



HONG KONG MONETARY AUTHORITY

# ***Breakdown of Covered Interest Parity: Mystery or Myth?***

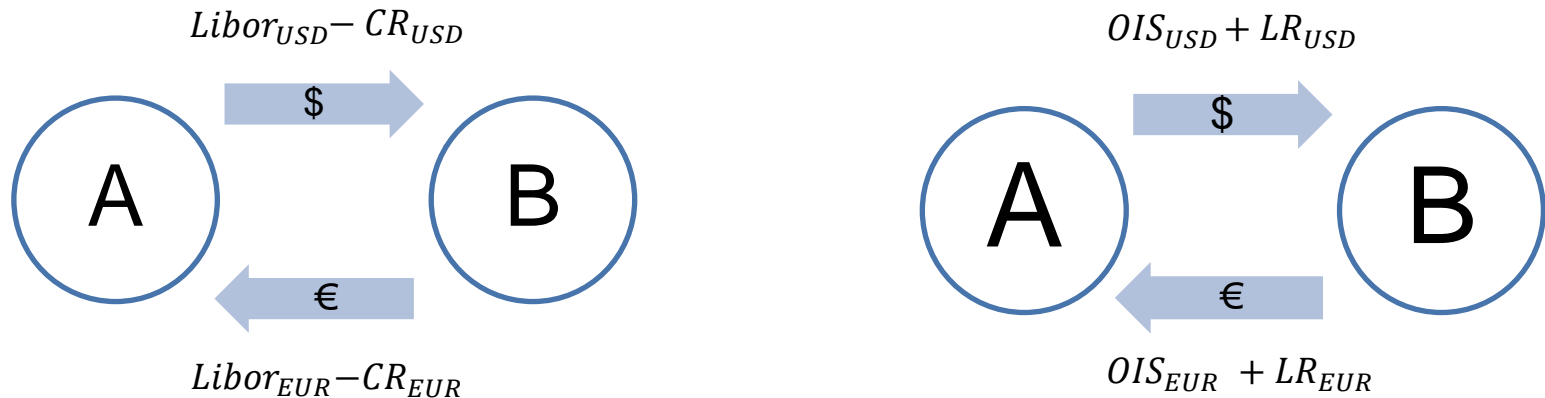
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Hong Kong Monetary Authority

29 November 2018

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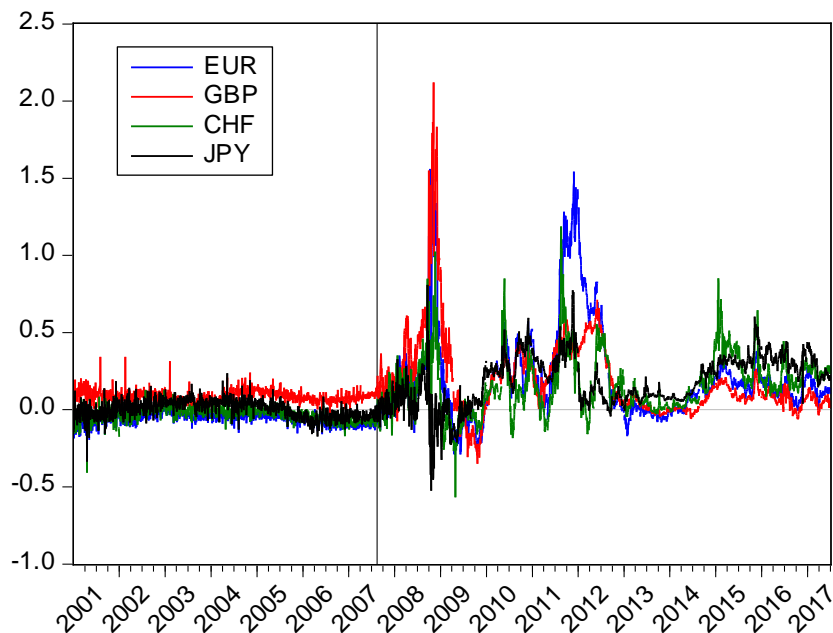
# Pricing the FX Swap



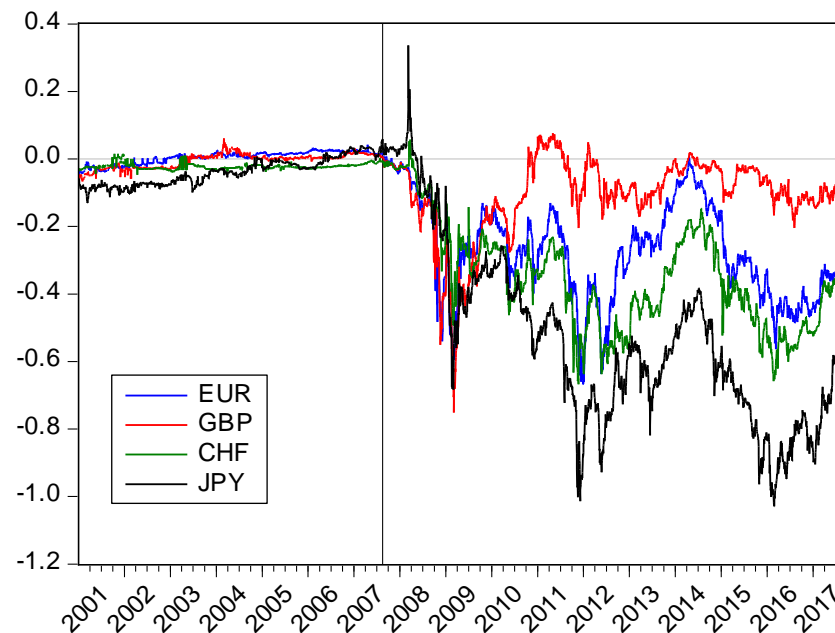
- Counterparty risk is largely eliminated, but the transaction is not totally risk-free because principals are exchanged.
- Using Libors to evaluate CIP, the resulting deviation basically reflects counterparty risk differential. Using OIS to evaluate CIP, the resulting deviation basically reflects funding liquidity risk differential.



