The Monetary Theory of Exchange Rates Redux: Evidence from China

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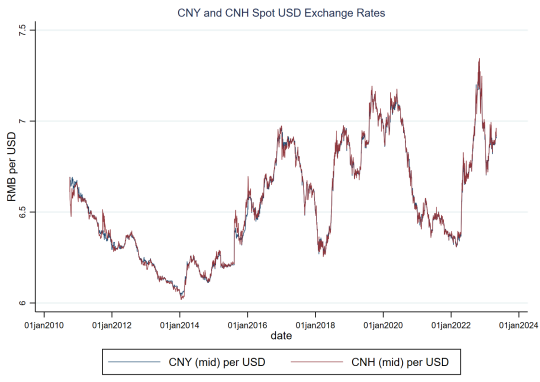
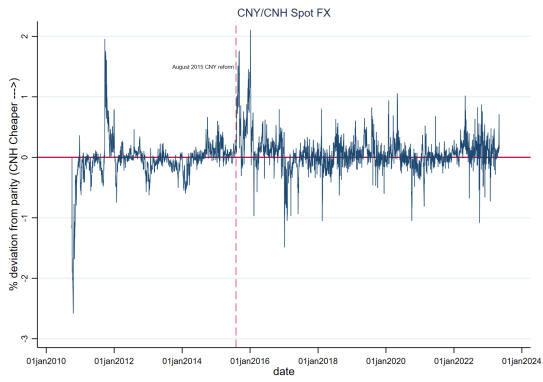
China's dual currency system: CNY/CNH





THE MONETARY THEORY OF EXCHANGE RATES

Monetary approach/theory of exchange rates: "The exchange rate is the relative price of different national monies, rather than national outputs, and is determined primarily by the demand and supplies of stocks of different national monies." Mussa (1977)

Frenkel (1976, 1983) and Mussa (1974, 1977) model (with modern shocks)

$$
\begin{aligned}
i &= i^o - \mathbb{E}(\Delta e) - w && \text{UIP (shock } w\text{)} \\
p + e &= p^o + v && \text{PPP (shock } v\text{)} \\
m - p &= -\eta i + u && \text{Money demand (shock } u\text{)} \\
m^o - p^o &= -\eta i^o + u^o && \text{Money demand, other (shocks } m^o\text{, } u^o\text{)}
\end{aligned}
$$

Central banks control money supply. Print more when the exchange rate is too high, and less when the exchange rate is too low.

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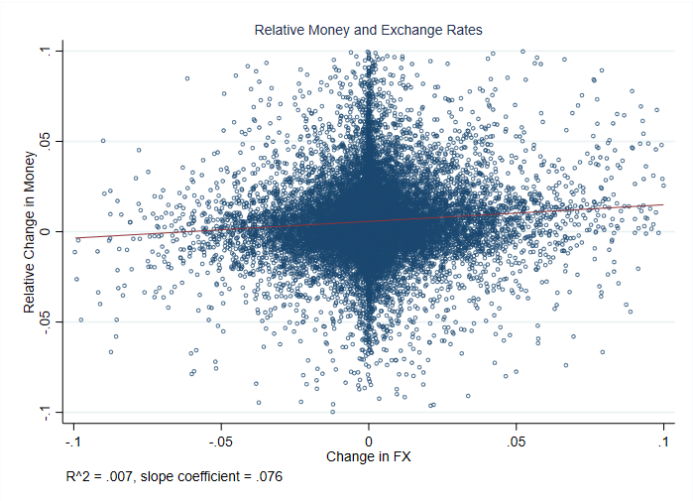
To maintain parity, policy rule:

