Deviations from Covered Interest Rate Parity

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This Paper

Currently, in one of the largest markets in the world, there are large, long-lasting, and systematic deviations from the covered interest rate parity,

- 1. leading to systematic arbitrage opportunities;
- 2. caused notably by the cost of financial intermediation...
- 3. and its interaction with global imbalances.

Outline

- 1. Arbitrage opportunities
 - Repo basis
 - KfW Basis
- 2. The causal role of banks' balance sheets:
 - the quarter ends' smoking gun
 - CIP deviations and a proxy for banks' balance sheet costs
 - CIP deviations and other spreads
- 3. The role of global imbalances: evidence from nominal interest rates
 - in the cross-section
 - in the time series

From the Covered Interest Parity' Deviations

to the Arbitrage Opportunities

Covered Interest Rate Parity

Without transaction costs:

$$1+y_t^{\$}=\left(1+y_t^{\star}\right)S_t/F_t$$

With transaction costs:

$$1+y^{\$,\textit{ask}}_t \geq (1+y^{\star,\textit{bid}}_t)S^{\textit{bid}}_t/F^{\textit{ask}}_t \text{ and } (1+y^{\$,\textit{bid}}_t)F^{\textit{bid}}_t/S^{\textit{ask}}_t \leq 1+y^{\star,\textit{ask}}_t$$

Deviation from Covered Interest Parity

Cross-currency basis x_t:

$$\left(1+y_t^{\$}\right)=\left(1+y_t^{\star}+\mathbf{x}_t\right)\frac{S_t}{F_t}.$$

In logs, for the intuition:



Three-Month Libor Cross-Currency Basis: G10 Currencies



Three-Month Libor Cross-Currency Basis: G10 Currencies



Five-Year Cross-Currency Basis: G10 Currencies



From the Covered Interest Parity' Deviations to the Arbitrage Opportunities

CIP Arbitrage with a Negative Basis ($x_t < 0$)



Risk-Free Arbitrage Opportunities

- Short-term CIP arbitrage:
 - General Collateral (GC) repo CIP arbitrage
 - Size: \$1.5 trillion in U.S., \$1.8 trillion in Europe, \$0.5 trillion in Japan.
- Long-term CIP arbitrage:
 - KfW bonds denominated in different currencies
 - KfW liabilities are fully backed by the German government
 - Size: Annual issuance about \$70 billion. Outstanding: \$370 billion (\$170 billion EUR and \$130 billion USD).
 - Other AAA supranational issuers: EIB, World Bank, etc.

Short-Term Arbitrage: Repo Contracts

- When the repo basis is negative:
 - 1. Borrow at USD repo for one week,
 - 2. Invest in EUR/CHF/DKK/JPY repo for one week,
 - 3. Perfectly hedge FX risk using FX forwards.

	CHF	DKK	EUR	JPY
Mean basis	-21.4	-41.3	-19.8	-22.3
Std dev of basis	(28.6)	(22.7)	(16.6)	(28.7)
Fractions of sample with negative basis	99%	96%	96%	100%
Mean arb. profits	16.3	19.3	11.5	17.8
Std dev of profits	(27.4)	(23.7)	(13.7)	(22.8)
Fractions of sample with positive profts	84%	67%	81%	93%

Note: All moments in basis points. Arbitrage profits take into account transaction costs of forwards and spots, but miss half repo bid-ask spreads for CHF,

EUR and JPY. The sample is 1/1/2009-12/31/2016.

