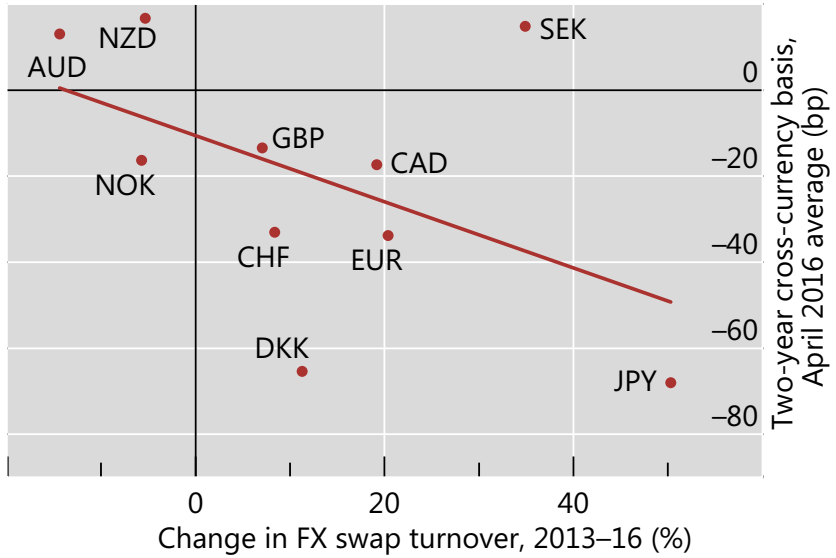
Supply/demand imbalances: CIP deviations respond the associated flows

FX swap turnover and demand push from currency hedging

Hedging demand and FX swap trading[1, 2]



Hedging costs and FX swap trading[1]



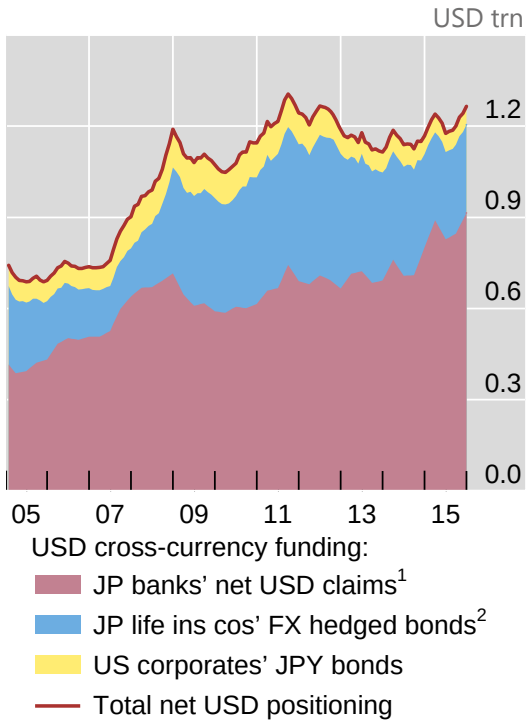
[1] Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis. [2] Bank hedging of US dollar assets via FX swaps estimated as the difference between gross consolidated US dollar assets and liabilities of BIS reporting banks in each currency jurisdiction; corporate hedging demand proxied by outstanding debt securities liabilities denominated in the respective currencies issued by non-financial corporates headquartered in the US (reverse yankee bonds).

Sources: Borio et al (2016); BIS debt securities statistics, international banking statistics and Triennial Central Bank Survey; BIS calculations.

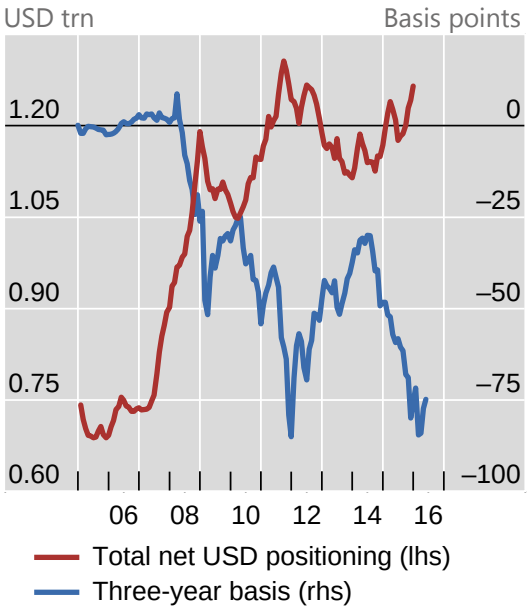
Supply/demand imbalances: Driven by FX hedging & funding demand

Sources of currency hedging demand and the yen/US dollar basis

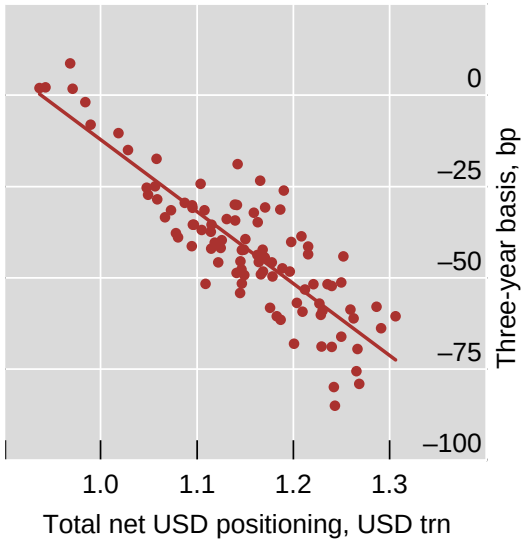
FX hedging demand by sector



FX hedging demand and the basis



FX hedging demand and the basis (Jan 2008- Dec 2015)