# 1-year CIP Deviation



# 5-year CCBS Basis

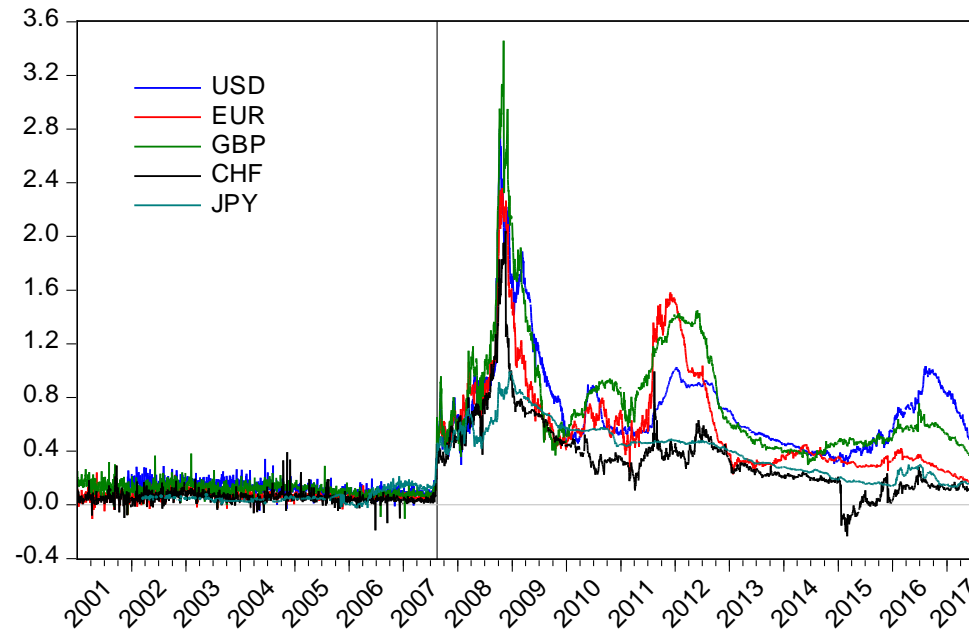


Vertical line represents 9 August 2007 (BNP Paribas suspended redemption for three of its investment funds).

Source: Bloomberg

- CIP deviation happened overnight on 9 August 2007 and has since refused to disappear.
- Most research focuses on why it does not disappear. We are more interested in why it happened in the first place.

# 12-month Libor-OIS Spread

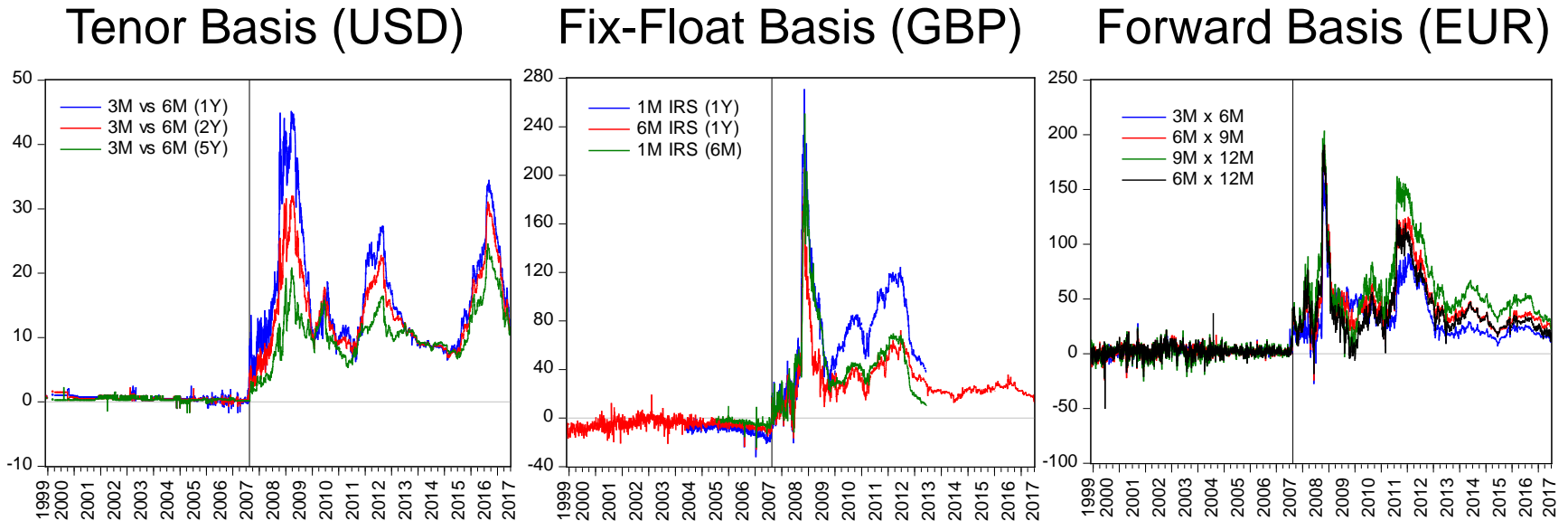


Vertical line represents 9 August 2007 (BNP Paribas suspended redemption for three of its investment funds).

Source: Bloomberg

- Libor – OIS = counterparty risk premium + funding liquidity risk premium.  
See: Michaud & Upper (2008), Sarkar (2009), Acharya et al (2011), Garleanu & Pedersen (2011), Gefang et al (2011), McAndrews et al (2016)
- It is no coincidence that CIP deviation (or CCBS basis) and Libor-OIS spread both happened overnight on 9 August 2007.