Long-Term Arbitrage: KfW Bonds

- When the KfW basis is negative (EUR/CHF/JPY), the arbitrage strategy for the dollar investor is:
 - 1. Short KfW bond issued in USD (shorting fee)
 - 2. Long KfW bond issued in EUR/CHF/JPY,
 - 3. Hedge EUR/CHF/JPY FX risk using cross-currency swaps,

	AUD	CHF	EUR	JPY
Mean basis	0.1	-23.5	-13.6	-30.2
Std. dev. of basis	(11.5)	(15.7)	(9.7)	(15.2)
Fractions of sample with negative basis	57%	97%	94%	98%
Mean arb. profit	5.8	15.2	8.7	20.2
Std. dev. of profit	(3.4)	(8.9)	(5.4)	(11.3)
Fractions of sample with negative basis	2%	33%	23%	63%

Notes: All moments in basis points. Arbitrage profits take into account transaction costs of bonds, swaps and median shorting fees. The sample is 1/1/2009-8/30/2016.

Small roll-over risk on shorting fees

The Cost of Financial Intermediation

Banks' Balance Sheet Costs

- Risk-weighted capital rules:
 - Capital charges for a 5-year Libor CIP trade increased from around 0.5% in 2000 to close to 4.5% in 2015
 - Implicit leverage is reduced from 200 to 20.
 - Caveat: Focus here on one CIP arbitrage trade, not on the whole bank portfolio.
- Non-risk-weighted capital rules:
 - Assume that banks need to hold 6% of their capital against the CIP trades, and that their overall objective in terms of rates of return on capital is 10%, then banks need at least a $6\% \times 10\% = 60$ basis point cross-currency basis to engage in the trade.
 - Many CIP deviations are not attractive enough.

Quarter-End Anomalies

- Banks face tighter balance sheet constraints at the quarter end due to regulatory filings (based on quarter-end snapshots for European banks, quarter average + snapshots for U.S. banks) and investors' attention.
- Difference-in-differences (in differences):
 - Quarter-end days vs. the rest of the quarters
 - ▶ Before vs. after the crisis (or the new 1/2015 regulation)
 - ▶ 3M deviations (unaffected) vs. 1M and 1W deviations (affected)
- Null hypothesis:
 - Level: CIP deviations increase at quarter ends, more so post the crisis.
 - Term structure:
 - 3M-1M declines 1M before quarter ends;
 - 1M-1W increases 1M before quarter ends; and then declines 1W before quarter ends.

Level of CIP Deviations at Quarter Ends: $|x^{Yen}|$



Larger Deviations for Contracts Reported at Quarter Ends

	3M	-1M	1M-1W		
	Libor	OIS	Libor	OIS	
QendM _t	0.565 (0.421)	0.573 (0.643)			
$QendM_t imes Post_t$	-4.023***	-4.808***			
$\mathbb{I}(\textit{Qend}M_t = 1,\textit{Qend}W_t = 0)$	(0.552)	(0.770)	-0.625 (0.591)	0.547 (1.338)	
$\mathbb{I}(QendM_t = 1, QendW_t = 0) \times Post_t$			6.517***	4.714***	
QendW _t			(0.760) -3.217*** (0.829)	(1.461) -3.780** (1.777)	
$QendW_t \times Post_t$			-6 567***	-10 34***	
$Post_t$	5.464*** (0.540)	5.395*** (0.576)	(1.073) 0.920 (0.636)	(1.951) -0.240 (1.091)	