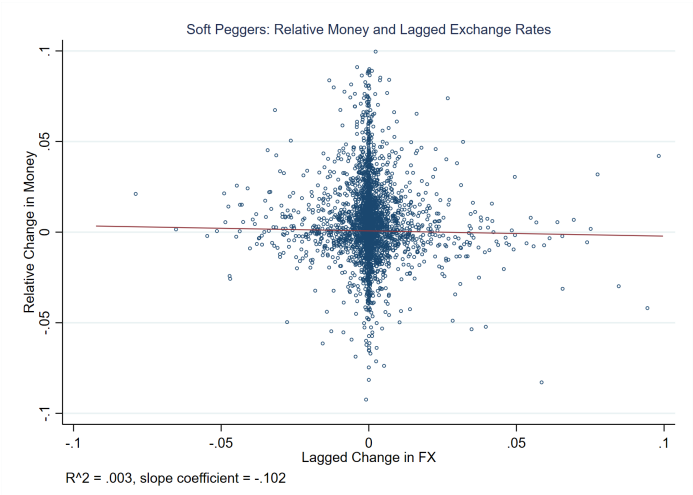
$$m = m^o + \eta w + v + u - u^o.$$

EXCHANGE RATES AND MONEY SUPPLIES



Monthly data 1959-2023, unbalanced panel of 95 countries, IFS, all relative to USD/ US m.

Exchange rates and money supplies: managed FX



Monthly data 2002-2023, unbalanced panel of 35 countries, 3-5 Ilzetzki-Reinhart-Rogoff scale

Why CNY/CNH is a good testing ground

Model solution is

$$e_t = \sum_{j=0}^{\infty} \left(\frac{\eta}{\eta + 1} \right)^{j+1} \mathbb{E}_t \left[u_{t+j} - u^o_{t+j} + v_{t+j} + \eta w_{t+j} - \left(m_{t+j} - m^o_{t+j} \right) \right],$$

other shocks dwarf movements in relative money.

What makes is CNH CNY a good testing ground?

- Integrated goods market so $Var(v) \approx 0$
- Same banks on both sides of the border, $Var(w) \approx 0$.
- PBoC controls the relative supply of the two moneys (including m^o)
- Transparent offshore monetary framework.

PLAN FOR THIS TALK

1) Institutional background.

2) A first test from the CNY reforms and post 2017 period. Monetary theory works quite well.

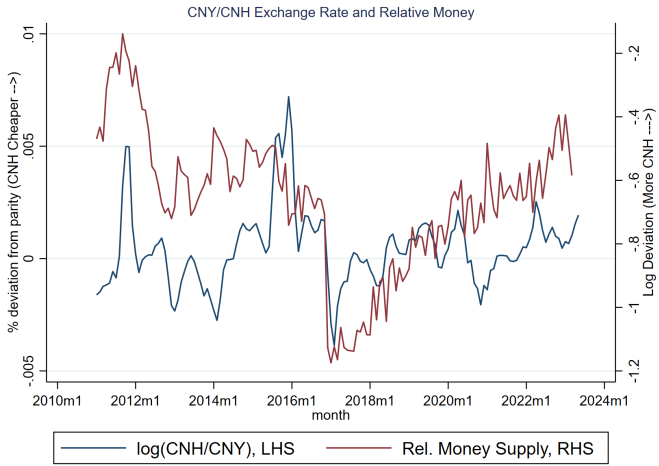
3) Model of the offshore/onshore banking system to develop clear empirical predictions: what is the right measure of money or interest rates?

4) Stronger support for the theory in the data.

THE DUAL CURRENCY SYSTEM

- Deposits in Shenzhen are in CNY. Deposits in Hong Kong are in CNH. (Both RMB)
- Closed capital account: an offshore reserve not the same as onshore.
  - → Key: otherwise either parity or one currency is not held in equilibrium (Gresham's law).
  - → Quotas on exchanging CNY/CNH for purposes of investment and on household transfers.
  - → Banks can borrow/lend in CNY/CNH so consider relative returns. Crossborder interbank lending controlled.
- Open current account:
  - → Chinese firms can trade using either currency. Invoice required to transfer across borders (trade settlement). Some firms accumulate large deposits in both.
- CNH market free. Offshore, mainly in Hong Kong. Can buy/sell USD freely.
- Offshore clearing bank issues offshore reserves. Agent of PBoC.

