Credit Migration and Covered Interest Rate Parity

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CIP and bond market

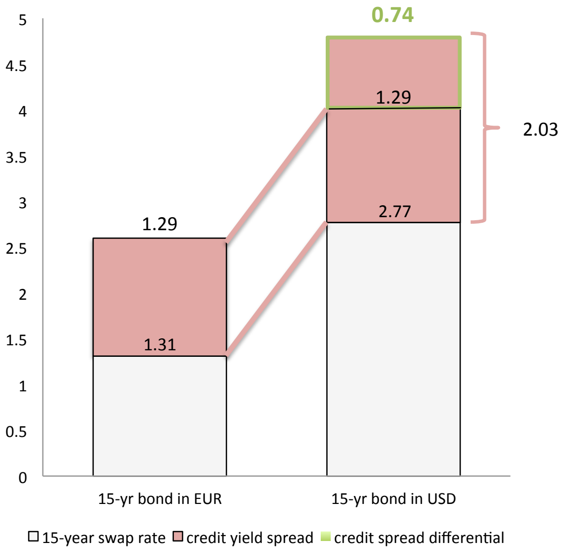
- Short-term CIP violation: related to bank funding and money market
- **This paper** studies the relationship between long-term CIP violation and bond market
  - How do CIP violations affect pricing in bond markets?
  - How do issuers (and investors) respond?
  - What are the influences of issuers and investors on CIP?
  - Which direction is the spillover?
  - How are CIP deviations integrated across the term structure?

The Law of One Price in credit and FX markets

- Credit
  - Credit spread should reflect the pricing of credit default risk:
    - probability of default and loss-given-default
  - Law-of-one-price violation in the credit market:
    - bonds with identical credit risk have different credit spreads
- Exchange rate
  - Forward exchange rate should be equal to the spot exchange rate after adjusting for risk-free rate differential between two currencies
- Law-of-one-price violation in one market can spill over to another

Example of discrepancy in the price of credit default risk

In November 2014, AT&T had bonds in USD around 15 year maturity trading 4.8% and bond in EUR with similar maturity trading at 2.6%.



Price discrepancy in credit risk along currency lines

Measurement

- Cross-sectional regression at each date t

$$S_{it} = \underbrace{\alpha_{\mathbf{ct}}}_{\text{currency FE}} + \underbrace{\beta_{ft}}_{\text{firm FE}} + \underbrace{\gamma_{mt}}_{\text{maturity FE}} + \underbrace{\delta_{rt}}_{\text{rating FE}} + \varepsilon_{it}$$

  - S_{it} is the yield spread over the swap curve for bond i
  - $\alpha_{\mathbf{ct}}$ is the residualized credit spread for currency c at time t

- $\alpha_{\mathbf{ct}} - \alpha_{\mathbf{usd,t}}$ measures the discrepancy in the price of credit risk between bonds denominated in currency c and those denominated in dollar at date t

Data detail

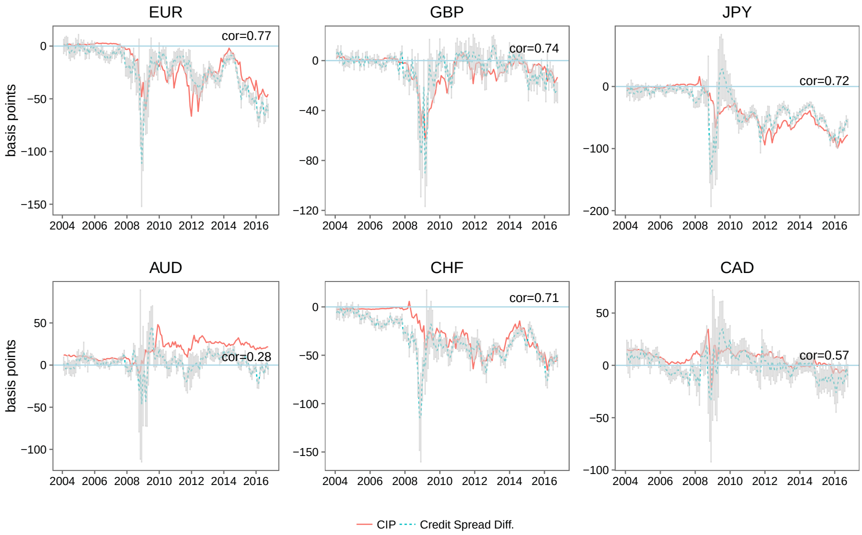
Credit spread differential widened after 2008