# Single-currency Swap Basis

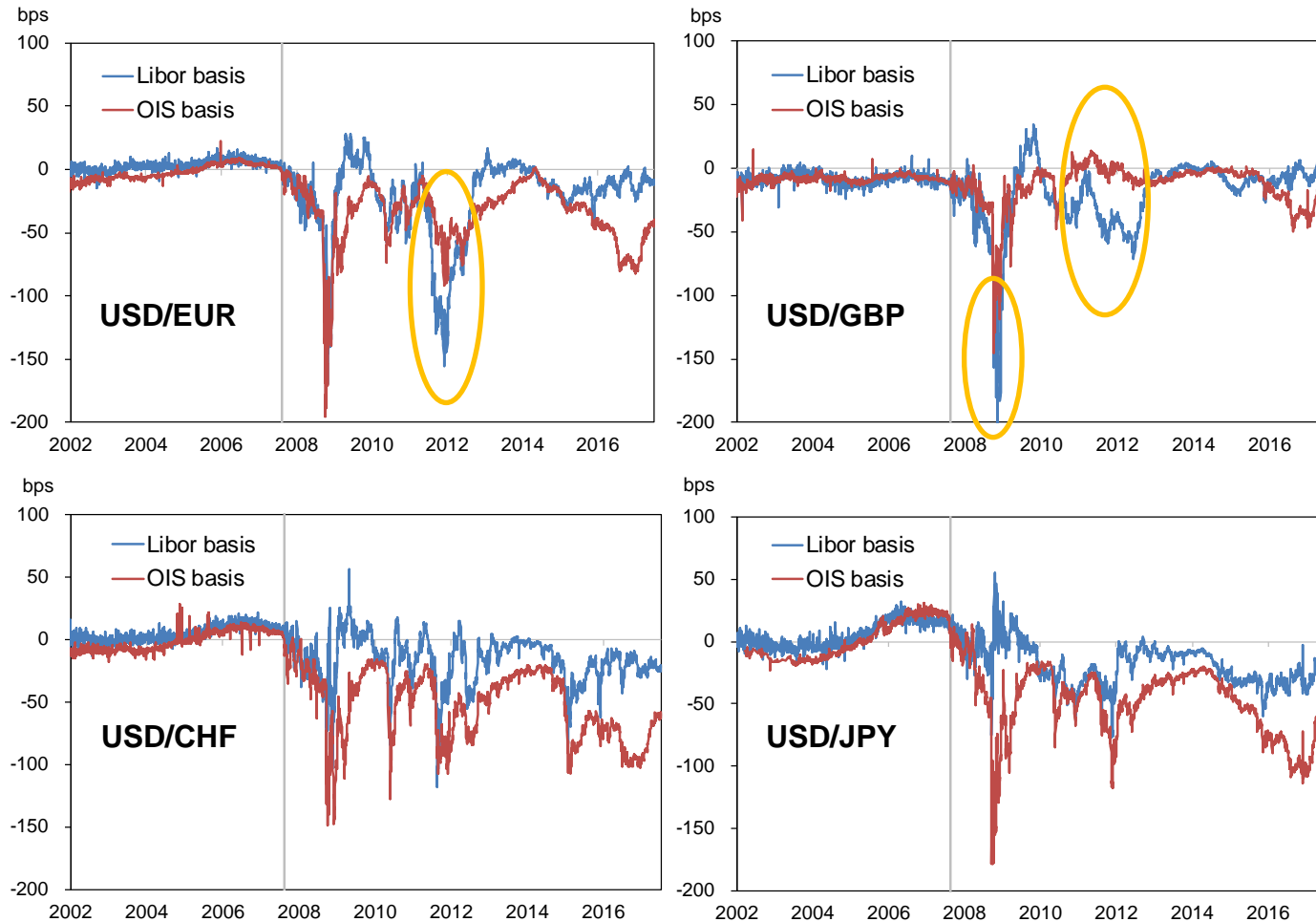


Vertical line represents 9 August 2007 (BNP Paribas suspended redemption for three of its investment funds).

Source: Bloomberg

- It is no coincidence that interest rate swap (IRS) bases also occurred overnight on 9 August 2007.
- An IRS is an exchange of two interest rates of the same currency. Basis happens not because two currencies are swapped, but because two interest rates are swapped.

# Libor Basis vs OIS Basis



- OIS basis has generally been larger than Libor basis due possibly to the global dollar shortage.
- Notable exceptions are the European debt crisis (for EUR and GBP) and GFC (for GBP) due possibly to banking problems in these markets.

# Libor Basis vs OIS Basis

**Libor basis**  $\alpha = \underbrace{(\ln F - \ln S)}_{\text{Swap points}} - \underbrace{(r - q)}_{\text{Libor differential}}$

**OIS basis**  $\bar{\alpha} = \underbrace{(\ln F - \ln S)}_{\text{Swap points}} - \underbrace{(\bar{r} - \bar{q})}_{\text{OIS differential}}$

$$\alpha - \bar{\alpha} = \underbrace{(q - \bar{q})}_{\text{DC Libor-OIS}} - \underbrace{(r - \bar{r})}_{\text{FC Libor-OIS}}$$

1.  $\alpha \neq \bar{\alpha} \Rightarrow (q - \bar{q}) \neq (r - \bar{r})$
2.  $\bar{\alpha} \neq 0 \Rightarrow \alpha \neq (q - \bar{q}) - (r - \bar{r})$
3.  $|\bar{\alpha}| > |\alpha| \Rightarrow (q - \bar{q}) > (r - \bar{r})$

- One cannot conclude from  $\bar{\alpha} \neq 0$  that  $\alpha$  is not a result of counterparty risk differential.





# Reinterpreting Libor Basis vs OIS Basis

$$r = \bar{r} + \beta(r - \bar{r}) + (1 - \beta)(r - \bar{r})$$

$$q = \bar{q} + \underbrace{\gamma(q - \bar{q})}_{\text{Counterparty risk premium}} + \underbrace{(1 - \gamma)(q - \bar{q})}_{\text{Funding liquidity risk premium}}$$

*Counterparty  
risk premium*

*Funding liquidity  
risk premium*

$$r^* = r - \beta(r - \bar{r}) = \bar{r} + (1 - \beta)(r - \bar{r})$$

$$q^* = q - \gamma(q - \bar{q}) = \bar{q} + (1 - \gamma)(q - \bar{q})$$

*Implicit interest rates used by the  
swap dealer in pricing ( $\ln F - \ln S$ )*

**Libor basis**      $\alpha = \gamma(q - \bar{q}) - \beta(r - \bar{r})$

**OIS basis**      $\bar{\alpha} = (1 - \beta)(r - \bar{r}) - (1 - \gamma)(q - \bar{q})$

$|\bar{\alpha}| > |\alpha| \Rightarrow$

**Funding liquidity  
risk differential  
(DC minus FC)**

**>**

**Counterparty  
risk differential  
(FC minus DC)**

# The Basis Matrix

$$B_n = (\alpha_{i,j})_{i,j=1}^n \text{ satisfies } \alpha_{i,j} + \alpha_{j,k} + \alpha_{k,i} = 0$$

- *Property 1:* Elements on the diagonal are 0.

$$\alpha_{i,i} = 0 \text{ for } i = 1, 2, \dots, n$$

- *Property 2:* The basis of currency  $i$  vis-à-vis currency  $j$  is exactly the negative of the basis of currency  $j$  vis-à-vis currency  $i$ .

$$\alpha_{i,j} + \alpha_{j,i} = 0 \text{ for } i, j = 1, 2, \dots, n$$

- *Property 3:* The basis matrix can be entirely determined by its  $i$ th row, where  $i = 1, 2, \dots, n$ .