A FIRST TEST



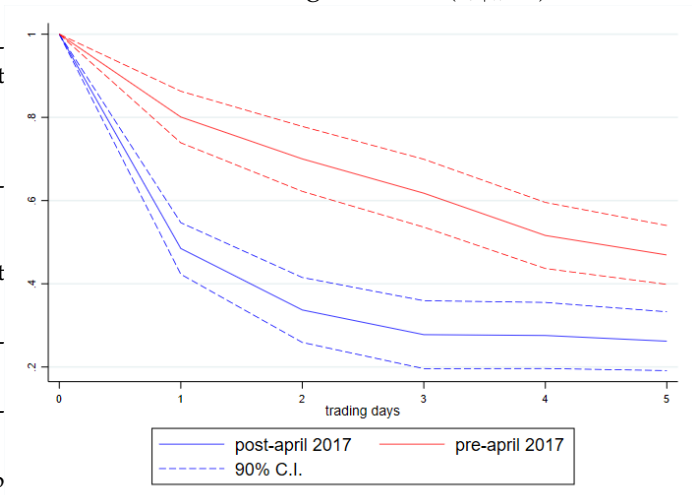
- Use relative stock of sight deposits (M1)
- Misalignment from CNY reform corrected in 2017 with contraction in offshore money.
- Since then, some relation, much stronger than other peggers.
- All driven by M in CNH
- Still low R^2

	$\Delta\left(m_t^{CNH} - m_t^{CNY}\right)$	Δm_t^{CNH}	Δm_t^{CNY}
Δe_{t-1}	-12.6330*	-12.9857*	-0.2403
	(7.327)	(6.916)	(2.690)
N	71	71	72
R^2	0.0361	0.0439	0.0001

POST-2017 PERIOD

- PBoC manages CNH money supply through bill issuance.
  - → Regular issuance schedule, pre-committed tender/settlement dates.
  - → 3M, 6M and 1Y bills.
  - → Equiv to term reverse repos (liquidity absorbing).
- HKMA CNH lender of last resort (from 2012 then refined/expanded)
  - → Operates multiple CNH liquidity facilities.
  - → Penalty rates, pegged to previous interbank rates.
  - → Funding: own resources, swap line with PBoC.

Autocorrelogram: $Corr(e_{t+h}, e_t)$



A MODEL OF THE OFFSHORE/ONSHORE MARKET

Representative Bank Balance Sheet

Assets	Liabilities
(onshore loans) x^o	c (capital)
(offshore loans) x	d^o (onshore deposits)
(on.reserves) m^o	d (offshore deposits)
(off. reserves) em	(on. official borrowing) z^o
(on. interbank loans) f^o	(off. official borrowing) z
(off. interbank loans) f	
(off. bill holdings) b	

Environment: risk neutral, competitive, no-discounting, single consumption good, 3 periods.

At 0: bank takes in deposits, makes loans and holds reserves.

At 1: heterogeneous withdrawl shocks: bank j suffers shock ω^j, if reserve deficit borrow from interbank market (f) and CB facility (z). Capital controls on interbank lending across markets.

At 2: payoffs.

Spirit of Bianchi and Bigio and Bianchi, Bigio (2022) and Engel (2023).

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Onshore reserve numeriare (price level=1).

e is offshore reserves per onshore reserve at date 0 (↑ depreciation).

At date 2, all assets payoff in consumption goods. Exchange rate=1.

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BANK FUNDING AND LENDING

Our focus is on the banking system in exchange rate determination. Rest of the economy stripped down.

Bank has a seperable real concave lending technology in offshore and onshore, again goods in goods out.

Bank liabilities held by deep pocketed households, opportunity costs of funds=1.

- Consume single consumption good in period 2.
- Deposits goods for real return in period 2 (no exchange rate).
- Deposits offer liquidity service $V(d,u)$ and $V^o(d^o,u^o)$. (Money demand shocks).