Residualized credit spread relative to dollar credit ($\alpha_{c,t} - \alpha_{usd,t}$)

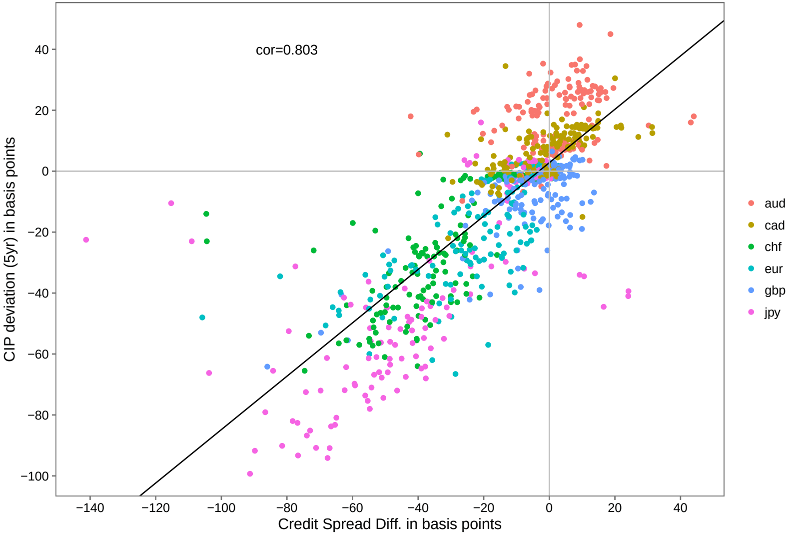
Deviations in credit and FX are aligned

Residualized credit spread differential (EU-US) and 5-year CIP deviations in EUR/USD

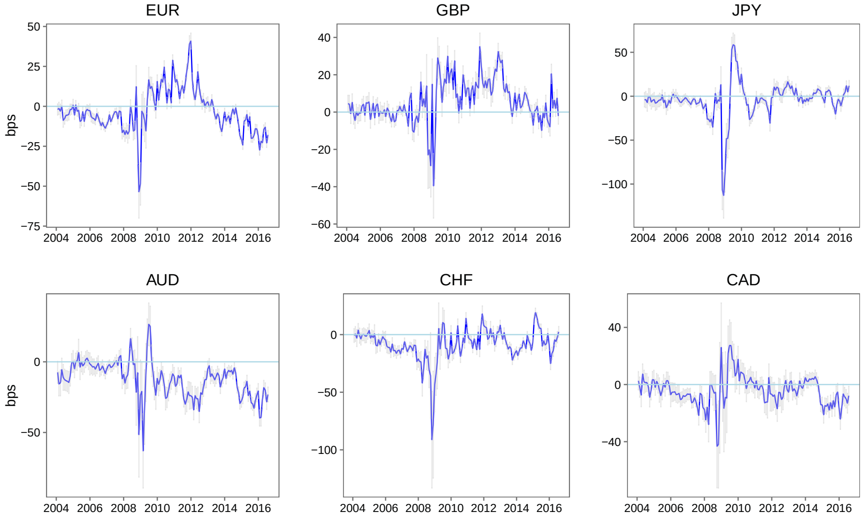
Alignment of credit spread differential and CIP deviation relative to USD



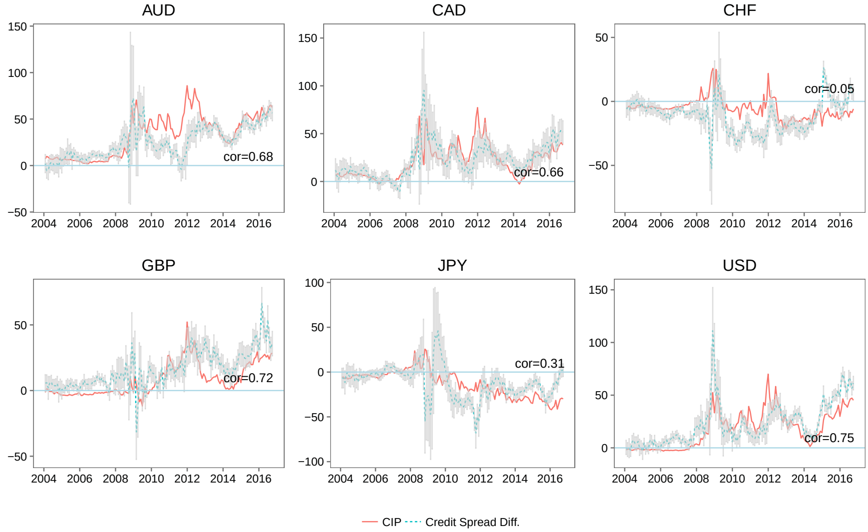
Cross-sectional and time serial alignment