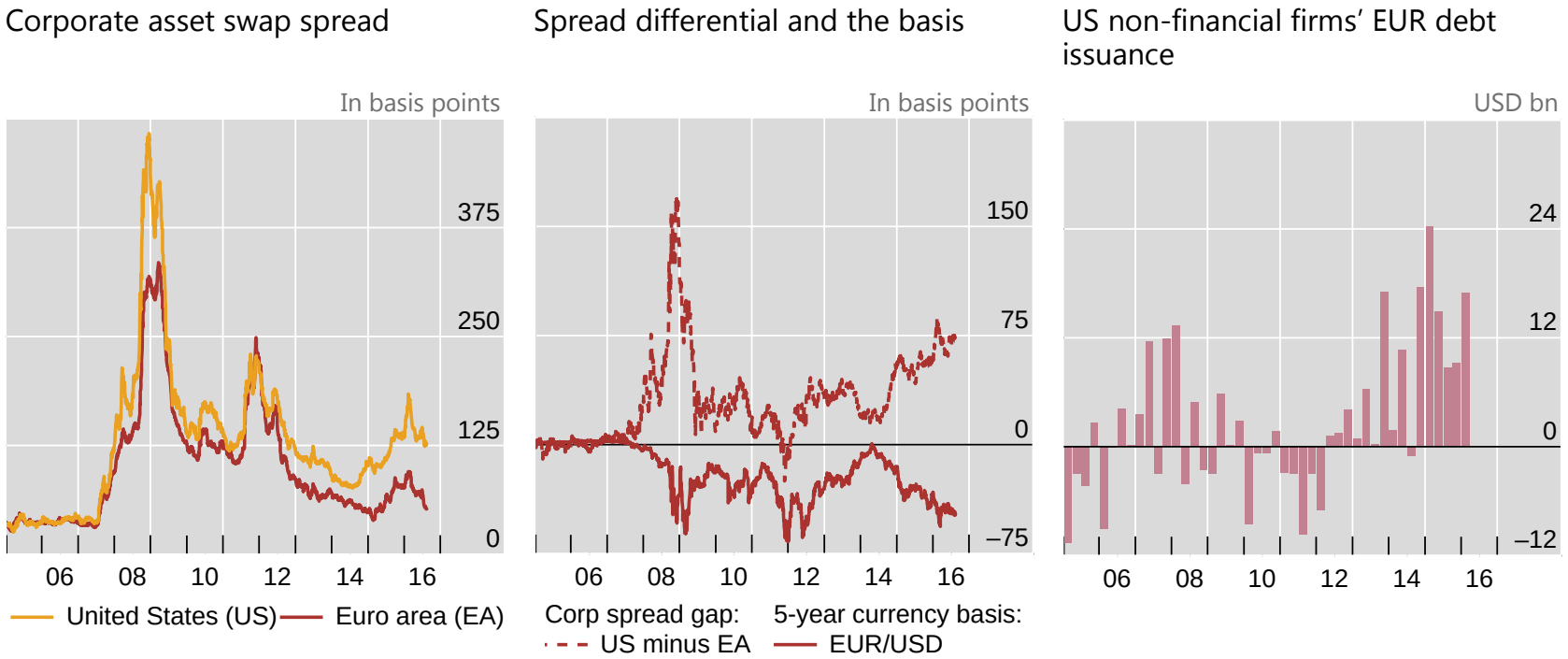
[1] Difference between gross USD assets and liabilities of Japanese banks; quarterly data linearly interpolated to monthly frequency. [2] Japan life insurance companies' currency-hedged US dollar bond holdings estimated by multiplying the stock of the insurance companies' FX bond holdings by their time-varying currency hedge ratios; monthly frequency.

Sources: Bank of Japan; Japanese Ministry of Finance; The Life Insurance Association of Japan; Barclays FICC Research; Bloomberg; BIS international banking statistics and debt securities statistics; authors' calculations.

Supply/demand imbalances: Use of USD/EUR swaps by US corporates

- Euro credit spread compression led to the rise of reverse yankee issuance
- Most of the issuance is long-term, average maturity about 10 years
- Hedge FX risk using currency swaps

Corporate credit spreads, reverse yankee issuance, and the EUR/USD basis



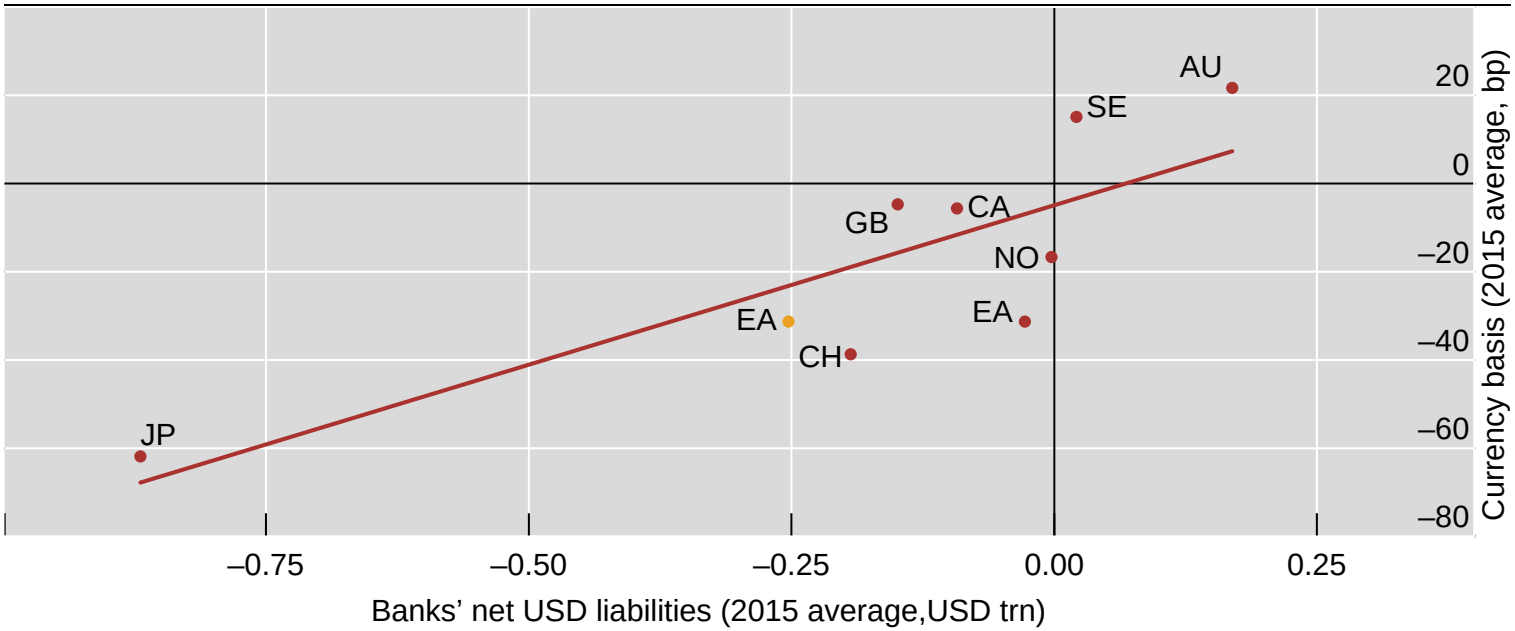
Sources: Bank of America Merrill Lynch; Bloomberg; BIS International Debt Securities Statistics; authors' calculations.