Supply and demand for liquidity (Period 1)

$s_j = \omega_j d + m, \;\; s_j^o = \omega_j^o d^o + m^o$ offshore and on. surplus of liquidity for bank j

$d \int_j (\omega_j) dj + d^o \int_j (\omega_j^o) dj = 0$ dual currency and open current account

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$S_+ = \int_j \max\{s_j, 0\} dj$	aggregate liquidity surplus to lend
$S_- = \int_j \min\{s_j, 0\} dj$	aggregate liquidity need to borrow
W	net interbank lending from onshore (capital controls)
$\theta = \frac{S_+}{S_- + W}$	Interbank market tightness
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$\theta = \frac{S_+}{S_- + W}$	Interbank market tightness
$\Psi_-(\theta)$	Probability borrower finds a match, falls with tightness
$\Psi_+(\theta)$	Probability lender finds a match, rise with tightness

Supply and demand for liquidity (Period 1)

IOR: R^m. CB liquidity facility rate: R^z. Interbank rate $R^f(\theta)$ (increasing in θ).

Marginal cost of investing surplus liquidity (taking θ as given):

$$\chi_+(\theta) = \Psi_+(\theta)R^f(\theta) + (1 - \Psi_+(\theta))R^m(\theta)$$

Marginal cost of financing a shortfall in liquidity (taking θ as given):

$$\chi_-(\theta) = \Psi_-(\theta)R^f(\theta) + (1 - \Psi_-(\theta))R^z$$

Bank chooses m d etc to maximise expected profits, taking into account liquidity costs.

EXCHANGE RATE DETERMINATION

When $W = 0$ interbank borrowing nets out. In expectation liqudity costs are just the expected cost of borrowing from the liquidity facility:

$$\chi(m,d) = \mathbb{E}_0\left[(1-\Psi_-(\theta))\min\{\omega d + m, 0\}\left(R^z - R^m\right)\right]$$

$$\chi^o(m^o,d^o) = \mathbb{E}\left[(1-\Psi^o_-(\theta^o))\min\{\omega^o d^o + m^o, 0\}\left(R^{o,z} - R^{o,m}\right)\right]$$

Combining optimality condition on m and m^o

$$\frac{R^{o,m} - \chi^o_{m^o}}{R^m - \chi_m} = e.$$

Exchange rate reflects the interest differential and differential liqudity benefit between the two reserves. Liquidity adjusted UIP condition.

EMPIRICAL PREDICTIONS

Shocks:

1) increase in money supply leads to depreciation: $m \uparrow \implies \chi_m \downarrow \implies e \uparrow$

2) exchange rates proxy money demand shocks: $u \downarrow \implies d \downarrow \implies \chi_m \downarrow \implies e \uparrow$

Maintaining parity: $e \uparrow$ respond by raising χ_m. Two isomorphic ways: reduce m, tighten controls on W. Tightens interbank market.

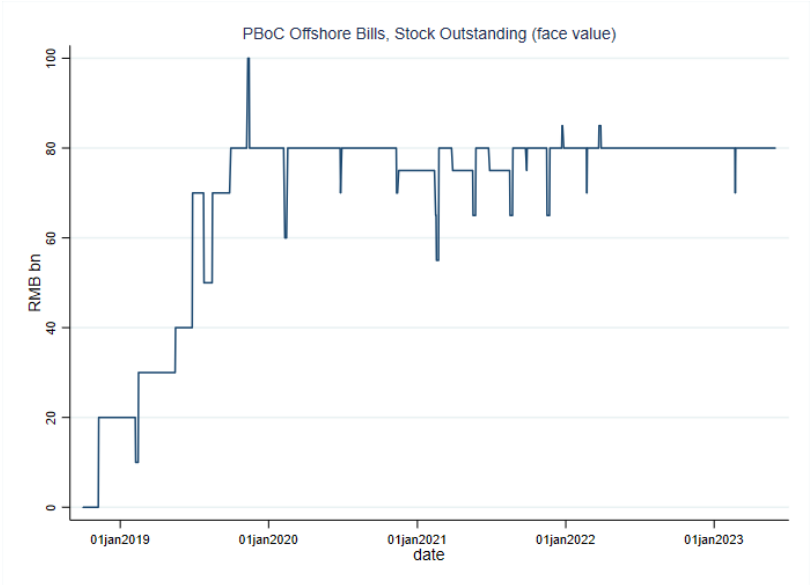
3) $\chi_m \uparrow$: $\theta \uparrow \implies \Psi_-(\theta) \downarrow \implies z \uparrow$. More borrowing from HKMA

4) $\chi_m \uparrow$: $\theta \uparrow \implies \mathbb{E}_0\left[R^f(\theta)\right] \downarrow$. Higher expected interbank rates

5) $\chi_m \uparrow$ has no impact on near money assets, bill prices constant.

