The anatomy of a peg: lessons from China's parallel currencies

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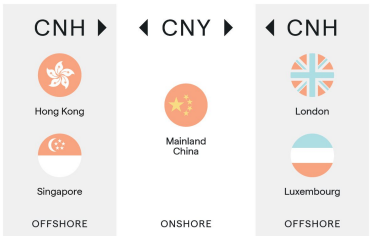
China's large-scale monetary experiment



- CNY: mainland currency, Chinese
- CNH: parallel currency, anyone
- Controls to convert CNH-CNY

Part of internationalisation strategy

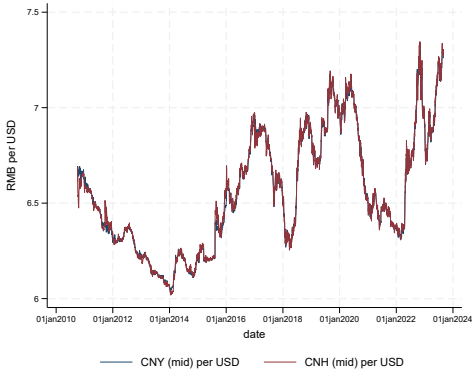
Open current account, closed capital account

- Open current account: CNH convertible. Chinese can export/import without restriction in CNH (or USD) and convert to CNY without limits against invoices.
- Closed capital account: restrictions on conversion for capital flows.
- Barrier: monitoring conversion of CNH to CNY and vice versa

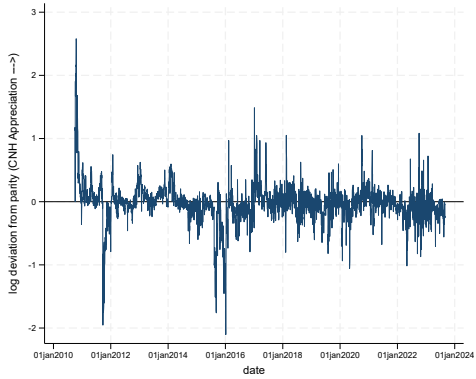
Gresham's law: the peg to parity and success

Tension: if $\ln(E) \neq 0$ for too long, capital controls will fail.

CNH ($\hat{E}$) and CNY ($\tilde{E}$) to USD



CNY to CNH (E)



CNY is domestic currency: $E \uparrow$ is a depreciation of CNY vs CNH. $\hat{E} \uparrow$ is a depreciation of CNH vs USD.
So $E * \hat{E} \equiv \tilde{E} \uparrow$ is a depreciation of CNY vs USD. more on the success of the peg

THIS PAPER

1) How does the system work?
   - Controlling scarcity of M to target E. Advantage: E as a pressure valve for $\hat{E}$.
   - Setting virtuous as testing ground for link between money and exchange rates.
   - Estimate elasticity of reserve demand; confirm scarcity.

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2) Monetary anatomy of a peg:
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   - Money adjustment insufficient to maintain peg, other policies required.

3) Liquidity anatomy of a peg:
   - Liquidity policies matter for exchange rates.
   - Case studies on the role of capital controls.

2. The CNH monetary regime

MONETARY POLICY OPERATIONS: CNH

People's Bank of China

Assets	Liabilities
(a) CNY Assets	(c) CNY Onshore Reserves
(b) FX Assets	(d) CNY Clearing Bank Reserves
	(e) CNH Bills
	(f) Equity, Others

Offshore Clearing Banks

Assets	Liabilities
(g) CNY Clearing Bank Reserves	(i) CNH Commercial Bank Sight Deposits
(h) Other Assets	(j) CNH HKMA Deposits
	(k) CNY Equity, Others

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Hong Kong Commercial Banks CNH

Assets	Liabilities
(q) Deposits at Clearing Banks	(t) Deposits
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- PBoC weekly manages M through bills: (e) down (d) up; (g) up (i) up ; (q) up, (r) down.

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Hong Kong Monetary Authority CNH

Assets	Liabilities
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(m) PLP Balances	
(n) Liquidity Facilities	
(o) Other Assets	

Hong Kong Commercial Banks CNH

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- PBoC weekly manages M through bills: (e) down (d) up; (g) up (i) up ; (q) up, (r) down.
- HKMA hourly manages M through lending facility: (l) down (m) up; (q) up (u) up.