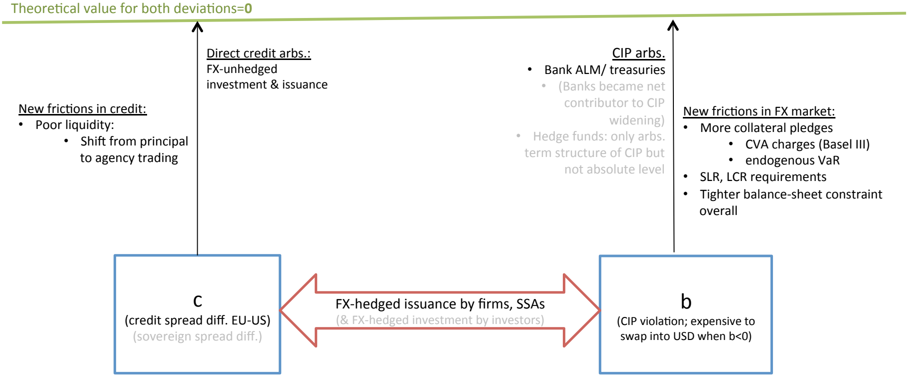


Net deviation (credit -CIP) is an arbitrageable incentive



Alignment of deviations relative to EUR





c shocks

- QEs: Fed QE (+), ECB QE (-)
- Differential reaching-for-yield motives
- U.S. Credit Crunch (07-08)
- Benchmark changes
  - e.g. Japan's GPIF
- Idiosyncratic shocks on individual bonds/issuers
  - Cross-section: larger for low grade bonds

b shocks

- Dollar liquidity shortage: foreign banks with dollar funding needs
  - wholesales $ funding shocks
  - MMF reform
- Fed IOER arb.
- Derivative hedging (e.g. PRDC)
- Hedging of previously unhedged FX exposure
  - E.g. Solvency II (UK) hedging requirement for insurance companies
  - Exporters covering their outright exposure

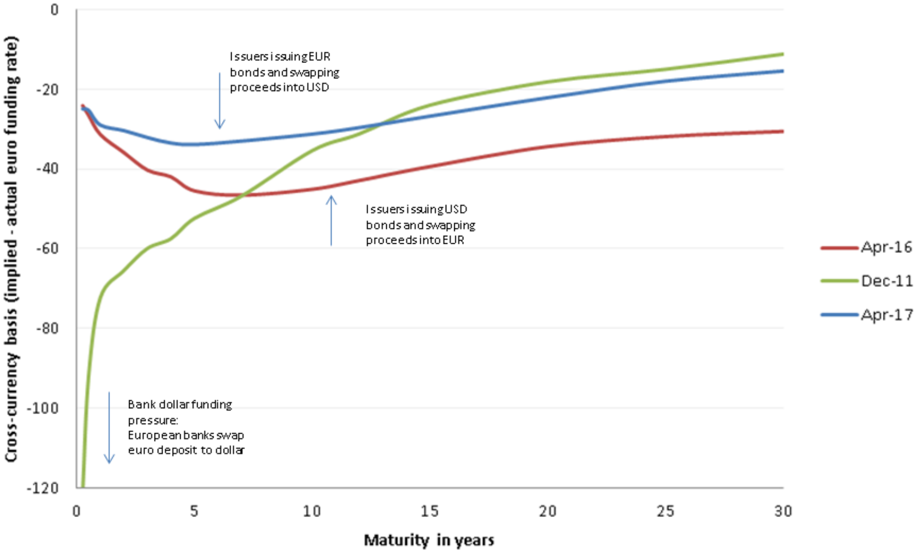
Theoretical backstop: Fed swap line OIS +100/ +50 since 2012

Why issuers and investors are the marginal pricers of long-term CIP?