Currency hedging demand also explains the basis in the cross-section

- Japanese bank fund USD assets by swapping out of JPY deposits
- US corporates fund USD investment by issuing EUR bonds, then swapping to USD
- Australian banks fund AUD mortgage by issuing USD bonds, then swapping to AUD

Currency hedging demand and three-year basis

Banks' consolidated net USD liabilities (plus euro reverse Yankee liabilities)



For Sweden (SE), net euro liabilities (x-axis) and the SEK/EUR basis (y-axis).

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

So, why does the basis respond to swap market flows?

Moving on to balance sheet constraints…

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

Select costs driving the sensitivity of swap pricing to flows

- **Risk exposure constraints**
  - RWA & credit valuation adjustment (CVA)
    - Fair value of exposures accounts for market risk & counterparty risk
  - Basel III leverage ratio & US SLR have a risk-based element
    - Total exposure calculation adjusted by a PFE factor
  - Exposure risk limits

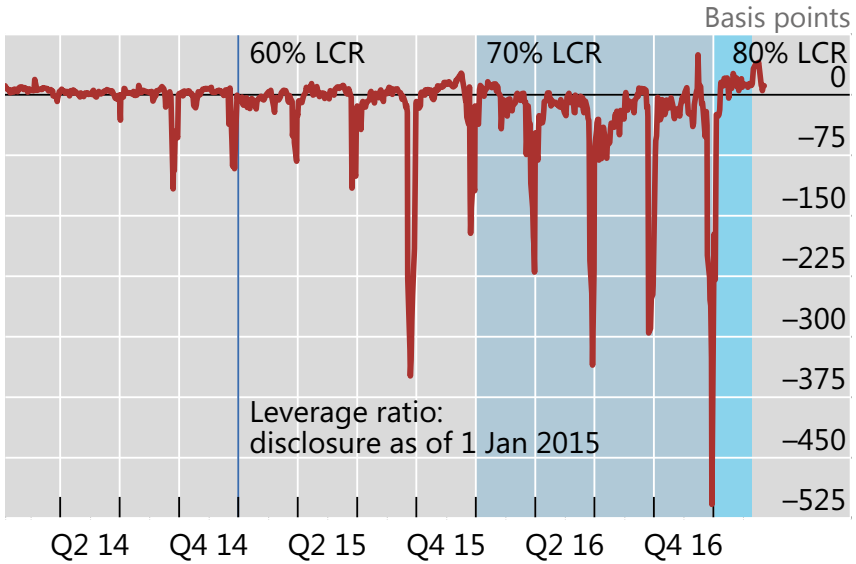
- **Funding & liquidity constraints**
  - Risk charges can be reduced by posting collateral in a two-way CSA
    - Collateral can be subject to haircuts
    - Additional collateral required if MtM of the swap is negative
  - LCR assessment in each significant currency (recommendation)
  - Risk limits by wholesale funding sources

- **Leverage ratio**

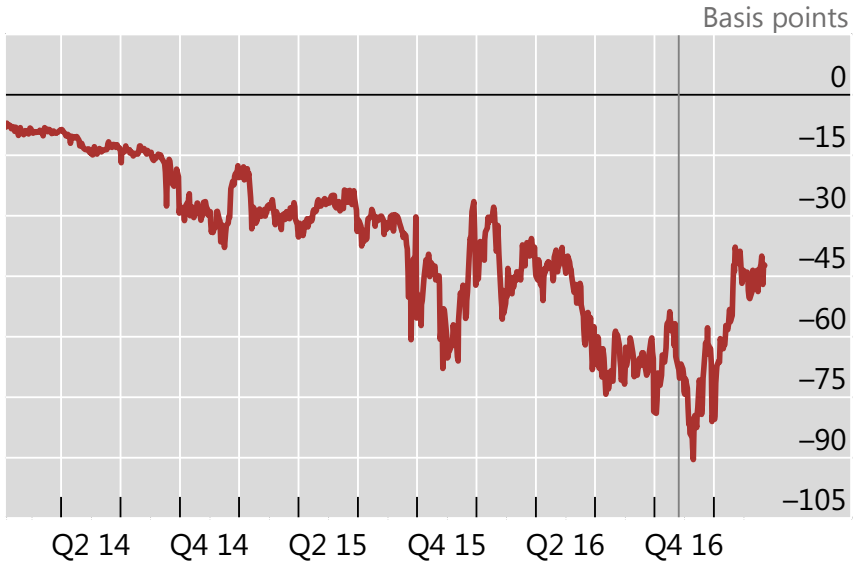
Regulatory reporting periods interact w/ balance sheet management, demand for collateral and asymmetric liquidity conditions

- Q-end window dressing by Japanese (and euro area) banks
- Excess supply of JPY liquidity, difficult to place yen cash

1-week JPY/USD basis



3-month JPY/USD basis



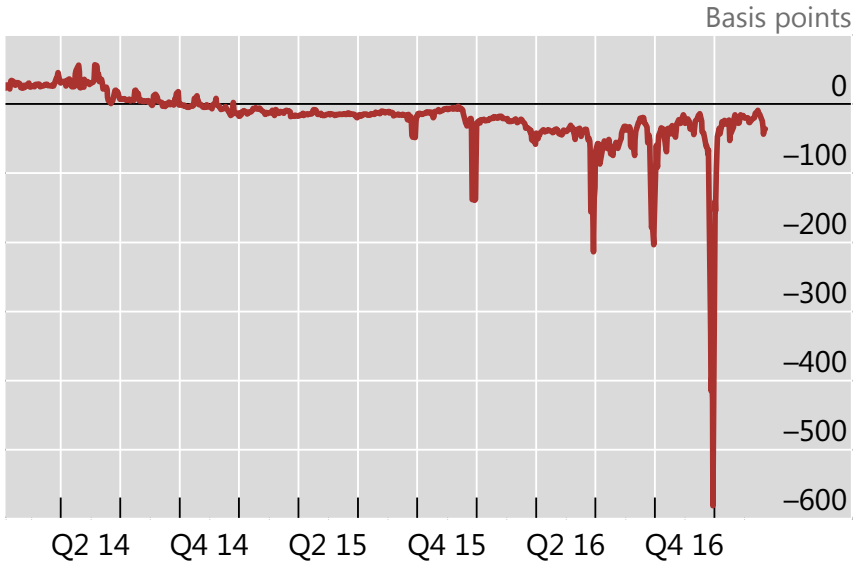
The vertical line in the upper left- and lower left-hand panels indicates 8 November 2016, US presidential election.

