Scrambling for Dollars

Beijing University Presentation

by Bianchi (MPLS FED)   Bigio (UCLA)   Engel (UW)
on April 8, 2023

Intro

> Motivation

UIP Deviation

$$\mathcal{L} = \underbrace{\mathbb{E}\left[\frac{1+i^m}{1+\pi}\right]}_{\text{€ Exp Real Ret}} - \underbrace{\mathbb{E}\left[\frac{1+i^{*,m}}{1+\pi^*}\cdot\frac{e'}{e}\right]}_{\text{\$ Exp Real Ret}}$$

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* ...but what's behind $\mathcal{L}$?

> Contribution

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- Paper: settlement frictions
  - **$ deposits** are international medium of exchange
    - settlements frictions
  - **$ reserve** assets ease settlement friction
    - “scramble for dollars” rather than “flight to safety”

> Birdeye View | International Payments

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- ⋆ International Settlements:
  - ∗ need settlement assets
  - ∗ clearing ("Nostro" account @ correpondant) (Fed account)

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- ⋆ International Settlements:
  - ∗ need settlement assets
  - ∗ clearing ("Nostro" account @ correpondant) (Fed account)
- ⋆ Potential $ settlement deficit
  - ∗ Interbank market (LIBOR) (Fed Funds)
  - ∗ Tap deficit w/ (credit line @ correpondant) (Fed discount window)

> Main Feature | UIP and FX

Deviations from UIP

$$\underbrace{\mathcal{L}\left(\mu, \mu^{*}, \Theta\right)}_{\$\ \mathrm{LP}} = \mathbb{E}\left[\frac{1+i^{m}}{1+\pi}\right] - \mathbb{E}\left[\frac{1+i^{*,m}}{1+\pi} \cdot \frac{e'}{e}\right]$$

$$\begin{aligned} \mu &= \text{€ reserve asset/ € deposit ratio} \\ \mu^{*} &= \text{\$ reserve asset/ \$ deposit ratio} \\ \Theta &= \text{transactions, technology, policy shocks} \end{aligned}$$

* $\mathcal{L}$: encodes frictions

> Talk

- ⋆ Evidence
  - ∗ financial sector μ correlates w/ e
  - ∗ dispersion in interbank rates correlate w/ e

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- ⋆ Evidence
  - ∗ financial sector μ correlates w/ e
  - ∗ dispersion in interbank rates correlate w/ e
- ⋆ Theory:
  - ∗ principle: interbank market unsecured
  - ∗ frictions $\Rrightarrow$ deviations UIP $\Rrightarrow$ FX determination
- ⋆ Fit regressions with shocks to:
  - ∗ payment (volatility)
  - ∗ US interest rate shocks

Empirical Evidence

> Empirical Result: $\mathcal{L}$ and Fed Funds dispersion

- Exchange rates
  - G10 currencies, 2001:m1- 2018:m1
- Regression:
  - Δe vs. inflation differentials
  - Dollar Liquidity Ratio

$$\mu^* \equiv \frac{\text{liquid assets}}{\text{short-term funds}}$$

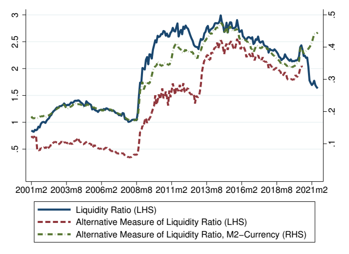
  - + bank liquid-asset/short-term fund ratio:

$$\text{Liquid Assets} \equiv \text{Reserves} + \text{US Treasury}$$

and

$$\text{Short-Term Fund} \equiv \text{Demand Desposits} + \text{Fin. Commercial Paper}$$