Important note: PBoC is not adjusting R^m (and to a lesser extent $R^{o,m}$). Test of quantity theory.

1) MONEY SUPPLY SHOCKS: BILL ROLL OFFS



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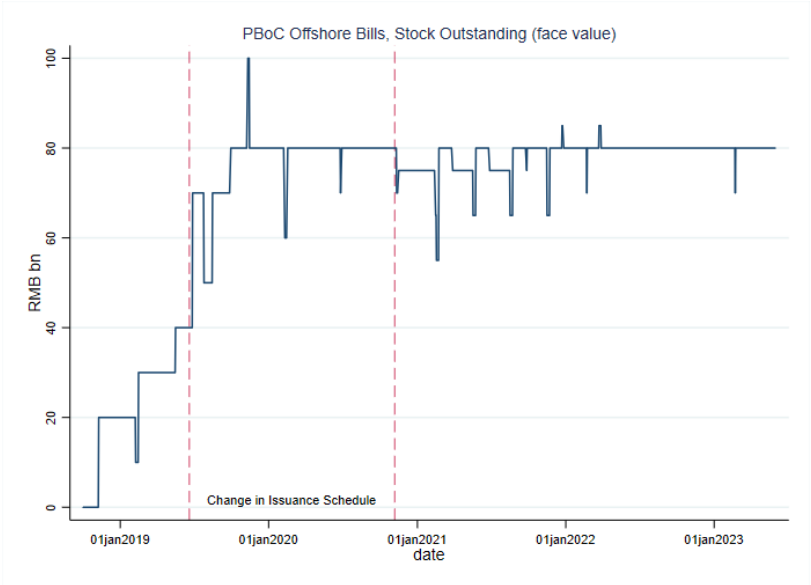

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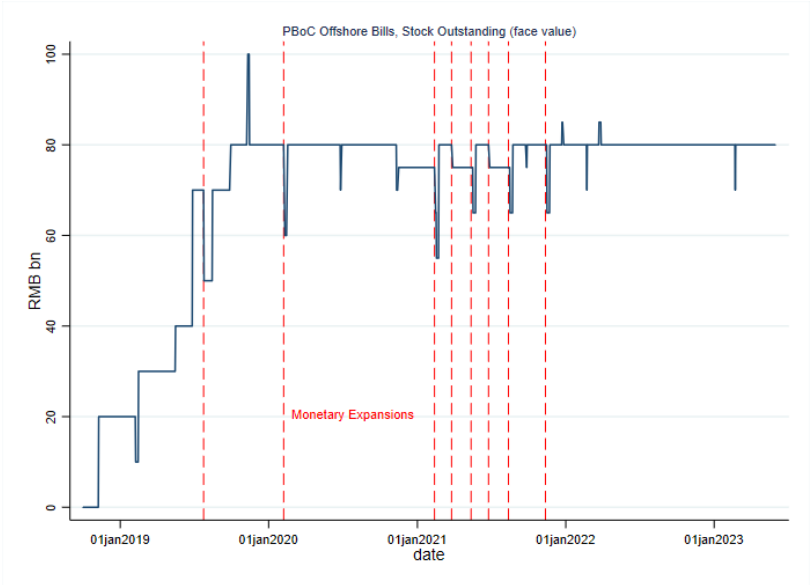
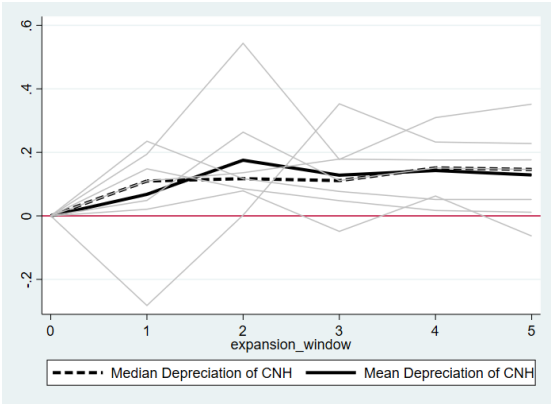
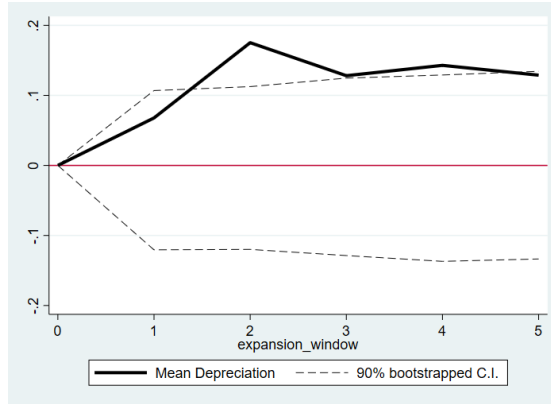