Sources: Bloomberg; BIS calculations.

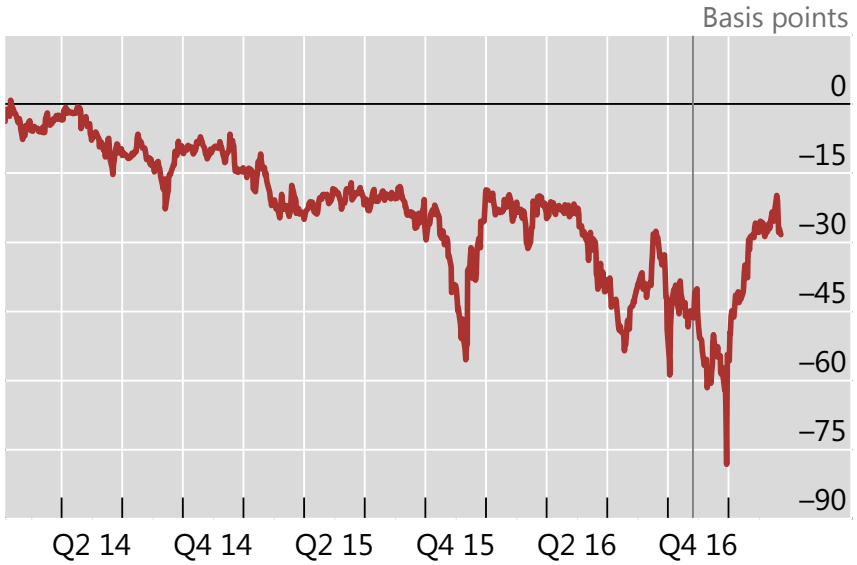
… similar developments for EUR/USD

- Q-end window dressing
- Excess supply of EUR liquidity, difficult to place euro cash

1-week EUR/USD basis



3-month EUR/USD basis



The vertical line in the upper left- and lower left-hand panels indicates 8 November 2016, US presidential election.

[1] US Treasury term spread (10-year minus 2-year yield) minus JGB Term spread (10-year minus 2-year).

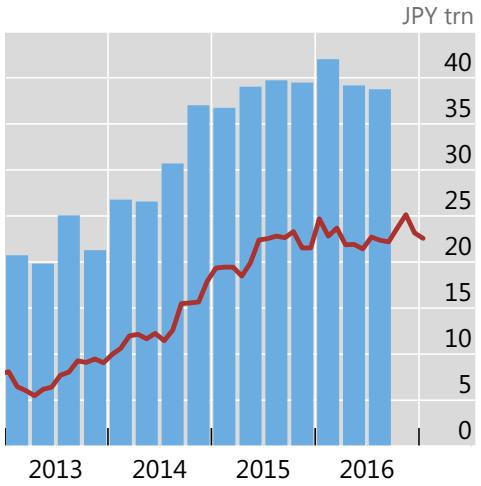
Sources: Bloomberg; BIS calculations.

Safe asset scarcity and exposure limits further inhibit arbitrage

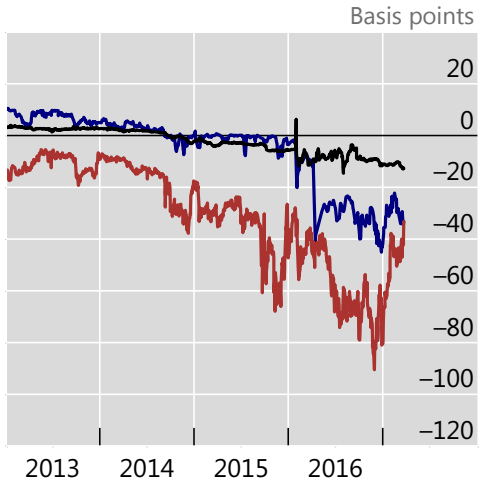
- Demand for safe JPY assets (BOJ CAB, T-bills, Repo) by CIP arbitrageurs
- Plus exposures limits potentially kicking in
- Against shrinking domestic supply of safe JPY and EUR assets (QE and HQLA demand)

Indicators of bank arbitrage activity and JPY and EUR money market spreads

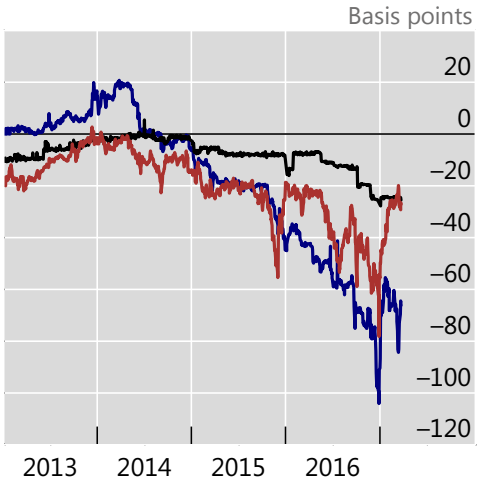
Foreign bank claims on Japan's official sector



Yen money market rates



Euro money market rates



[1] Non-Japanese banks' consolidated claims on an ultimate risk basis, including yen claims booked in Japan, on the official sector, which includes the Ministry of Finance and the Bank of Japan. [2] Repo rate for Euro area is the French 3 month GC repo rate.

Sources: BIS consolidated banking statistics; Bank of Japan; Bloomberg; BIS calculations.