Sample period: January 2000 - September 2016

Larger Deviations for Contracts Reported at Quarter Ends

especially after 1/2015

		3M-1M		1M-1W			
	Libor	OIS	Repo	Libor	OIS	Repo	
$QendM_t$	0.565 (0.414)	0.573 (0.636)	-0.471 (0.414)				
$QendM_t \times Post07_t$	-2.390* ^{**}	-3.400***	-7.721***				
$QendM_t imes Post15_t$	(0.567) -9.476*** (0.934)	(0.786) -7.970*** (1.102)	(2.025) -18.87*** (5.827)				
$\mathbb{I}_{QendM_t=1,QendW_t=0}$	(0.000)	()	(0.02.)	-0.625	0.543	0.827	
$\mathbb{I}_{\textit{QendM}_t=1, \textit{QendW}_t=0} \times \textit{Post07}_t$				(0.577) 4.242*** (0.772)	(1.315) 2.392	(1.020) 8.270***	
$\mathbb{I}_{\textit{Qend}M_t=1,\textit{Qend}W_t=0} \times \textit{Post15}_t$				(0.773) 12.76*** (1.226)	(1.400) 11.05^{***} (1.426)	(1.505) 19.84*** (2.625)	
QendW _t				-3.217***	-3.782**	-5.618***	
$QendW_t imes Post07_t$				(0.809) -1.404	(1.743) -5.725***	(1.525) -8.307***	
$QendW_t imes Post15_t$				(1.085) -33.39*** (1.849)	(1.950) -25.22*** (2.057)	(2.353) -77.10*** (6.177)	
$Post07_t$	5.925*** (0.553)	7.358*** (0.593)	5.925*** (1.216)	0.843	-0.524	1.087	
$Post15_t$	-2.591*** (0.890)	2.312*** (0.816)	0.162 (3.603)	0.444 (1.022)	1.594 (1.030)	5.516** (2.160)	

Taking Stock

- ▶ Banks' balance sheets at the end of the quarter locally cause CIP deviations
 - 1. Role of recent banking regulation on asset prices and arbitrage opportunities
 - 2. Self-regulating behavior of banks? New focus of investors?

A Proxy for the Banks' Balance Sheet Costs:



Excess reserves of depository institutions around \$2 trillion in fall 2016

One-Week IOER-Based CIP Deviations (2009-2016)

Currency	Libor basis	IOER-Libor	OIS basis	IOER-OIS	Repo basis	IOER-Repo	IOER basis
CHF	-21.4	-15.5	-36.8	-24.8	-25.2	-16.5	-13.2
	(28.6)	(29.5)	(36.9)	(37.4)	(32.0)	(34.0)	(30.3)
DKK	-41.3	-35.4	-29.1	-16.1	-33.8	-24.4	-12.0
	(22.7)	(25.6)	(23.6)	(24.4)	(25.2)	(26.2)	(25.7)
EUR	-19.8	-13.9	-22.9	-11.1	-15.5	-7.1	8.8
	(16.6)	(19.1)	(15.8)	(17.2)	(14.7)	(17.3)	(23.6)
JPY	-22.3	-16.4	-26.5	-14.3	-26.6	-18.2	-15.6
	(28.7)	(29.1)	(30.7)	(30.9)	(29.1)	(30.9)	(29.4)
Total	-26.1	-20.2	-28.3	-16.1	-24.7	-16.0	-7.9
	(26.2)	(27.6)	(27.8)	(28.4)	(26.7)	(28.4)	(29.1)

Correlation with Other Fixed-Income Spreads



The Link with Interest Rates

CIP Deviations and Interest Rates: Across Countries





- Other correlations:
 - Corr(KfW basis, KfW yield)=95%
 - Corr(OIS basis, OIS)=83%
 - Corr(Tres basis, Tres yields)=86%.

Funding Cost Arbitrage: KfW+SSA Relative Issuance



CIP Deviations and Nominal Interest Rates: Time Series

- Announcement effects of ECB monetary policy decisions on the cross-currency basis.
 - Event window: 5 minutes before the statement release to end of the press conference for each ECB monthly monetary policy meeting since 2010.
 - Measure monetary policy asymmetry: changes in 2-year German bund and U.S. Treasury yield differentials.
 - Intraday 1-year Libor cross-currency basis directly quoted by a major European bank.

ECB Monetary Policy and Euro/Dollar Basis



$$\Delta x_i = 0.024 + 0.150^{***} (\Delta y_i^{GE} - \Delta y_i^{US}).$$

(0.056) (0.025)

Conclusion



- 1. Persistent arbitrage opportunities in currency markets post-crisis.
- 2. Partly due to banks' balance sheet costs
- 3. Strongly correlated with nominal interest rates