# Basis Matrix on 30 June 2017

	USD	EUR	GBP	CHF	JPY
USD	0.0	-33.1	-7.4	-35.0	-57.8
EUR	33.1	0.0	25.8	-1.9	-24.7
GBP	7.4	-25.8	0.0	-27.6	-50.4
CHF	35.0	1.9	27.6	0.0	-22.8
JPY	57.8	24.7	50.4	22.8	0.0

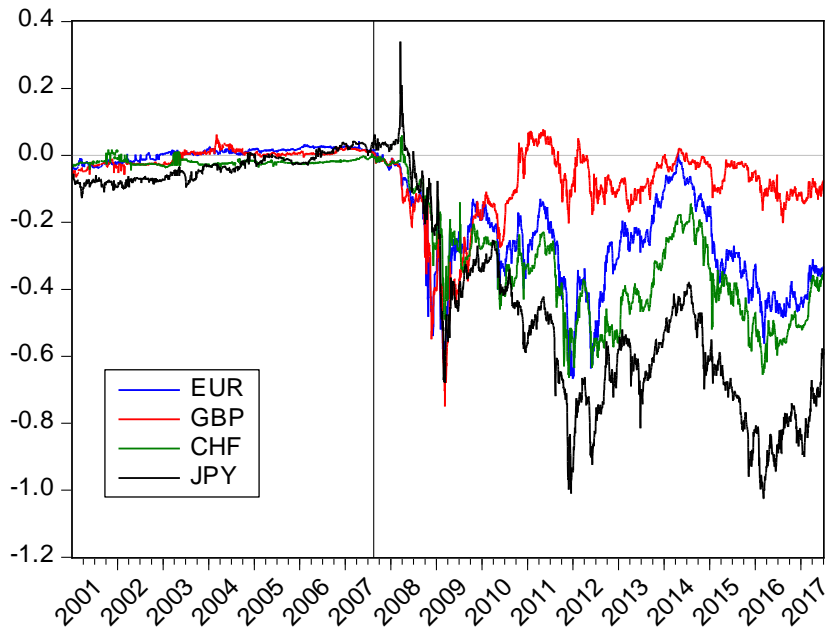
	USD	EUR	GBP	CHF	JPY
USD	0.0	-33.1	-6.9	-35.6	-58.5
EUR	33.1	0.0	26.3	-2.5	-25.4
GBP	6.9	-26.3	0.0	-28.8	-51.6
CHF	35.6	2.5	28.8	0.0	-22.9
JPY	58.5	25.4	51.6	22.9	0.0

	USD	EUR	GBP	CHF	JPY
USD	0.0	0.0	-0.5	0.6	0.7
EUR	0.0	0.0	-0.5	0.6	0.7
GBP	0.5	0.5	0.0	1.1	1.2
CHF	-0.6	-0.6	-1.1	0.0	0.1
JPY	-0.7	-0.7	-1.2	-0.1	0.0

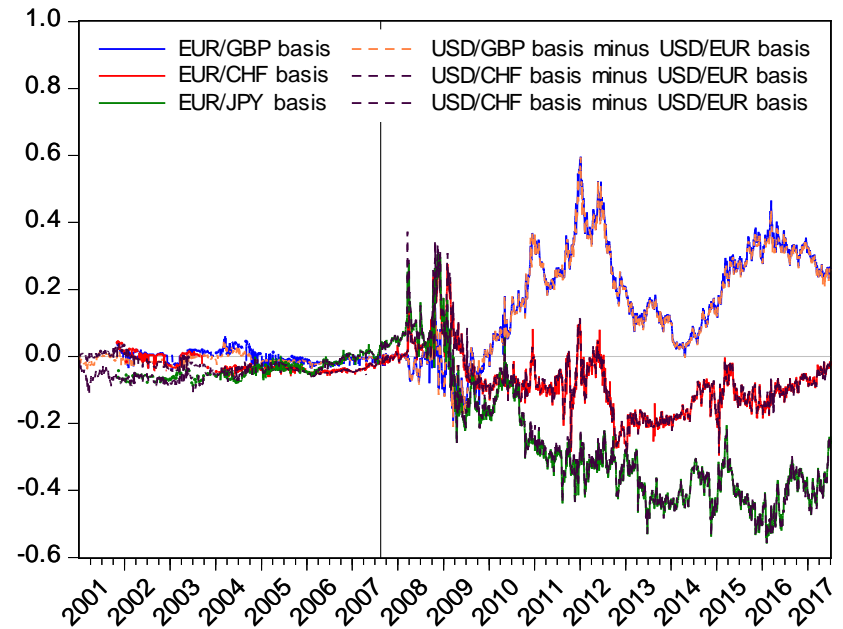
Source: Bloomberg and authors' estimates.

# 5-Year CCBS Basis

## With a USD leg



## With a EUR leg



Vertical line represents 9 August 2007 (BNP Paribas suspended redemption for three of its investment funds).