- Issuers and (real-money) investors:
  - need to borrow/invest regardless
  - Issuers with domestic funding (and investors with local-currency benchmarks) needs simply change the allocation of synthetic versus actual local-currency bond issuance
  - U.S. investors swap dollar to euro to invest in euro-denominated bonds (sovereign, SSA and corporate)

- Hedge funds
  - need to maintain small cash outlay, i.e. require high leverage
  - but can't lever up easily: unsecured borrowing is difficult; collateralized borrowing, e.g. via repo market, requires scarce high-quality collateral
  - excels at integrating CIP term-structure via forward-starting cross-currency basis swap that does not have initial cash exchange

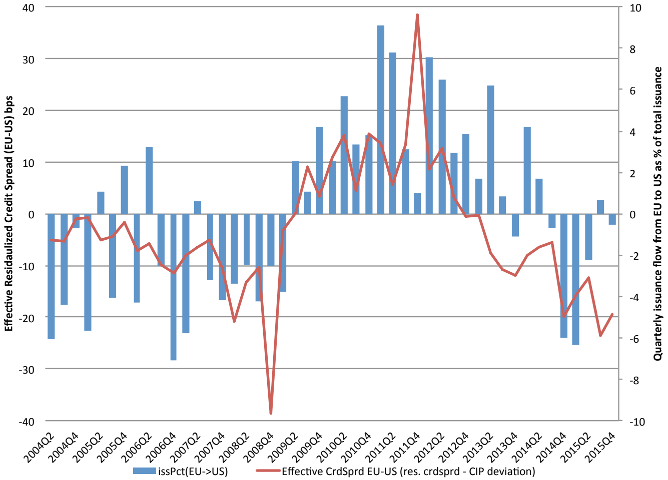
CIP term structure for EUR/USD



Issuance flow and net deviation

- cheaper net cost of issuance in EUR induces more issuance in euro and less in dollar

$$issPct^{EU \to US} = \frac{\text{EU firm issuance in dollar - US firm issuance in euro}}{\text{total issuance in dollar \& euro}}$$



Spillover of deviations

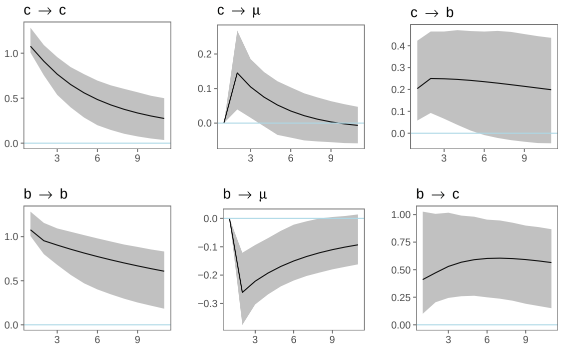
Structured VAR

Dollar issuance share:

$$\mu \equiv \frac{\text{EU firm issuance in dollar - US firm issuance in euro}}{\text{total issuance in dollar \& euro}}$$

IRF of credit spread differential c, currency-basis b, and dollar issuance share μmatching model prediction

$$\varepsilon_{credit} \ \textit{shock: } c\uparrow \Rightarrow \ \mu\uparrow \Rightarrow \ b\uparrow$$
$$\varepsilon_{basis} \ \textit{shock: } b\uparrow \Rightarrow \ \mu\downarrow \Rightarrow \ c\uparrow$$



Issuance and net deviation

$$issPct^{EU \rightarrow US}_{6m.avg.} = \beta_0 + \beta_1 netdev_t + \beta_2 ratediff_t + \varepsilon_{t+1}$$

	Net issuance flow (EU→US) /total issuance pct.					
	eur	gbp	jpy	aud	chf	cad
net dev.	0.247	0.157	0.0353	0.00709	0.119	-0.0534
	[5.08]	[2.11]	[2.10]	[0.07]	[3.47]	[-0.75]
rate diff.	0.0175	-0.0165	0.0256	0.0271	0.00675	0.093
	[1.65]	[-0.77]	[5.50]	[3.52]	[1.14]	[5.32]
_cons	0.984	9.51	5.94	2.26	0.266	7.32
	[0.99]	[4.92]	[4.46]	[1.49]	[0.31]	[6.63]
n	151	151	151	151	151	151

t-stats in bracket based on Newey-West standard errors with lag selection based on Newey-West(1994)