> Empirical Result: $\mathcal{L}$ and Fed Funds dispersion



$ Liquidity Ratio

> Empirical Result: $\mathcal{L}$ and Liquidity Ratio

- Baseline regression

$$\Delta e_t = \alpha + \beta_1 \times \Delta\left(\mu_t^*\right) + \beta_2(\pi_t - \pi_t^*) + \beta_3 \mu_{t-1} + \epsilon_t$$

where

$$\mu^* \equiv \frac{\text{liquid assets}}{\text{short-term funds}}$$

Baseline Regression

	EU	AU	CA	JY	NZ	NK	SK	SW	UK
$\Delta\left(\mu_t\right)$	0.23***	0.24***	0.13***	-0.15***	0.30***	0.19***	0.21***	0.15***	0.17***
$\pi_t - \pi_t^*$	-0.54***	-0.42**	-0.41*	0.01	-0.71***	-0.11	-0.49**	-0.67***	-0.39**
μ_{t-1}	0.01**	0.01	0.01	0.00	0.01	0.01*	0.01	0.01	0.01*
cons	-0.01***	-0.00	-0.01*	-0.00	-0.01**	-0.01*	-0.01**	-0.02***	-0.01
N	234	232	234	234	232	234	234	234	234
adj. R^2	0.11	0.05	0.03	0.03	0.10	0.03	0.05	0.04	0.04

t statistics in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

> Remarks

* Regressions
  * quantity variable: not return vs. return

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  * quantity variable: not return vs. return
* Threats:
  * Liquidity Ratio is endogenous (demand vs. supply)
    * supply of assets: depreciates FX
    * demand shocks: appreciate FX
    * but supply responds endogenously
  * correlation with Risk Premia
  * breaking of sample, QE out

> Remarks

- Instrumental Variable Approach

$$\hat{\mu}^* = \alpha + \beta_1^o \Delta(\sigma_t) + \epsilon_t$$

$\sigma_t \equiv$ US LIBOR | Average Monthly Min-Max Traded

- Why?
  - our theory builds on frictions in interbank market (OTC)
  - when frictions aggravate: dispersion increases
  - correlates with greater demand

> Empirical Result: $\mathcal{L}$ and Settlement Frictions

* Second stage IV:

$$\Delta e_t = \alpha + \beta_1 \hat{\mu}^* + \beta_2(\pi_t - \pi_t^*) + \epsilon_t$$

BASELINE REGRESSION

	Euro	AU	CAN	JPN	NZ	NWY	SWE	CH	U.K.
$\hat{\mu}^*$	**0.18**	**0.37****	**0.27****	**-0.22***	**0.54*****	**0.26***	**0.34****	**-0.08**	**0.36*****
$\pi_t - \pi_t^*$	-0.52**	-0.45**	-0.31*	-0.04	-0.74***	-0.06	-0.39**	-0.31	-0.31*
μ_{t-1}^*	0.01	0.01*	0.01**	0.01	0.01	0.01**	0.01	0.01	0.01
ΔVIX_t	0.15***	0.36***	0.32***	-0.01***	0.31***	0.25***	0.20***	0.08**	0.12***
Constant	0.01	0.01	0.01*	0.01	0.01	0.02*	0.01	-0.00	0.01
N	245	245	245	245	245	245	245	245	245

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Dynamic Two-Currency World

> Features

* Open-economy model version of Bianchi-Bigio (2021)
  * stochastic GE, infinite horizon, discrete time
  * 2-country: Euro | US (foreign)

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* Action: "global banks"
    * assets: b real loans | m reserves in \$ and €
    * liabilities: d liabilities in \$ and €
    * payment shocks | settlement friction

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  * assets: b real loans | m reserves in \$ and €
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* Static Demand System by design:
  * static loan demand and deposit supply
  * firms: working capital loans
  * consumers: | work | CIA in two currencies | **risk neutral**
    * **risk neutral** + quasi-linear: static central bank
* Central bank
  * set policy rates | reserve supply | transfers
* Aggregate shocks
  * payment volatility
  * policy

> Environment

* Time: t, discrete, infinite horizon
* X_t vector aggregate shocks

> Environment

- Time: t, discrete, infinite horizon
- X_t vector aggregate shocks
- P_t denominated in €, P_t^* denominated in $
  - dollar denominated
- One good (LOP)

$$P_t = P_t^* e_t$$

- Real Expected Returns:

$$R^x = \mathbb{E}\left[\frac{1+i^x}{1+\pi}\right], \; R^{*,x} = \mathbb{E}\left[\frac{1+i^{*,x}}{1+\pi^*}\right]$$