Source: Bloomberg

# Model

## Risk-adjusted CIP

$$\frac{F}{S} = \frac{1 + r^*}{1 + q^*} = \frac{1 + r - \beta(r - \bar{r})}{1 + q - \gamma(q - \bar{q})} = \frac{1 + \bar{r} + (1 - \beta)(r - \bar{r})}{1 + \bar{q} + (1 - \gamma)(q - \bar{q})}$$

## Log transformation and rearranging

$$\ln F - \ln S \approx \beta \bar{r} - \gamma \bar{q} + (1 - \beta)r - (1 - \gamma)q$$

## Estimating equation

$$\Delta F p_t = C_0 + C_1 \Delta \bar{r}_t + C_2 \Delta \bar{q}_t + C_3 \Delta r_t + C_4 \Delta q_t + \varepsilon_t$$

# Data

- 5-year CCBS of 7 currency pairs involving 5 major currencies
  - EUR, GBP, CHF and JPY vis-à-vis USD
  - GBP, CHF, and JPY vis-à-vis EUR
- Sources and availability
  - Sample period defined by data availability covers 22 Sep 2009 to 30 Jun 2017
  - All data collected from Bloomberg
  - Daily frequency and synchronized at London time 6:00 p.m.
- Dealing with outliers
  - Trimming by 5 standard deviations
  - Winsorizing between 0.5%-99.5% percentiles

# Metadata

	USD	EUR	GBP	CHF	JPY
			<u>IRS rates</u>		
Reference rate	3M Libor	3M Euribor	3M Libor	3M Libor	6M Libor
Payment frequency	Quarterly	Annually	Quarterly	Annually	Semi-annually
			<u>OIS rates</u>		
Reference rate	Effective Fed funds rate	Euro overnight index average	Sterling overnight index average	Tom/next indexed swap in CHF fixing	Tokyo overnight average rate
Description	A weighted average of rates on trades arranged by major brokers	A weighted average of overnight unsecured lending rates in the interbank market, initiated within the Euro area by contributing banks	A weighted average rate of unsecured sterling overnight cash transactions brokered in London by WMBA member firms	Based on quotations from approximately 30 reference banks for its Tom/next unsecured lending rate to prime banks, supplied to Cosmorex AG	Based on uncollateralized overnight average call rates for lending among financial institutions, published by Bank of Japan
Published by	Federal Reserve Bank New York	European Central Bank	Wholesale Markets Brokers' Association	Cosmorex AG	Bank of Japan

# Descriptive Statistic

	USD	EUR	GBP	CHF	JPY
	<u>5-year IRS rate (%)</u>				
Mean	1.60	1.01	1.55	0.27	0.26
Median	1.60	0.83	1.45	0.25	0.25
Maximum	2.94	3.10	3.34	1.73	0.78
Minimum	0.72	-0.34	0.30	-1.00	-0.24
Std. Dev.	0.50	0.93	0.69	0.72	0.19
Obs.	2,012	2,029	1,978	2,015	2,029

	<u>5-year OIS rate (%)</u>				
Mean	1.34	0.78	1.30	0.14	0.14
Median	1.37	0.63	1.18	0.13	0.15
Maximum	2.79	2.82	3.11	1.60	0.57
Minimum	0.47	-0.47	0.13	-0.95	-0.37
Std. Dev.	0.53	0.85	0.68	0.61	0.17
Obs.	2,029	2,029	2,029	1,899	2,029

	<u>5-year IRS-OIS spread (bps)</u>				
Mean	26.3	22.7	25.6	5.2	11.2
Median	25.1	19.6	22.7	9.2	10.5
Maximum	55.7	57.6	66.4	32.3	21.6
Minimum	13.0	7.3	12.1	-18.1	2.6
Std. Dev.	7.1	9.6	8.4	9.3	4.0
Obs.	2,012	2,029	1,978	1,887	2,029

	USD	EUR	GBP	CHF	JPY
	<u>5-year forward premium (annualized, %) vis-à-vis USD</u>				
Mean		-0.93	-0.15	-1.77	-2.01
Median		-0.75	-0.04	-1.51	-2.06
Maximum		0.69	0.62	-0.57	-1.10
Minimum		-2.58	-1.59	-3.19	-2.93
Std. Dev.		0.82	0.47	0.66	0.40
Obs.		2,029	2,029	2,029	2,029

	<u>5-year forward premium (annualized, %) vis-à-vis EUR</u>			
Mean		0.78	-0.84	-1.08
Median		0.65	-0.80	-0.94
Maximum		2.02	-0.26	0.01
Minimum		-0.36	-1.57	-3.11
Std. Dev.		0.51	0.28	0.69
Obs.		2,029	2,029	2,029