Firm-level panel: Issuance and net deviation

- Linear probability model of firm issuance choice in currency c: $I_{ftc}\{\text{issued in } c\}$ is an indicator that equals to 1 if firm f issues bond in currency c in month t

$$I_{ftc}\{\text{issued in } c\} = \beta_0 + \beta_1 c_t + \beta_2 b_t + \varepsilon_t$$

	prob.(issue in ccy c)	
	(1)	(2)
credit dev. c	-0.0727	
	[-5.41]	
cip	0.135	
	[3.19]	
net dev. (c-b)		-0.074
		[-5.53]
firm FE	x	x
time FE	x	x
ccy FE	x	x
rsq	0.18	0.18
n	28726	28726

t-stats in bracket based on robust standard errors clustered by firm and time

Evidence from SEC filings

AMGEN

10K: “To hedge our exposure to foreign currency exchange rate risk associated with certain of our long-term notes denominated in foreign currencies, we entered into cross-currency swap contracts, which effectively convert the interest payments and principal repayment of the respective notes from euros/pounds sterling to U.S. dollars.”

APPLE INC.

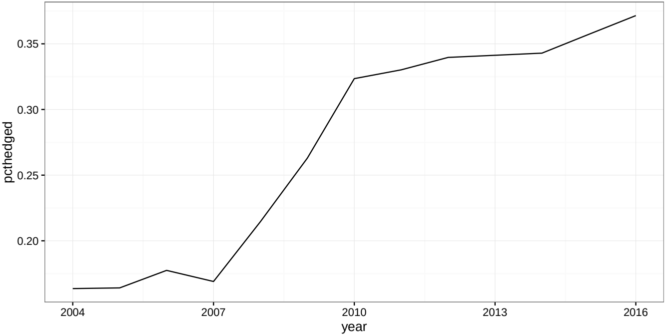
10Q: “In the first quarter of 2015, the Company issued €2.8 billion of Euro-denominated long-term debt. To manage foreign currency risk associated with this issuance, the Company entered into currency swaps with an aggregate notional amount of $3.5 billion, which effectively converted the Euro-denominated notes to U.S. dollar-denominated notes.”

at&t

10K: “We have entered into multiple cross-currency swaps to hedge our exposure to variability in expected future cash flows that are attributable to foreign currency risk generated from the issuance of our Euro, British pound sterling, Canadian dollar and Swiss Franc denominated debt. ”

A textual analysis of hedged issuance for S&P 500 firms

Fraction of SEC 10K filings of S&P500 firms with mentions of words relating to 1) "debt issuance", 2) "exchange rate", 3) "hedging" and 4) "derivatives" in the *same* sentence



Conclusion

- CIP violations and global bond market distortions are linked
- Discrepancy in the price of credit risk for bonds denominated in different currencies
- High alignment between credit spread differential and CIP violations
- Currency-hedged issuance and investments tie together the two violations
- Arbitrage processes are imperfect in both markets, but capital flows ensure that the deviations are linked
- Limits to arbitrage in one market can spillover to another

Thank you!

Appendix

Appendix: Model setup

- Two credit markets (euro- and dollar- based) with two downward sloping demand curves
- FX swap market also with a downward sloping demand curve

- Main ingredients:
    - Corporations: U.S. firm that can issue debt in both currencies (can also be broadly interpreted as global investor that both buy and sell debt with currency hedge)
    - U.S. credit investors: can only invest in USD
    - European credit investors: can only invest EUR
    - Currency swap trader: arbitrage CIP deviation but needs to post collateral

Appendix: Simple firm decision

- suppose for simplicity that UIP holds, but CIP fails
- fixed debt amount D needed for dollar-based operation
- credit spread differential (EU-US) c and CIP basis b
  - e.g. $c = -75$ bps, $b = -50$ bps, effective cost difference of issuing in EUR: $c - b = -25$ bps
- chooses dollar issuance share μ to minimize cost

$$\min_{\mu} \left(\underbrace{-\mu c}_{\text{credit spread diff.}} + \underbrace{\mu b}_{\text{CIP/hedging cost}} \right) D$$

- if effective credit spread difference $c - b < 0$, choose $\mu = 0$, otherwise choose $\mu = 1$
- If total debt amount D is large, then $c - b$ is driven to zero