> Bank's Problem w/o Frictions

- Bank maximizes:

$$v\left(n,X\right)=\max_{\{b,m^{*},d^{*},d,m\}\geq 0} Div+\beta\mathbb{E}\left[v\left(n',X'\right)|X\right]$$

w/ budget

$$Div+b+m^{*}+m=n+d+d^{*}$$

> Bank's Problem w/o Frictions

* Bank maximizes:

$$v(n, X) = \max_{\{b, m^*, d^*, d, m\} \geq 0} Div + \beta \mathbb{E}\left[v\left(n', X'\right)|X\right]$$

w/ budget

$$Div + b + m^* + m = n + d + d^*$$

* No equity frictions so:

$$v(n, X) = n.$$

> Bank's Problem w/o Frictions

- Expected net-worth:

$$\mathbb{E}\left[n'|X\right] = \underbrace{R^b b + R^m m + R^{m,*} m^* - R^d d - R^{*,d} d^*}_{\text{Expected Portfolio Returns}}$$

> Bank's Problem w/o Frictions

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$$\mathbb{E}\left[n'|X\right] = \underbrace{R^b b + R^m m + R^{m,*} m^* - R^d d - R^{*,d} d^*}_{\text{Expected Portfolio Returns}}$$

* Without frictions

$$\frac{1}{\beta} = R^b = R^m = R^{m,*} = R^d = R^{*,d}$$

and

$$\mathcal{L} = 0$$

> Bank's Problem w/ Settlement Frictions

* Net-worth

$$\mathbb{E}\left[n'|X\right] = \underbrace{R^b b + R^m m + R^{m,*} m^* - R^d d - R^{*,d} d^*}_{\text{Expected Portfolio Returns}}$$

$$+ \underbrace{\mathbb{E}\left[\chi^*(s^*|\theta^*)\right] + \mathbb{E}\left[\chi(s|\theta)\right]}_{\text{Expected Settlement Costs}}$$

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* Background: b is illiquid | d circulates | m settles
* Settlement balance (continuum in paper):

$$s = \begin{cases} m + \delta d & \text{pr. } 1/2 \\ m - \delta d & \text{pr. } 1/2 \end{cases} \text{ and } s^* = \begin{cases} m + \delta d & \text{pr. } 1/2 \\ m - \delta d & \text{pr. } 1/2 \end{cases}.$$

* χ capture settlement costs

> Bank's Problem

* Replace b from budget constraint:

$$\begin{aligned}
\mathbb{E}\left[n'|X\right] &= R^b\left(n - Div\right) \\
&+ \underbrace{\left(R^b - R^d\right)d - \left(R^b - R^m\right)m + \mathbb{E}\left[\chi(s|\theta)\right]}_{\text{€ return}} \\
&+ \underbrace{\left(R^b - R^{*,d}\right)d^* - \left(R^b - R^{*,m}\right)m^* + \mathbb{E}\left[\chi(s^*|\theta)\right]}_{\text{\$ return}}
\end{aligned}$$

> Portfolio w/ Settlement Frictions

Portfolio Separation

* Indeterminate *Div*
* $R^b = 1/\beta =$ Return on Equity

* Portfolio:
  * $\{m, d\}$ and $\{m^*, d^*\}$ solved separately

> Portfolio w Settlement Frictions | One Currency Problem

* Bank Objective

$$\Pi = \max_{\{m,d\}} \underbrace{\left(R^b - R^d\right)}_{\text{Arbitrage}} \cdot d - \underbrace{\left(R^b - R^m\right)}_{\text{Liq. Insurance}} \cdot m + \underbrace{\mathbb{E}\left[\chi(s)|\theta\right]}_{\substack{\text{Settlement}\\ \text{Cost}}}$$

* Settlement balance:

$$s = \begin{cases} m + \delta d \text{ pr. } 1/2 \\ m - \delta d \text{ pr. } 1/2 \end{cases}$$

* χ average settlement cost
    * source of curvature

> Microfoundation - Settlment Cost

* Dynamic OTC
  * Alfonso and Lagos (2014,ECMA) + Atkeson et al. (2015,ECMA) = Bianchi-Bigio OTC Model

* Sequential search for reserves:

$$\underbrace{\theta(\mu)}_{\text{Int. Bank Tightness}} \equiv -\frac{S^-}{S^+} = -\frac{\delta D - M}{\delta D + M} = -\frac{\delta - \mu}{\delta + \mu}$$