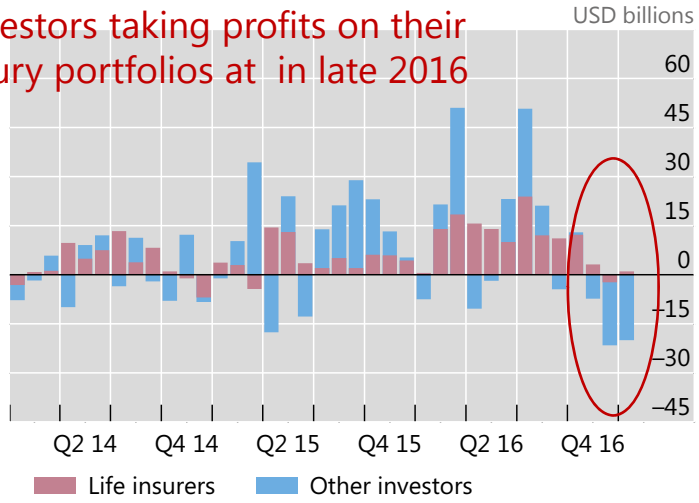
How long will the basis persist?

How long will the basis persist?

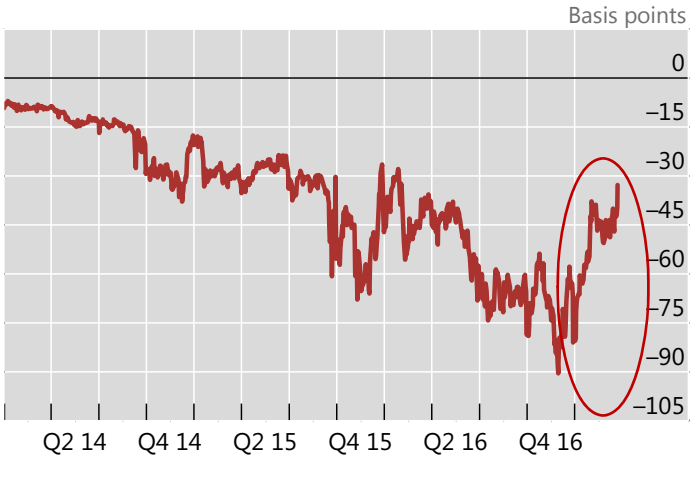
- **Cyclical drivers :**
  - Basis will narrow if:
    - **Monetary policies converge:** convergence in funding liquidity premia; FX hedging flows become more two-sided;
    - **FX hedged flows contract:** Eg if FX-hedged portfolios of pension funds, insurance companies, and banks contract or allowed to take-on more FX risk
    - **Supply of safe assets rises** in "cheap currencies" (eg CHF, EUR, JPY)

Net flows into long-term FX debt by Japanese portfolio investors[1]

JP investors taking profits on their Treasury portfolios at in late 2016



3-month JPY/USD currency basis



The vertical line in the upper left- and lower left-hand panels indicates 8 November 2016, US presidential election.

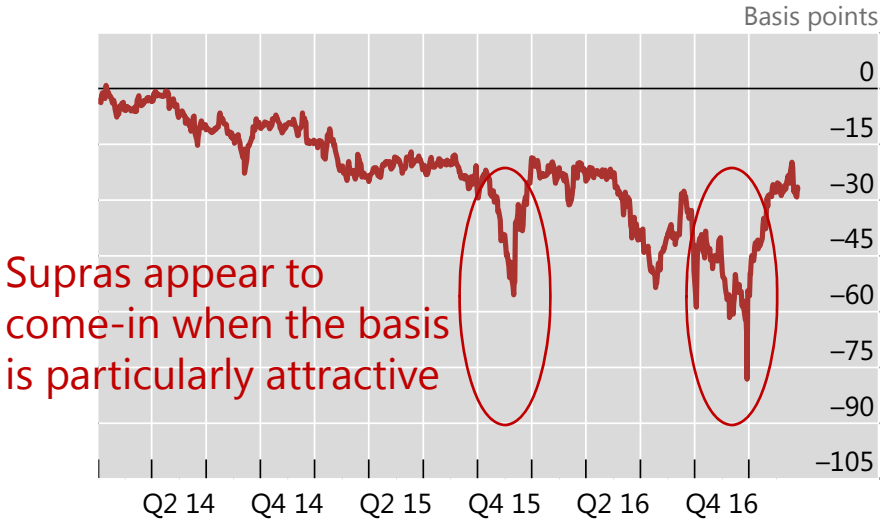
[1] January 2017 flows based on Barclays Foreign Exchange Research

Source: Boomberg; Thomson Reuters Datastream; Barclays; BIS calculatoins

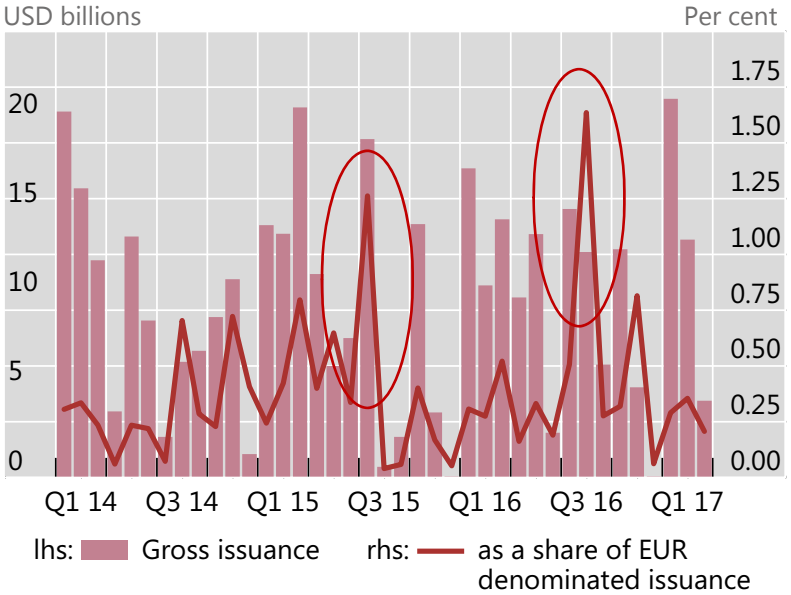
How long will the basis persist?