Capital Controls CNY & HKD

3. Money and the exchange rate

Offshore Banking and the Exchange Rate

- Static, risk neutral + competitive. Banks raise deposits onshore or offshore. Cost of equity of 1. Chinese and RoW households supply deposits; liquidity benefit. Asset side unimportant.

- Key ingredient: Liquidity cost per deposit: $\phi(M/D)$, decreasing in reserve-deposit ratio

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- Bank indifference between reserves in CNY or CNH

$$\left(\frac{\mathbb{E}(E')}{E}\right)\left(R^m - \phi'(M/D)\right) = \underbrace{\text{value of CNY reserve}}_{=1, \text{ normalisation}}$$

  → $\mathbb{E}(E') = 1 \implies$ credible peg.

  → R^m CNH reserve gross rate (1 in data, no interest rate shocks).

  → M/D is offshore reserve-deposit ratio ($\phi''(.) > 0$)

  → onshore policy independent of E, normalise.

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$$\left(R^m - \phi'(M/D)\right) = E$$

  → Interest semi-elasticity of reserve demand $\varepsilon_m \equiv \partial ln(M)/\partial R^m$ – negative of elasticity wrt E.

  → Key object in central banking. US estimate 50 to ∞. Lopez-Salido and Vissing-Jorgensen (2023), Afonso et al (2023)

  → For M to matter for E, we need $\varepsilon_m < \infty$... scarce reserves

DEPOSITORS

- Chinese households demand for deposits (isoelastic convenience benefit)

$$\left(\frac{\mathbb{E}(E')}{E}\right) R^d = k - v(D_{dom})^{-\alpha}$$

  → Rate of deposits R^d.

  → v is a preference (money demand) shock.

  → interest semi-elasticity $\varepsilon_d \equiv (R^d \mathbb{E}(E')D^\alpha)/(vE\alpha)$

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- Foreign households individually hold deposits subject to UIP condition (foreign return $\hat{R}$).

$$R^d = \left(\frac{\mathbb{E}(\hat{E}')}{\hat{E}}\right)(\hat{R})$$

  → Close the model with capital controls: exogenous NFA position is foreign deposits $\hat{D}$.

  → $D = \hat{D} + D_{dom}$, $\hat{D}$ is another money demand shock.

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- Bank deposit supply

$$\left(\frac{\mathbb{E}(E')}{E}\right)\left[R^d + \phi(M/D) - \left(\frac{M}{D}\right)\phi'(M/D)\right] = 1$$

  $\rightarrow$ $\phi(M/D) - \left(\frac{M}{D}\right)\phi'(M/D)$ is liquidity cost of issuing a deposit.

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- With credible peg $\mathbb{E}(E') = 1$, deposit market clearing:

$$E(1 - k + v(D - \hat{D})^{-\alpha}) = \phi\left(\frac{M}{D}\right) - \left(\frac{M}{D}\right)\phi'\left(\frac{M}{D}\right). \tag{1}$$

ANALYSIS

Equilibrium for (E, D) intersection of reserve and deposit market conditions.

$$\left(R^m - \phi'(M/D)\right) = E$$

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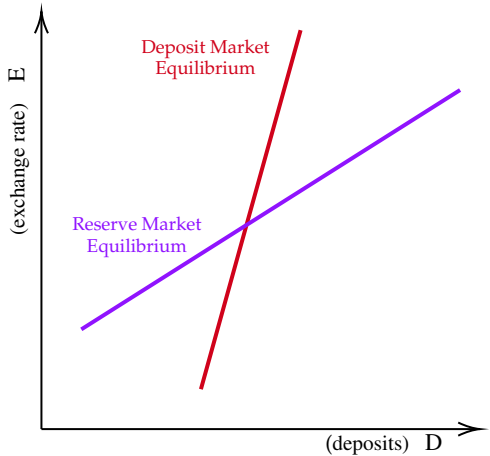
$\hat{E}, R^d$ solved for recursively, M, v, $\hat{D}$ are exogenous shifters.