* Matching:
  * borrow interbank prob $\psi^-(\theta)$, else discount window
  * lend interbank prob $\psi^+(\theta)$, else stay idle

* Clearing:

$$\psi^-(\theta) \cdot S^- = \psi^+(\theta) \cdot S^+$$

> Microfoundation - Intermediation Cost

Liquidity Yields

Penalty

$$\Delta R \equiv \underbrace{R^{dw}}_{\text{penalty}} - R^{m}$$

average liquidity yields:

$$\chi^{+} \equiv \psi^{+}(\bar{R} - R^{m}) \text{ and } \chi^{-} \equiv \psi^{-}(\bar{R}\text{-}R^{m}) + \Delta\text{R}\left(1 - \psi^{-}\right)$$

and

$$\bar{R} \equiv \text{endogenous interbank rate} = f(\theta)\,.$$

* Function χ

$$\chi(s) = \begin{cases} \chi^{-} \cdot s & \text{if } s \leq 0 \\ \chi^{+} \cdot s & \text{if } s > 0 \end{cases}$$

> Yields Equilibrium Rates

Liquidity Premia

For reserves

$$R^b = R^m + \underbrace{\frac{1}{2}\left[\chi^+ + \chi^-\right]}_{\text{reserve-LP}}$$

For liabilities

$$R^b = R^d + \underbrace{\frac{\delta}{2}\left(\chi^- - \chi^+\right)}_{\text{dep-LP}}$$

> Yields Equilibrium Rates

Liquidity Premia

For reserves

$$R^b = R^m + \underbrace{\frac{1}{2}\left[\chi^+ + \chi^-\right]}_{\text{reserve-LP}}$$

For liabilities

$$R^b = R^d + \frac{\delta}{2}\underbrace{\left(\chi^- - \chi^+\right)}_{\text{dep-LP}}$$

Across currencies:

$$R^m + \underbrace{\frac{1}{2}\left[\chi^+ + \chi^-\right]}_{\text{reserve-LP}} = R^{*,m} + \underbrace{\frac{1}{2}\left[\chi^{*,+} + \chi^{*,-}\right]}_{\text{reserve-LP}}$$

* Liquidity premia: works like "risk" premia
  * **NOT:** risk aversion | not limited equity
  * **YES:** currency payment size | settlement technology | monetary policy

Theoretical Results

> Theorems | Special Case

* Following Propositions
  * deposit supply: perfectly inelastic
  * i.i.d shocks or random walk

* Generalize to a continuum shocks;

General Shock

withdrawal shock ω distributed $F(\cdot, \sigma)$. Deficit is:

$$\delta(\sigma, \mu) = \int_{\mu}^{1} \omega f(\omega, \sigma)\, d\omega$$

> Size of Dollar

Funding Shock

Shock D^*

1) iid: appreciates dollar, reduces liquidity ratio and increase premia:

$$\frac{d \log e}{d \log D^*} \in [0, 1),$$

2) rw: appreciates dollar, but neutral

$$\frac{d \log e^*}{d \log D^*} = 1$$

> Liquidity Risk

Assume:

$\delta^*_{\sigma^*} > 0$

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$\delta^*_{\sigma^*} > 0$

Dollar Payment Volatility

Shock σ^*:

1) iid: appreciates the dollar, raises liquidity ratio, and increase premia:

$$\frac{d\log e}{d\log\sigma^*} = \frac{d\log\mu^*}{d\log\sigma^*} \geq 0,$$

2) rw: appreciates the dollar, raises the liquidity ratio, but neutral:

$$\frac{d\log e}{d\log\sigma^*} = \frac{d\log\mu^*}{d\log\sigma^*} \geq 0.$$

- Takeaway:
  - liquidity risk: increases scramble for dollars, correlation with bond premia
  - if us vol permanently high: dollar low interest rate currency

> Interest Rate

Effects of Policy Rates

Shock to $i^{*,m}$ fixed ΔR

1) iid: appreciates dollar, raises liquidity ratio and reduces the premia:

$$\frac{d\log e}{d\log\left(1+i^{*,m}\right)} = \frac{d\log\mu}{d\log\left(1+i^{*,m}\right)} \in (0,1].$$