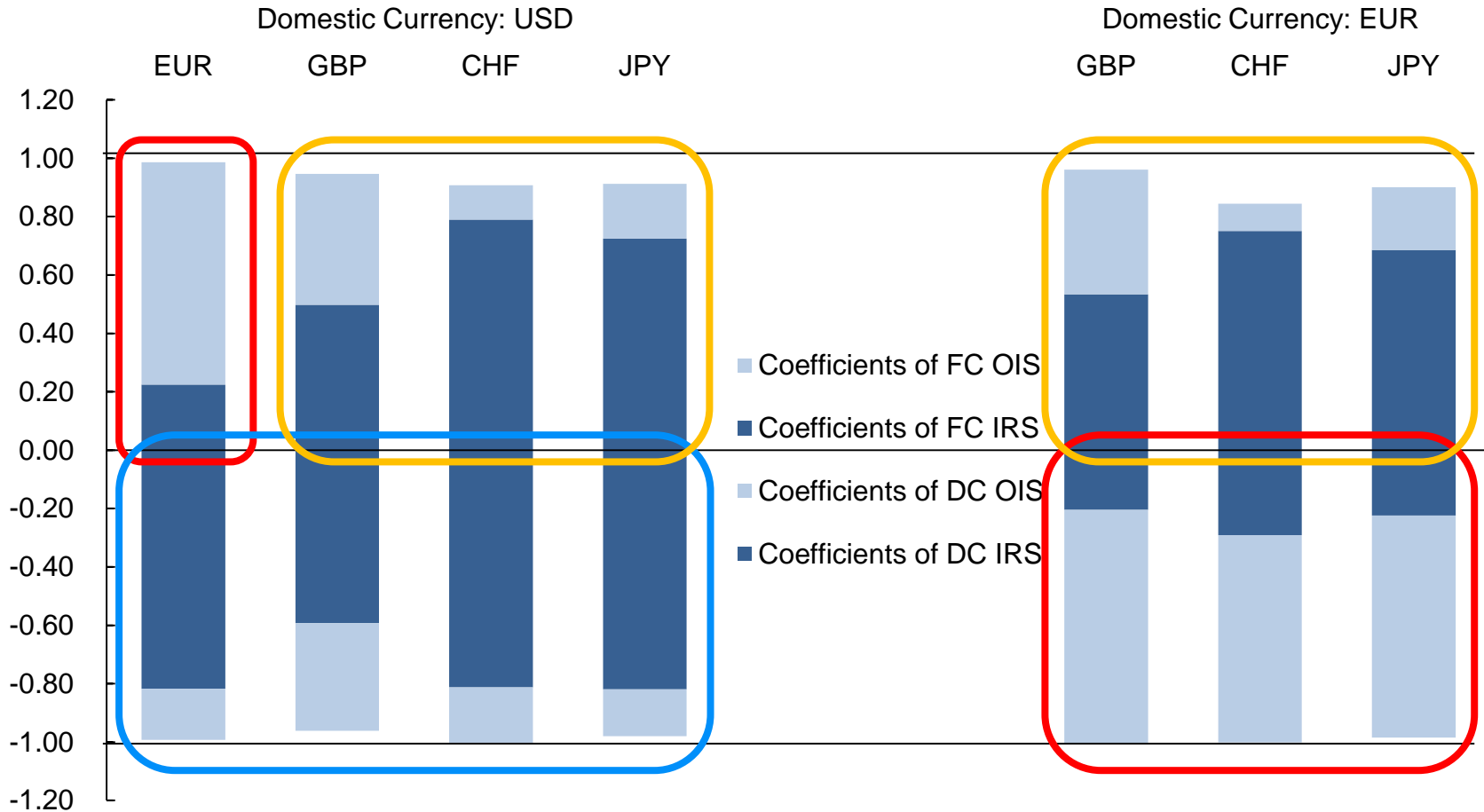
# Estimation and results

$$\Delta Fp_t = C_0 + C_1 \Delta \bar{r}_t + C_2 \Delta \bar{q}_t + C_3 \Delta r_t + C_4 \Delta q_t + \varepsilon_t$$

Foreign currency	EUR	GBP	CHF	JPY	GBP	CHF	JPY
	<i>USD as domestic currency</i>				<i>EUR as domestic currency</i>		
Constant	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
C1 (FC OIS)	0.7616*** (0.0382)	0.4480*** (0.0446)	0.1175*** (0.0346)	0.1882*** (0.0643)	0.4262*** (0.0505)	0.0936** (0.0365)	0.2143*** (0.0694)
C2 (DC OIS)	-0.1747*** (0.0333)	-0.3682*** (0.0386)	-0.1893*** (0.0556)	-0.1606*** (0.0495)	-0.7986*** (0.0486)	-0.7096*** (0.0723)	-0.7609*** (0.0629)
C3 (FC IRS)	0.2246*** (0.0368)	0.4979*** (0.0445)	0.7899*** (0.0453)	0.7243*** (0.0703)	0.5343*** (0.0514)	0.7506*** (0.0483)	0.6860*** (0.0742)
C4 (DC IRS)	-0.8176*** (0.0329)	-0.5927*** (0.0376)	-0.8128*** (0.0548)	-0.8196*** (0.0495)	-0.2042*** (0.0468)	-0.2913*** (0.0699)	-0.2239*** (0.0616)
R-squared	0.7986	0.7104	0.6278	0.6873	0.6398	0.3742	0.5183
Adj. R-squared	0.7982	0.7098	0.6270	0.6866	0.6390	0.3729	0.5173
Obs.	1,987	1,908	1,823	1,974	1,930	1,865	2,015

\*\*, and \*\*\* denote statistical significance at 5% and 1% levels.

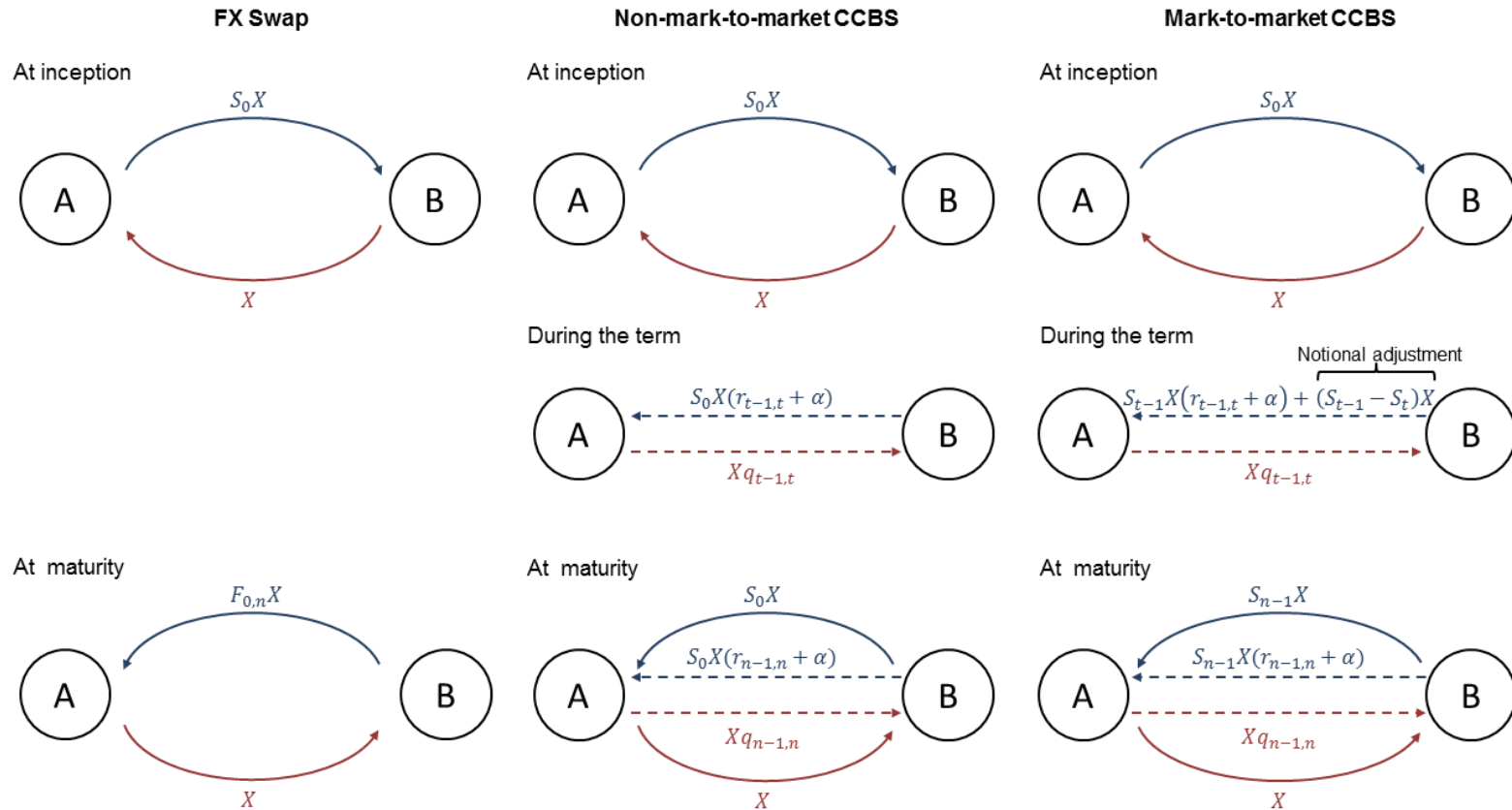
# Shares of Counterparty and Liquidity Risks