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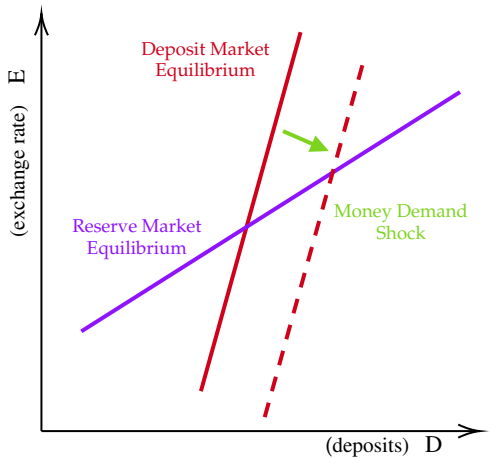

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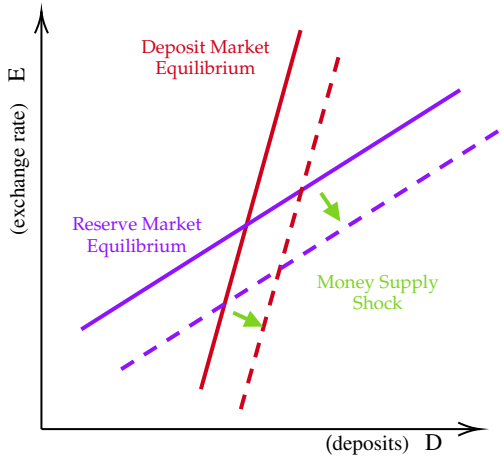

Analysis

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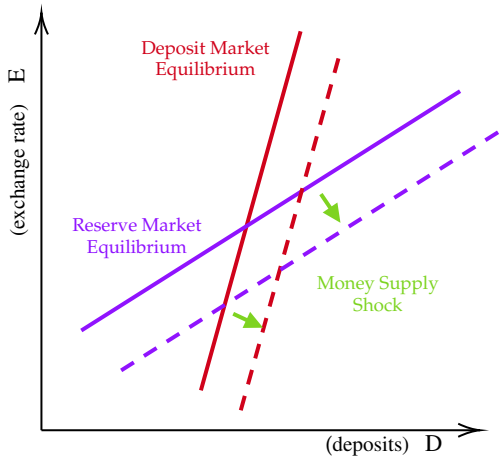
Intuitively,

$$d\log(E)/d\log(M) = (\varepsilon_m + (M/D)\varepsilon_d)^{-1}$$



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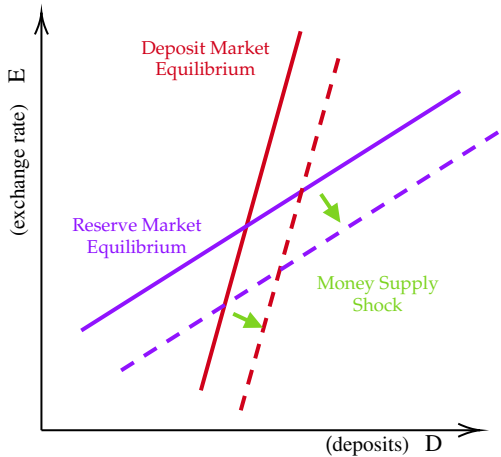
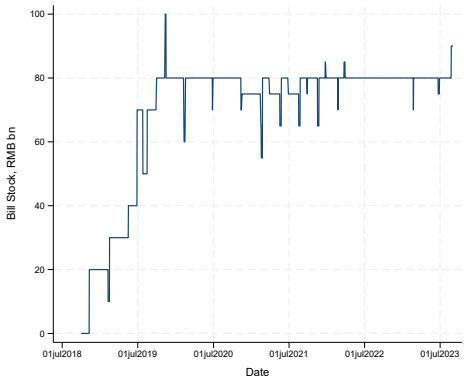
- $\frac{M}{D} = \frac{196}{730}$,
- $\varepsilon_d \approx 10$, Benati et al (2021)
- $d\log(E)/d\log(M)$ – estimate



ESTIMATING $d\log(E)/d\log(M)$

CNH bill stock



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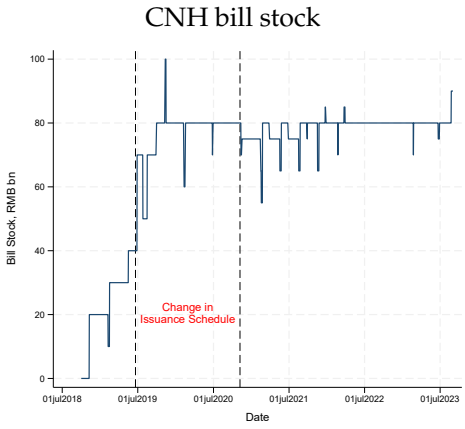