2) rw: appreciates dollar, increases liquidity ratio and reduces all premia:

$$\frac{d\log e}{d\log\left(1+i^{*,m}\right)} = \frac{d\log\mu^{*}}{d\log\left(1+i^{*,m}\right)} > 0.$$

- Takeway: but not 1-for-1 as in standard model
  - Fama puzzle, Alvarez, Atkeson, Kehoe

Producing the Data

> Back to Empirical relationships

Generalized shocks to AR(1): log-linear approx

Effects of Policy Rates

Regression

$$\Delta \log e = cons + \beta^{e}_{\mu^*} \cdot \Delta \log \mu$$

Then, theoretical coefficient:

$$\beta^{e}_{\mu^*} = \sum_{x \in \{\sigma^*, D^*\}} \beta_x \cdot \boldsymbol{w}_x$$

β_x

$$\beta_{\sigma^*} = 1 \text{ and } \beta_{D^*} \approx \frac{\left(1 - \rho^{D^*}\right) R^{b}_{ss}}{\mathcal{LP}_{\theta^*} \theta^{*}_{\mu^*} \mu^{*}_{ss}} < 0.$$

Weights $\boldsymbol{w}^x$: high variance, high persistence

- Takeway: payment volatility drives relationship if signal is strong

> Moment Fit

Calibration:

* Calibrate interbank features

Estimate:

* Kalman filter: shocks to $\sigma' s$ and $D' s$ and UIP wedge
* Fit: BP, CIP, FX and Liquidity Ratios

* Baseline regression

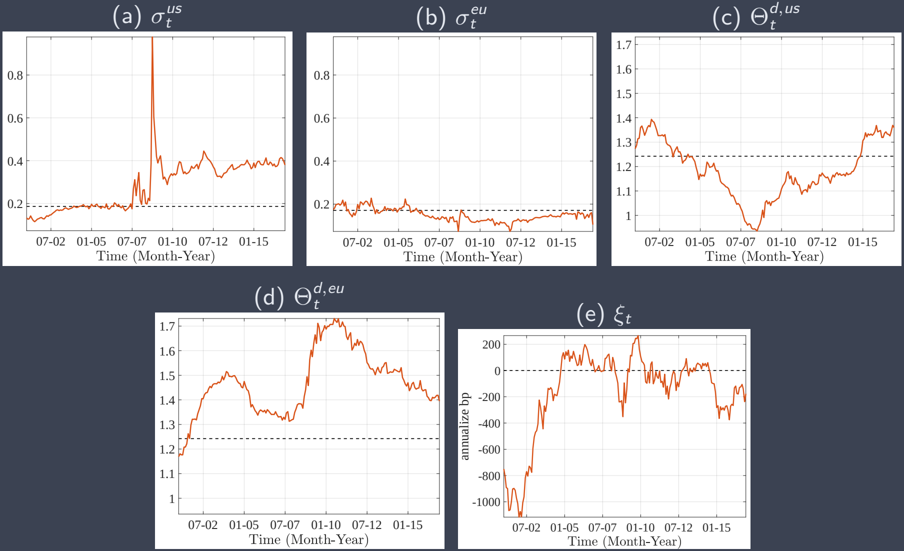
$$\Delta e_t = \alpha + \beta_1 \Delta\left(\mu_t^*\right) + \beta_2(\pi_t - \pi_t^*) + \beta_3 \mu_{t-1} + \epsilon_t$$

* Other countries: like Euro, but different policy rates

Baseline Regression as in Empirical Section

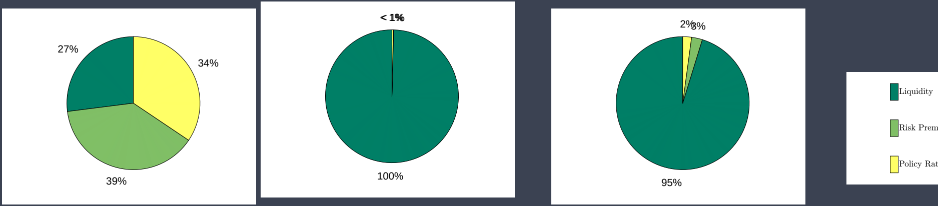
	EU	AU	CA	JY	NZ	NK	SK	SW	UK
$\Delta\left(\mu_t\right)$	**0.12**	**0.16**	**0.17**	**0.17**	**0.16**	**0.15**	**0.16**	**0.16**	**0.16**
$\pi_t - \pi_t^*$	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
μ_{t-1}	0.01	0.01	0.01	0.00	0.01	0.01*	0.01	0.01	0.01*
cons	0.01	0.01	0.01	0.01	0.01	0.01	0.01*	0.01	0.01
N	234	232	234	234	232	234	234	234	234
adj. R^2	0.04	0.03	0.06	0.04	0.04	0.05	0.05	0.06	0.05