1) Money supply shocks: event studies





2) Exchange rates as money demand shocks: bill auction results

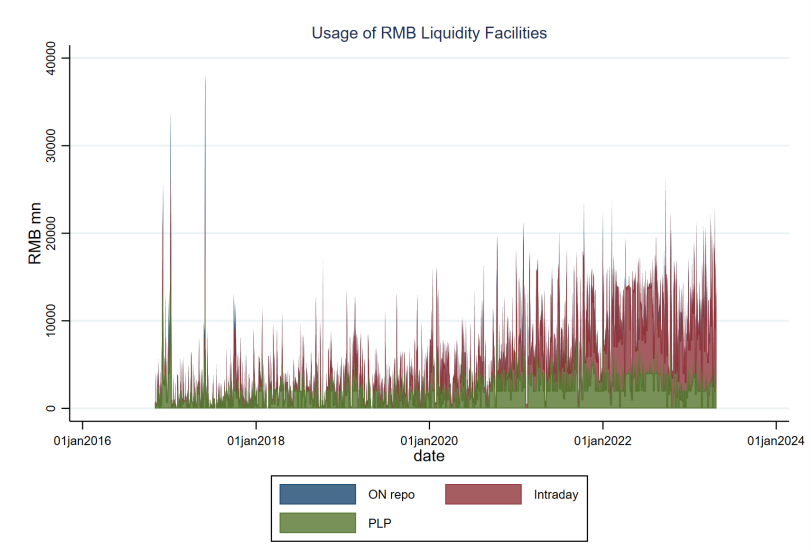
Bill Auction Subscription Rates

	Response of Subscription Rate							
maturity	all		1 year		6M		3M	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
e_t	1.283		1.677*		2.681**		1.453	
	(0.85)		(0.92)		(1.12)		(0.95)	
$\frac{1}{5}\sum_0^4 e_{t-h}$		2.767***		3.384***		2.757***		3.376***
		(0.93)		(1.01)		(0.93)		(1.12)
No. auctions	35		19		16		19	
R^2	0.054	0.142	0.150	0.335	0.221	0.131	0.110	0.324

Heteroskedasticity robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

NB: Median 5 trading days between auction announcement and the tender.

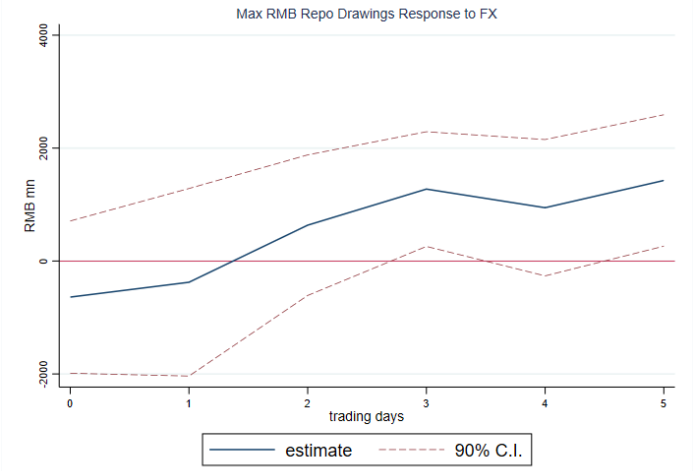
3) Usage of the HKMA's CNH Liquidity Facilities