Simple result: perfect alignment of deviations

Extended Model

Appendix: Credit market

- Two bonds with same default probability π and loss-given-default L, **payoff variance** V; identical except for promised yield Y_U and Y_E:

$$Y_E - Y_U = c + (r_E - r_U)$$

- Mean-variance U.S. and E.U. credit investors with risk tolerance τ choose investment amount X_U or X_E *in their respective market:* $X_i = \frac{\tau}{V}\left((1-\pi)\,Y_i - \pi L - r_i\right)$, where $i = U$ or E
- **Exogenous euro-relative-to-dollar bond demand** ε_c
- Credit market clearing:

$$X_U = \mu D$$
$$X_E + \varepsilon_c = (1-\mu)\,D$$

- Credit spread differential (EU-US):

$$\underbrace{c}_{\text{credit spread differential}} = \underbrace{\frac{V}{\tau}}_{\text{elasticity of bond demand}} \underbrace{\left((1-2\mu)\,D - \varepsilon_c\right)}_{\text{net bond supply in EUR rel. to USD}}$$

Appendix: FX markets

- FX swap trader with wealth W chooses swap size s devoted to arbitraging CIP deviation b or alternative investment opportunity with profit of $f(I)$. Assume that FX swap trading requires collateral proportional to the size of the trade, which takes away $\gamma|s|$ from wealth W.

$$\max_s bs + f(W - \gamma|s|)$$

  - Take functional form $f(I) = \phi_0 I - \frac{1}{2}\phi I^2$ and assume that swap trader has just enough wealth W to take advantage of all positive-NPV investment opportunities in $f(I)$
  - Similar to Ivashina, Scharfstein, and Stein (2015)
- Firm has hedging demand $(1-\mu)D$ from earlier
- Exogenous demand shock for FX swapping into dollar ε_b
- CIP deviation (negative means more costly to swap into USD):

$$\underbrace{b}_{\text{CIP basis}} = -\underbrace{\gamma^2}_{\substack{\text{haircut} \\ \text{on collateral}}} \underbrace{(D(1-\mu) + \varepsilon_b)}_{\substack{\text{net hedging demand} \\ \text{(swap into USD)}}}$$

Appendix: Summary of equilibrium conditions

- CIP basis (negative means more costly to swap into USD):

$$\underbrace{b}_{\text{CIP basis}} = - \underbrace{\gamma^2}_{\substack{\text{elasticity of} \\ \text{fx swap supply}}} \underbrace{\left(D\left(1-\mu\right)+\varepsilon_b\right)}_{\substack{\text{net hedging demand} \\ \text{to swap EUR into USD}}}$$

- Credit spread differential (EU-US):

$$\underbrace{c}_{\text{credit deviation}} = \underbrace{\frac{V}{\tau}}_{\substack{\text{elasticity of} \\ \text{bond demand}}} \underbrace{\left(\left(1-2\mu\right)D-\varepsilon_c\right)}_{\substack{\text{net bond supply} \\ \text{in EUR rel. to USD}}}$$

- Firm choice of dollar issuance ratio:

$$\mu = \begin{cases} 1 & \text{if } c-b>0 \\ 0 & \text{if } c-b<0 \end{cases}$$

Extended Model

Appendix: Model predictions

Prediction 1: Spillover of deviations

$$c \uparrow \Leftrightarrow b \uparrow \text{ when there are } \varepsilon_c \text{ or } \varepsilon_b \text{ shocks}$$

$$\textit{If } \varepsilon_c \uparrow, \textit{ then } c \downarrow \Rightarrow \ \mu \downarrow \Rightarrow \ b \downarrow.$$

$$\textit{If } \varepsilon_b \uparrow, \textit{ then } b \downarrow \Rightarrow \ \mu \uparrow \Rightarrow \ c \downarrow$$

- Shocks to one market is transmitted to the other through capital flows
  - Credit spread differential c and CIP deviations b respond in the same direction to either shocks
  - Dollar issuance share μ responds differentially depending on the shock

Appendix: Model predictions

Prediction 2: Issuance flow and net deviation

$$(c - b) \downarrow \implies \mu \downarrow$$

- cheaper net cost of issuance in EUR induces more issuance flow towards E.U. and less issuance in the U.S.

Appendix: Model predictions

Prediction 3: Arbitrage capital and aligned deviations

$$\frac{\partial|c-b|}{\partial D} < 0$$

$$\lim_{D\to\infty} c - b = 0.$$

- An exogenous increase in total amount of issuance decreases the absolute value of the net deviation.
- As total debt issuance increases towards infinity, the two deviations become identical.