> Filtered Shocks



Estimated Shocks using the Kalman filter

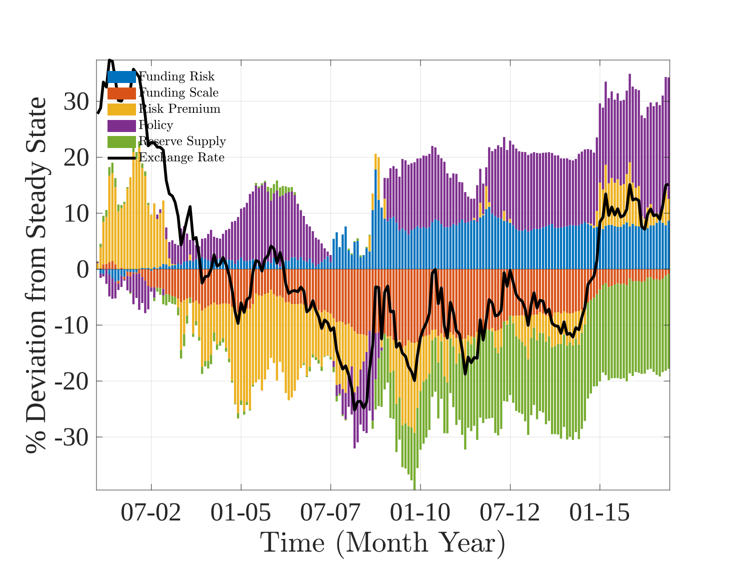
> Variance Decomposition



(a) Euro-Dollar (b) $\mathcal{BP}$ (c) $\mathcal{CIP}$

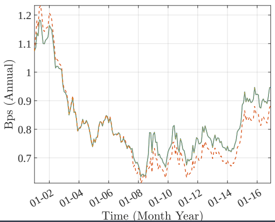
Variance Decomposition of Shocks

> Shock Decomposition

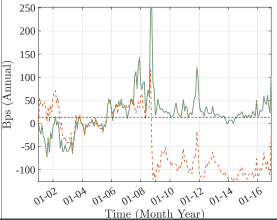


> Counterfactuals

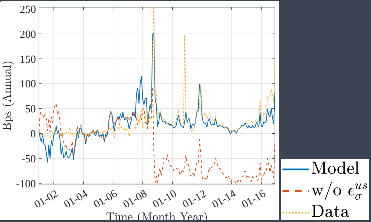
(a) Log Euro-Dollar



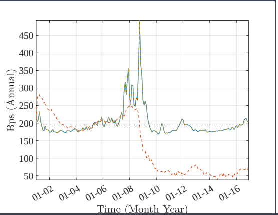
(b) $\mathcal{CIP}$ (reserves)



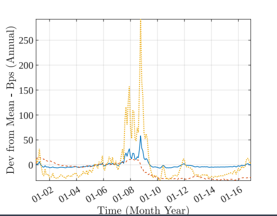
(c) $\mathcal{CIP}$ (interbank)



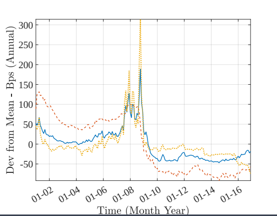
(d) Convenience Yield $(R^b - R^m)$



(e) Ted Spread ($R^{f,us}$- $R^{m,us}$) - deviation from mean



(f) Funding Spread $(R^{d,us} - R^{m,us})$ - deviation from mean



Counterfactual without σ^{us}

Conclusion

> Conclusions

* Recent work: convenience yield | liquidity yields | specialness of $
  * source of convenience yield: liquidity of financial institutions
  * model: links liquidity | payment frictions | FX
  * empirically: evidence of correlation
* We are relating the model to RER