# Conclusion

- Breakdown of CIP is no mystery:
  - New trading environment: uncollateralized and collateralized transactions are no longer the same
  - Rational behavior: no more use of “unsecured” interest rates to price “secured” transactions
- It is a myth that breakdown of CIP reflects:
  - Unexploited arbitrage opportunities
  - Market failure
- The basis matrix challenges:
  - Quantity constraints cause limits to arbitrage
  - CIP deviation is a dollar phenomenon

# FX Swap and CCBS

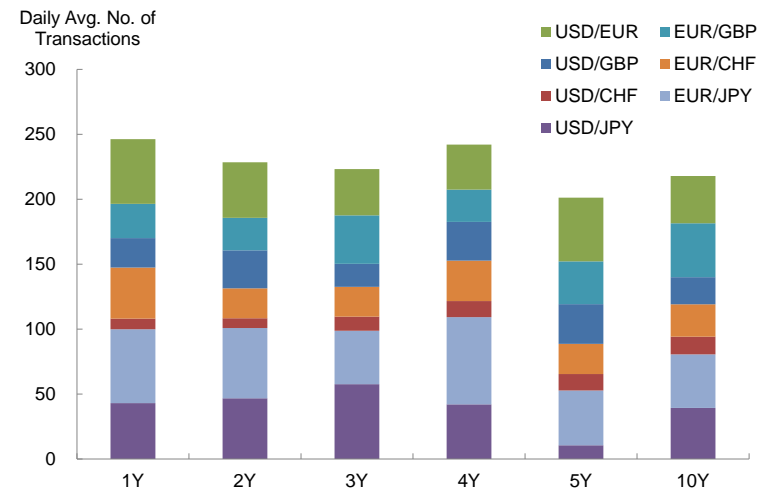
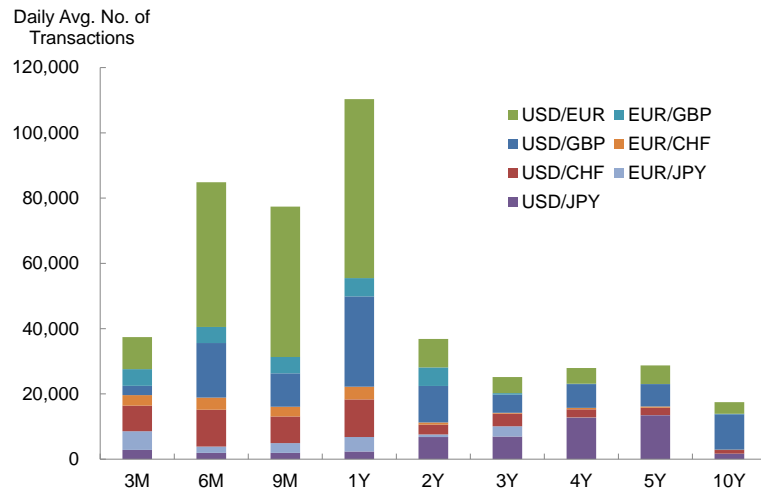


- Both FX swap and CCBS exchange principals but only CCBS exchanges interest payments periodically.
- For CCBS, the market tradition is to quote the foreign currency Libor plus "alpha" (CCBS basis) for US dollar Libor flat.



# FX Swap

# CCBS



Sample period covers 7 July 2016 to 30 June 2017

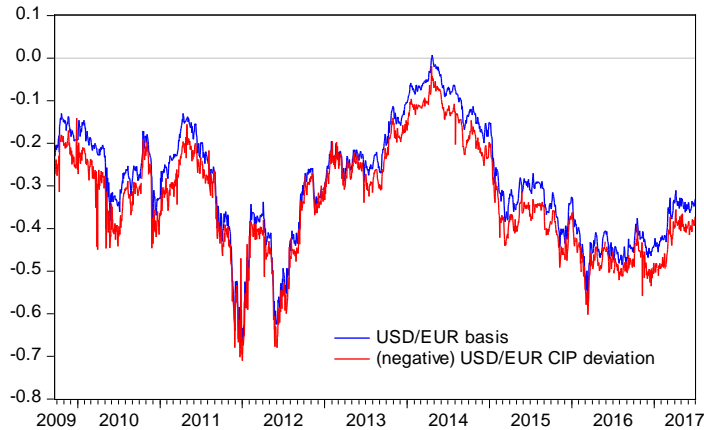
Source: Bloomberg

- FX swap is a much larger market.
- FX swap is more popular for shorter tenors and CCBS is only used for longer tenors.