Appendix: Model predictions

Prediction 4: Limits to arbitrage spillover

	Prediction 4 $\gamma \uparrow$ FX haircut	Prediction 5 $\tau \uparrow$ credit risk tol.	Prediction 6 $V \uparrow$ bond risk
$\lvert c \rvert$	$\uparrow$	$\downarrow$	$\uparrow$
$\lvert b \rvert$	$\uparrow$	$\downarrow$	$\uparrow$

- Limits to arbitrage spills over from one market to the other.

Appendix: Model extensions

These extensions, shown in the paper appendix, do not change the main implications of the model

- Global investor that both buys and sells bonds instead of firm that only issues
- Firm is free to choose FX hedging ratio and have a portion of its currency exposure unhedged
- Firm does not have to believe in UIP
- Firm can have foreign operating cashflows and a desired currency mix other than entirely in dollar; there could be shocks to their operation abroad

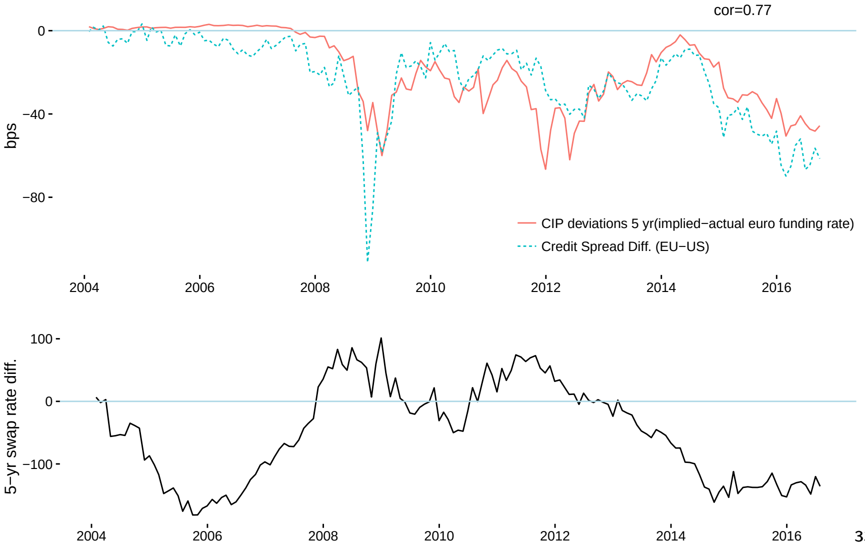
Appendix: Falsifiable alternative

- Alternative hypothesis based on intermediary-based asset pricing: fluctuations to binding constraints for intermediary jointly determine both deviations
    - Equivalent to delivering shocks to and tying together the two elasticities in my model, i.e. suppose $\gamma^2 = \frac{V}{\tau} \equiv \lambda$

- While it is true that the **absolute value of deviations** would be correlated through intermediary capital, that is $\frac{\partial |b|}{\partial \lambda} \propto \frac{\partial |c|}{\partial \lambda}$, shocks to λ would not explain the high alignment in the **direction** and **magnitude** of the deviations in b and c.

- Debt issuing firm in my model effectively fulfills the role of cross-market intermediary

Appendix: Credit and FX LOOP deviations and funding rate difference



Appendix: Bond data summary

- Bond characteristics data from Thompson One SDC Platinum. Bond prices data from Bloomberg
- Include all bullet bonds with original maturity greater than 1 year, amount issued greater than $50mm that can be matched between the two databases.

		All bonds		Global issuers only	
		Number	Notional $bil	Number	Notional $bil
currency	all	35,204	15,937	24,090	12,294
	usd	12,772	6,443	7,954	4,561
	eur	8,625	5,446	6,653	4,556
	jpy	8,152	1,969	5,316	1,474
	gbp	1,492	766	1,238	678
	cad	1,124	516	700	419
	chf	2,017	478	1,301	304
	aud	1,022	319	928	302
rating*	AA- or higher	12,060	7,331	10,528	6,741
	A+ to BBB-	13,732	5,796	8,593	3,782
	HY (BB+ or lower)	1,932	899	1,057	541
	NA	7,480	1,912	3,912	1,230
maturity*	<3yrs	1,268	807	1,012	691
	3-7 yrs	14,850	7,173	10,415	5,702
	7-10 yrs	4,755	1,904	3,141	1,396
	10yr+	14,331	6,054	9,522	4,505

*Rating and maturity summarized here are at issuance. Remaining maturity used in regression is calculated for at date.