Daily Drawings of HKMA RMB repos (intraday, max)

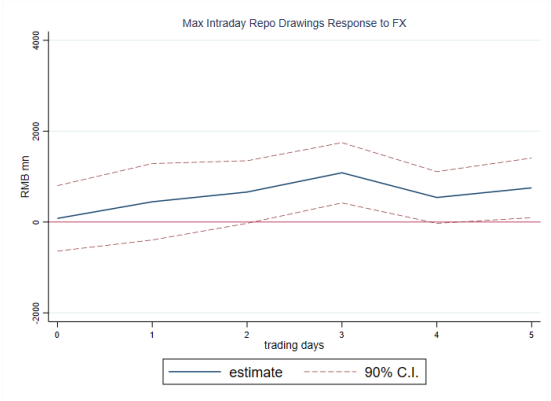
3) Usage of the HKMA's CNH Liquidity Facilities: Response to CNH depreciation

Plot of β_h from regression $z_{t+h} = \beta_h * e_t + \gamma_h e_{t-1} + \delta_h e_{t-1} + \text{error}$

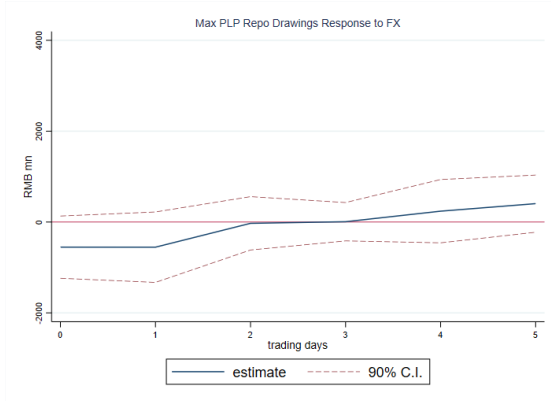


3) Usage of the HKMA's CNH Liquidity Facilities: Facility types

Standard Facility (intraday repo)

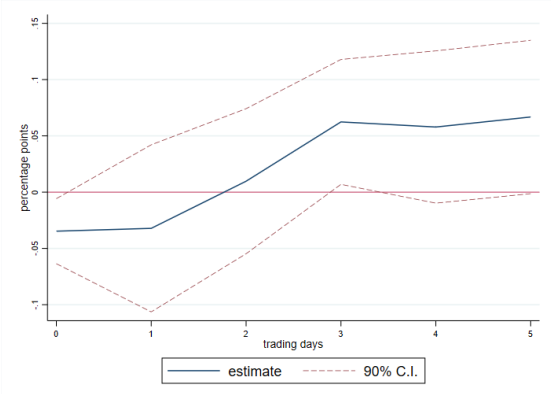


Primary Liquidity Providers Facility

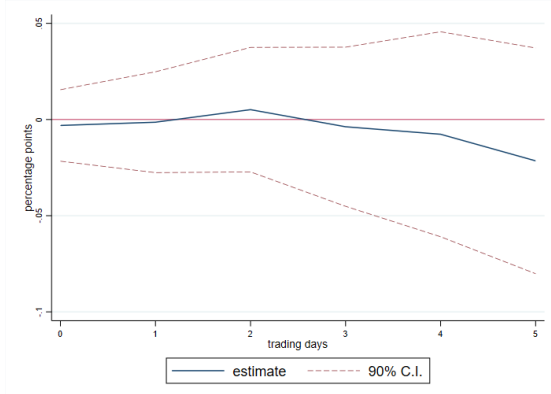


4) & 5) Response of interest differentials

1 Month Interbank – $\mathbb{E}_0\left[R^f(\theta) - R^{of}(\theta^o)\right]$



CNH vs CNY bills



Conclusions

- CNH/CNY : Peculiar, but useful FX market, where policy has successfully maintain parity.
- Great testing ground for monetary theory of exchange rates.
- Empirical predictions matched.
- Requires careful measurement of relative monies and opportunity costs by thinking through the banking system.