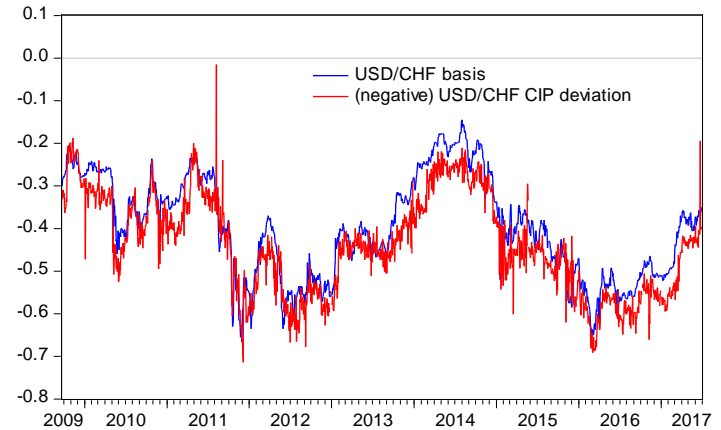


# 5-Year CIP Deviation and CCBS Basis

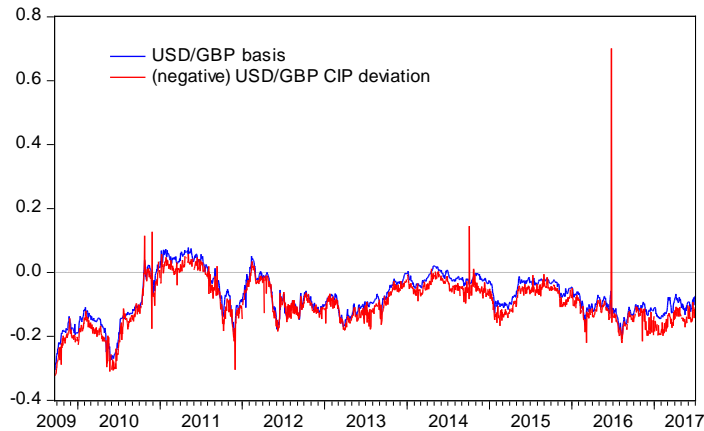
## USD/EUR



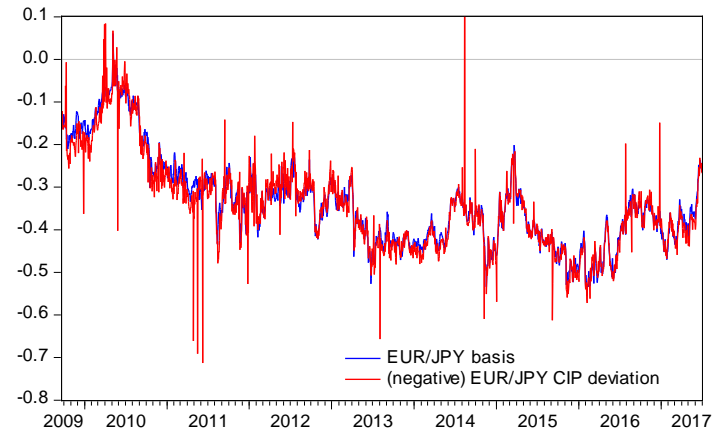
## USD/CHF



## USD/GBP



## USD/JPY

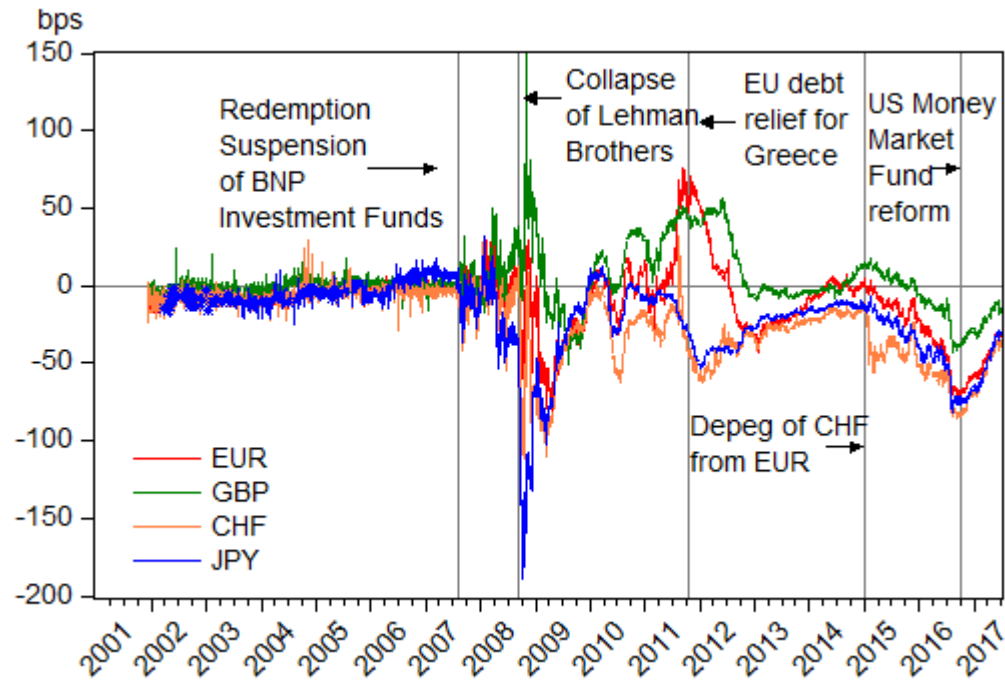


# Quarter-End Spikes (1W Libor-OIS Spreads)

	USD	EUR	GBP	CHF	JPY	Panel
	<i>Whole period</i>					
Constant	0.1257*** (0.0184)	0.0460* (0.0250)	0.0917*** (0.0146)	-0.0758*** (0.0208)	0.0366*** (0.0072)	0.0522*** (0.0017)
Quarter	0.0528*** (0.0085)	0.0275** (0.0135)	0.0182** (0.0071)	0.0092 (0.0167)	0.0100** (0.0047)	0.0247*** (0.0063)
Obs.	2,501	2,535	2,501	1,815	2,255	11,607
R-squared	0.0023	0.0041	0.0011	0.0002	0.0010	0.1217
	<i>Positive interest rate period</i>					
Constant		0.0735** (0.0291)		0.0250*** (0.0060)	0.0417*** (0.0105)	
Quarter		0.0398** (0.0201)		0.0230*** (0.0065)	0.0170*** (0.0053)	
Obs.		1,751		1,244	1,896	
R-squared		0.0069		0.0023	0.0027	
	<i>Negative interest rate period</i>					
Constant		-0.0156** (0.0070)		-0.2951*** (0.0055)	0.0092 (0.0609)	
Quarter		0.0056** (0.0024)		-0.0242*** (0.0084)	-0.0259* (0.0141)	
Obs.		784		571	359	
R-squared		0.0047		0.0109	0.0322	

\*, \*\*, and \*\*\* denote statistical significance at 10%, 5% and 1% levels.

# 12-month Spread of Spreads of Major Currencies



Spread of spreads = non-USD Libor-OIS spread - USD Libor OIS Spreads

Source: Bloomberg