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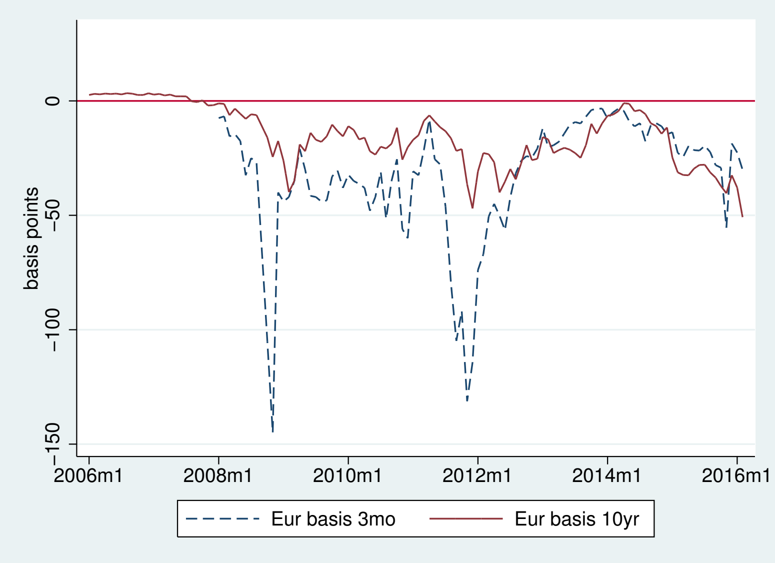
Appendix: CIP short- and long-term for EUR/USD



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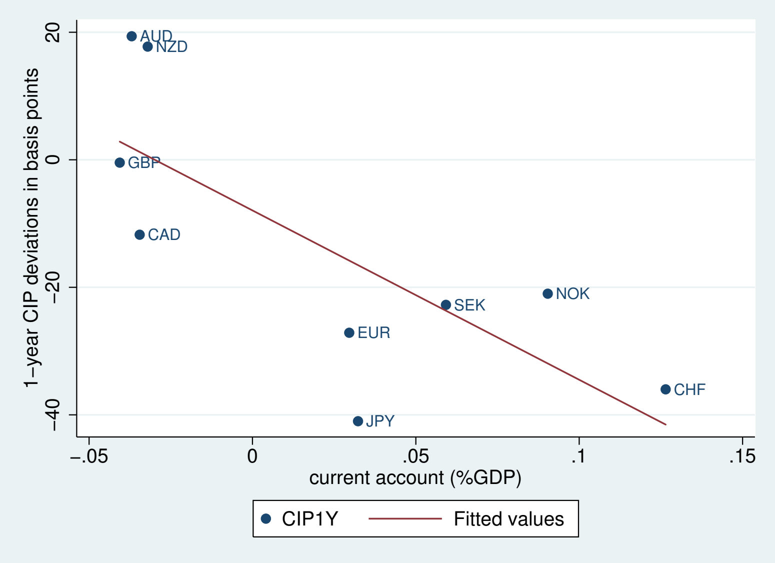
Appendix: CIP cross-sectional heterogeneity



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Appendix: Predictions 4-5: Haircut γ and risk tolerance τ

High grade vs low grade residualized credit spread: all currencies

- $\gamma \downarrow \Longrightarrow |b| \downarrow, |c| \downarrow$, lower haircut γ decreases both deviations
  - proxy γ^{-1} using broker-dealer leverage factor constructed following Adrian, Etula and Muir (2014)
- $\tau \downarrow \Longrightarrow |c| \uparrow, |b| \uparrow$, lower risk tolerance increases both deviations: proxy using VIX index

	credit dev. $\|c\|$		cip dev. $\|b\|$	
levfac γ^{-1}	-4.916		-1.755	
	[-3.40]		[-2.26]	
vix τ^{-1}		0.932		0.499
		[4.15]		[3.25]
_cons	17.83	0.947	18.37	9.589
	[8.70]	[0.21]	[8.09]	[2.40]
N	288	906	288	906

t-stats in bracket based on Newey-West standard errors with lags of 4 quarters or 12 months

- $V \uparrow \Longrightarrow |c| \uparrow$, higher bond risk is associated with larger credit deviation

Appendix Prediction 6: Bond risk V

High grade vs low grade EU-US residualized credit spread

- $V \uparrow \implies |c| \uparrow$, higher bond risk is associated with larger credit deviation