- **Structural drivers**
  - basis will narrow if:
    - **CIP arbitrage by non-bank players**: arb by agency bond issuers, mandates of asset managers change
    - but institutional and structural constraints abound…

3-month EUR/USD currency basis



USD debt issuance by euro area agency, supranational and quasi-sovereigns



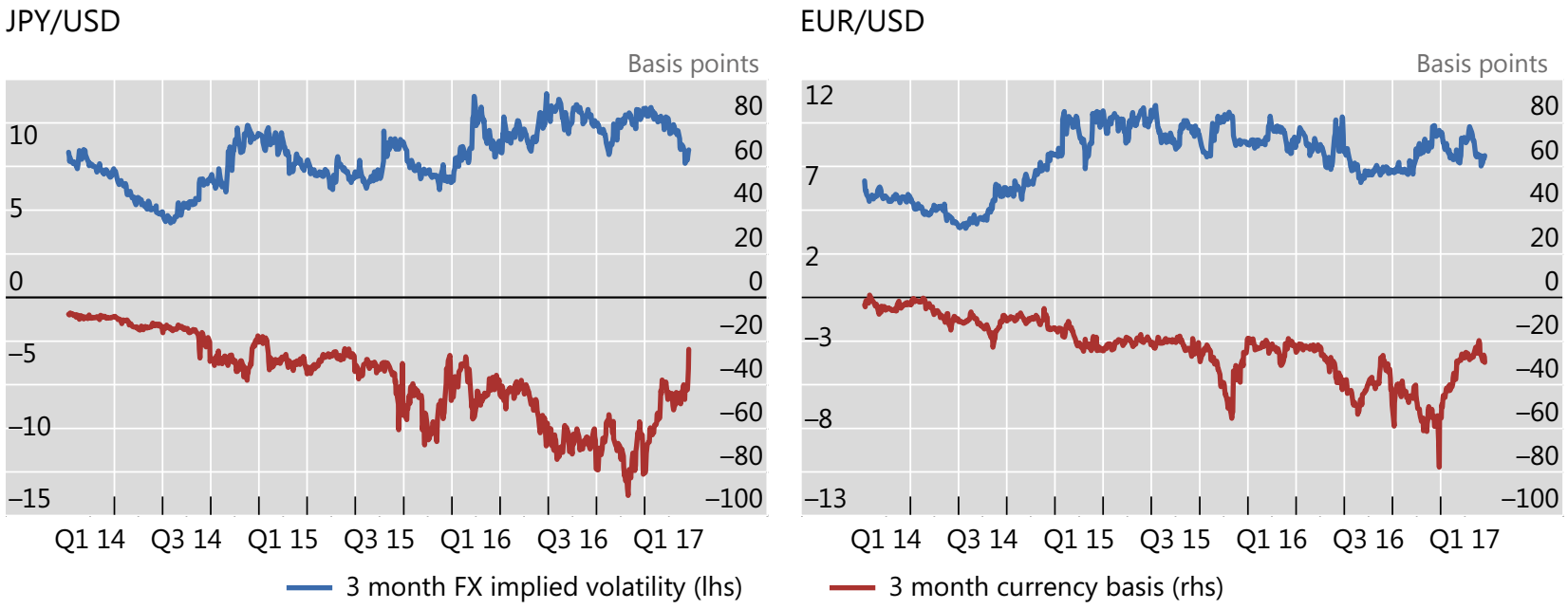
The vertical line in the upper left- and lower left-hand panels indicates 8 November 2016, US presidential election.

Source: Boomberg; Thomson Reuters DealScan; BIS calculatoins

How long will the basis persist?

- **Structural drivers**
  - But, unlikely to disappear completely & no-arb bounds will continue to respond to flows
    - Fewer banks provide FX swap market liquidity & internalize large volumes
    - Money markets more segmented
    - Leverage constraints, capital costs & funding costs *priced-in at all times*

Hence, for example, should expect currency basis to continue to respond to ***MtM*** risks:



Sources: Bloomberg; BIS calculations.

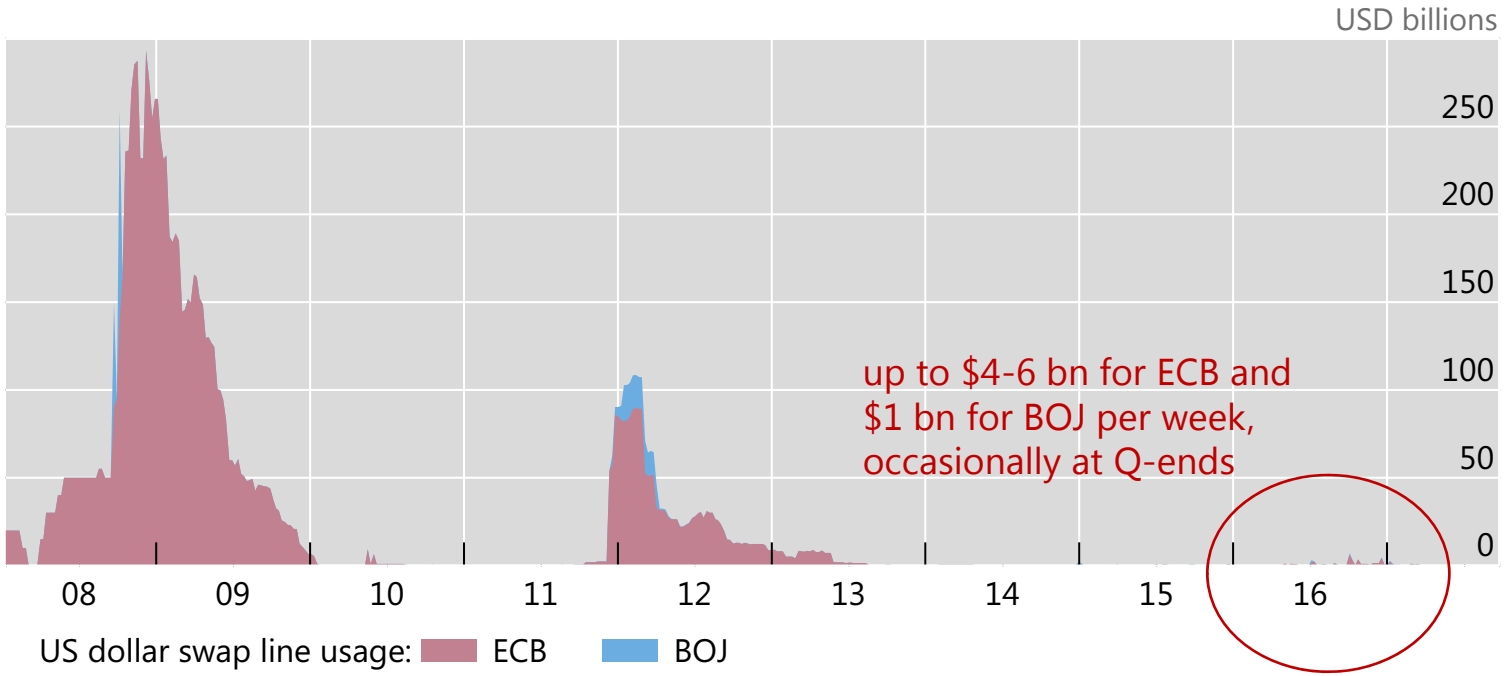
Should we be concerned?

Dislocation vs equilibrating mechanism

So far, no evidence of aggregate USD liquidity stress..

- **CB dollar swap facilities as backstops:** usage minimal compared to 2008-09 and 2012
- Despite Q-end turn, **swap markets appeared to have functioned smoothly**
- Non-US banks offset about $555 billion reduction in US MMF funding in 2015-16 by increasing offshore **USD deposit funding** by over $530 billion…

US dollar swap line usage



Sources: Federal Reserve Bank of New York; BIS calculations.

Dislocation vs equilibrating mechanism

FX swap pricing reflects flows and differences in monetary conditions

- Largely reflects the use of FX swaps to back **long-term investment and funding strategies**
- Hence, **high usage of some longer-term USD facilities from CB reserves**
- **Prices adjust** to the aggregate balance sheet exposure → ***a good thing?!***
    - Endogenous limit to reliance on FX swaps due to FX hedging costs
    - but can also lead to more FX risk going unhedged…

Top 4 JP life insurers, H2FY16 plans	Foreign securities	FX bond holdings (JPY bn, Jun 2016)
Nippon	Flexibly switch to FX-unhedged foreign bond investment after increasing FX-hedged investment in H1	13,394.9
Daiichi	FX-hedged foreign bond investment flat; possibly increase depending on domestic/overseas yield levels	6,969.9
Sumitomo	Increase; accumulate credit; increase FX-unhedged foreign bond investment when JPY appreciates	5,552.5
Meiji Yasuda	Increase foreign bonds; increase FX-unhedged foreign bond investment with eye on exchange rates	1,688.6

Source: USDJPY basis, signs of modulation, Japan Perspectives, Barclays, 4 November, 2016

Should central banks be concerned?

- **Maturity mismatches FX funding & hedging profiles**
  - Rolling over short-term FX swaps for funding long-term USD investments
  - Liquidity concentrated around 3-month tenors

- **Concentration risk**
  - Warehousing of risk falls onto a handful of top-tier dealer banks
  - Interviews suggest that institutional and corporate clients increasingly rely on fewer banks for their FX hedges

- Risks to market functioning from **balance sheet contraction at period-ends**
  - May disappear when the daily computation of the leverage ratio will apply to non-US banks as well
  - Also a reflection of broader liquidity abundance and collateral scarcity in CHF, EUR, JPY

Select recent related publications

- Arai, F., Y. Makabe, Y. Okawara, and T. Nagano (2016): "Recent Trends in Cross-currency Basis," Bank of Japan Review Series, September 16-E-7, Bank of Japan.
- Avdjiev, S, W Du, C Koch and H Shin (2016): The dollar, bank leverage and the deviation from covered interest parity, *BIS Working Papers* no 592
- Borio, C, R McCauley, P McGuire and V Sushko (2016): Covered interest parity lost: understanding the cross-currency basis, *BIS Quarterly Review*, September.
- Du, W., A. Tepper, and A. Verdelhan (2017): "Deviations from Covered Interest Rate Parity," *NBER Working Papers* 23170.
- Iida, T., T. Kimura, and N. Sudo (2016): "Regulatory Reforms and the Dollar Funding of Global Banks: Evidence from the Impact of Monetary Policy Divergence," Bank of Japan Working Papers, (16-E-14).
- Iñaki A, T Ehlers, E Eren and R McCauley (2017): "Non-US banks' global dollar funding grows despite US money market reform", *BIS Quarterly Review*, pp 22-23, March.
- Liao, G. Y. (2016): "Credit Migration and Covered Interest Rate Parity," mimeo, Harvard University.
- Pinnington, J., and M. Shamloo (2016): "Limits to Arbitrage and Deviations from Covered Interest Rate Parity," Staff Discussion Papers 16-4, Bank of Canada.
- Rime, D, A Schrimpf and O Syrstad (2016): "Segmented money markets and covered interest parity arbitrage", Available at SSRN.
- Sushko, V, C Borio, R McCauley and P McGuire (2016): The failure of covered interest parity: FX hedging demand and costly balance sheets, *BIS Working Papers,* no 590, October.
- Wong, A, C. Ng, and D W Leung (2016): "Risk-adjusted Covered Interest Parity: Theory and Evidence," Working Papers 16, *Hong Kong Institute for Monetary Research*.

Technical Appendix

Pricing relationship between FX swaps and XCCY swaps

FX swap cash flows:

FX swap dealer quote swap points (F – S), XCCY swap dealers quote the basis α. For a hypothetical 1-period term, the no-arbitrage relation between FX swap points and XCCY basis can be expressed as:

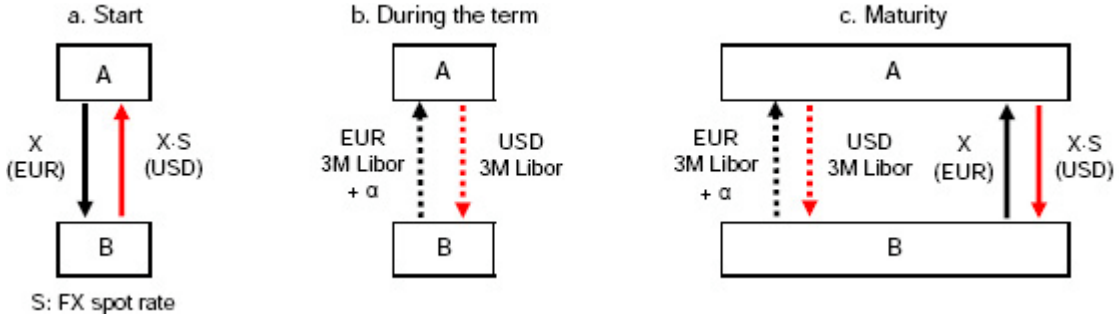
$$F_1 - S = S \times \frac{1 + r_{d,1} + \alpha_1}{1 + r_{f,1}}$$

In logs:

$$\alpha_1 = f_1 - s - (r_d - r_f)$$

$$-\alpha_1 = r_d - (f_1 - s - r_f)$$

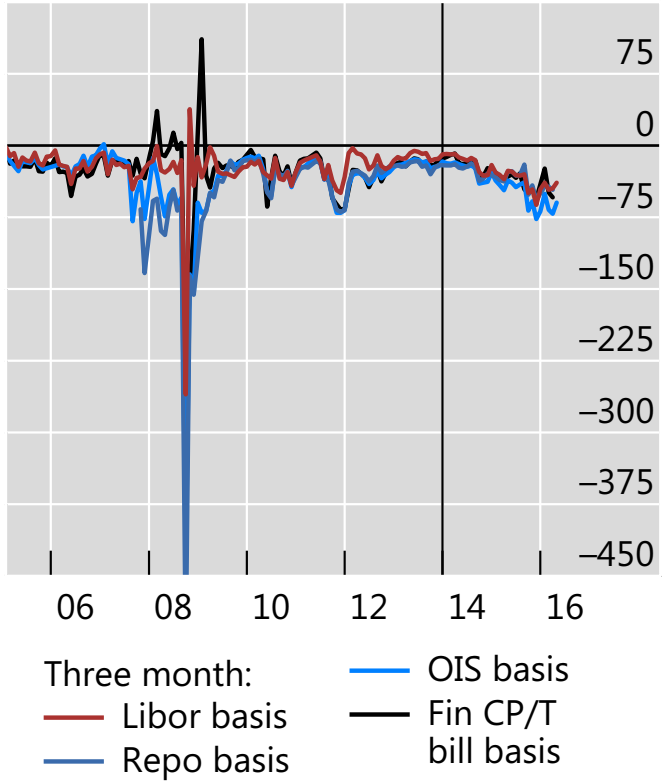
Cross-currency basis swap cash flows:



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

JPY/USD short-term FX swap basis based on different rates

- Libor-basis narrower than OIS-basis because accounts for bank 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, must think about *(F – S)*



Fundamental sources of **balance sheet costs**

Can be gleaned from a simple CIP arbitrageur's problem:

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

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

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

Counterparties not 100% riskless, so market risk relevant: ▸ CVA

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

inverse of balance sheet risk tolerance

counterparty risk

market risk

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

Market clearing forward rate compensates for balance sheet costs:

$$x_{t,f} = D_t^{XC}$$

$$\Rightarrow f_t^B = s_t^A + r_t - r_t^* + \underbrace{\theta_t \rho \sigma_s^2 D_t^{XC}}_{\text{Hurdle rate}}$$

FX hedging demand imbalances (eg residual FX swap market flows)

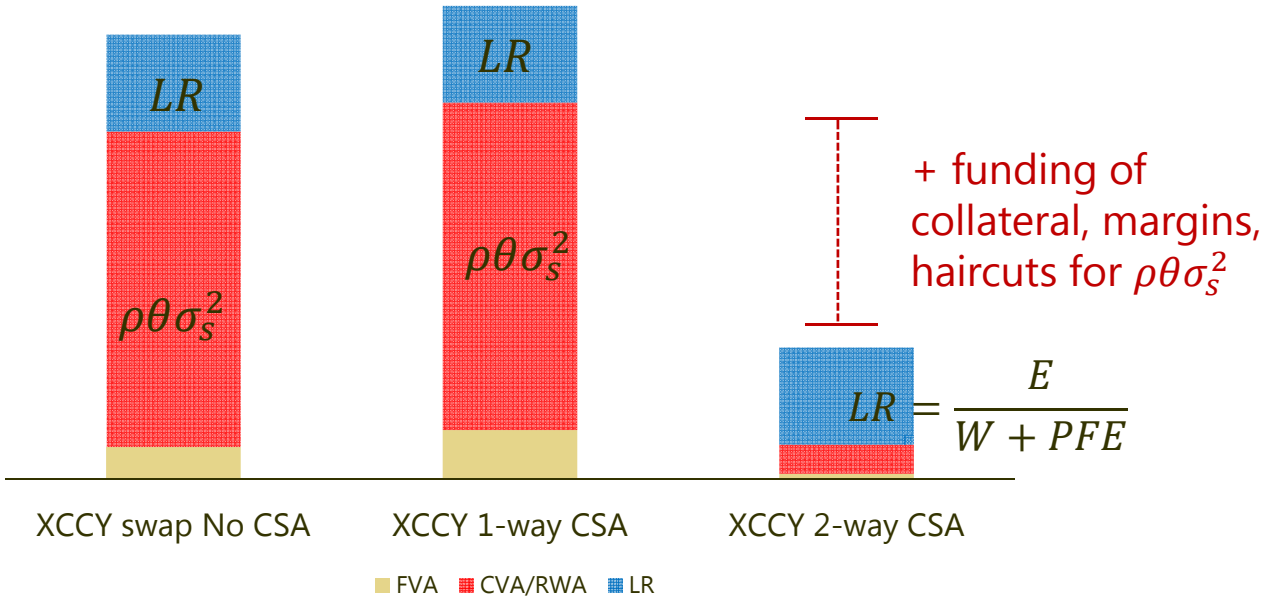
Elasticity with which flows affect swap pricing

Implications:

- CIP arbitrageurs, banks setting prices in FX swaps, will pass their balance sheet costs to end-users
- In aggregate, FX points, $(f^B_t - s^A_t)$, will compensate for the balance sheet exposure to any residual client flow imbalances, D^{XC}_t
- No-arbitrage bounds, and hence the currency basis, widen in *proportion* to FX hedging flows

Relationship to factors driving the pricing of an OTC derivative:

Additional costs for a EUR/USD XCCY swap:



Basel III LR and US SLR also have a risk-based constraint flavor:

PFE factor	< 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

Sources: Motte F (2015): "Impacts of regulations on derivatives markets, dealers' perspective"; HSBC; "Supplementary leverage ratio", Davis Polk & Wardwell LLP, September 12, 2014