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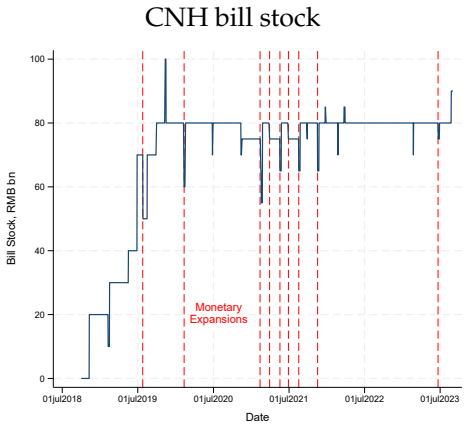

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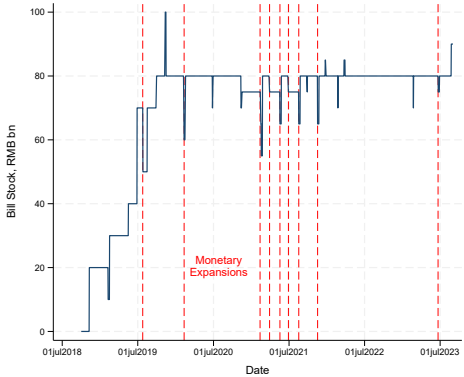
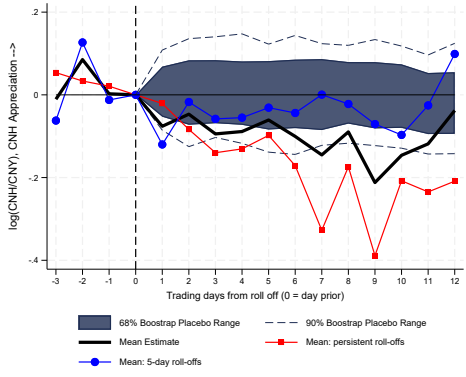


Response of E to M



$$\varepsilon_m = \frac{11/196}{0.0011} - \left(\frac{196}{730}\right)\varepsilon_d = 48. \tag{2}$$

Same figure as US in 2007 under scarce reserve system. Second, time series, exercise in the paper.

E AS A PRESSURE VALVE FOR $\hat{E}$

How about $\hat{E}$? UIP condition:

$$R^d = \left(\frac{\mathbb{E}(\hat{E}')}{\hat{E}} \right) (\hat{R})$$

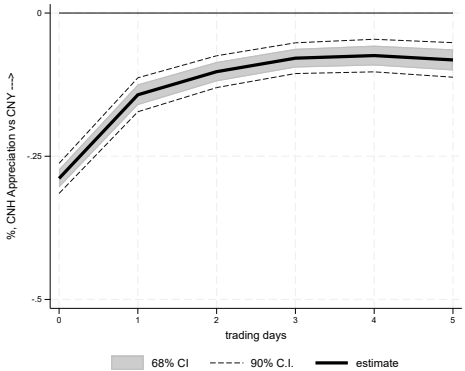
R^d always comoves with E no matter the shock... and so $\hat{E}$ and E should comove negatively.

Implication:

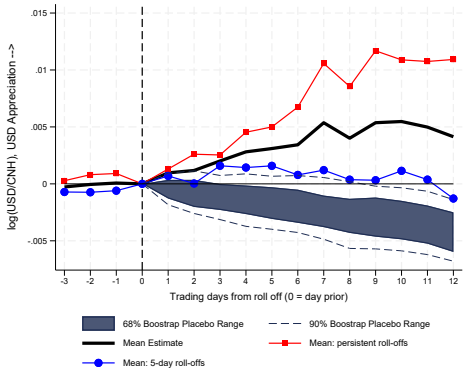
- When the yuan is depreciating against USD, CNH depreciates more than CNY...
- ...and v.v. when appreciating...
- ... failure to perfectly maintain the peg is a tool to slow an FX adjustment.

Testing the co-movement between E and $\hat{E}$

Dynamic conditional corr. $\log(E)$ on $\log(\hat{E})$



Response of $\hat{E}$ to M



4. Monetary anatomy of the peg

ESTIMATING THE POLICY RULE FOR MONEY SUPPLY

We posit the following policy rule

$$\log(M'/M) = \eta \log(E). \tag{3}$$

Is (i) $\eta \neq 0$ and, if so, (ii) is η big enough to maintain the peg.

E contaminated by high frequency policy changes (and other supply shocks). IV strategy based on CNY:

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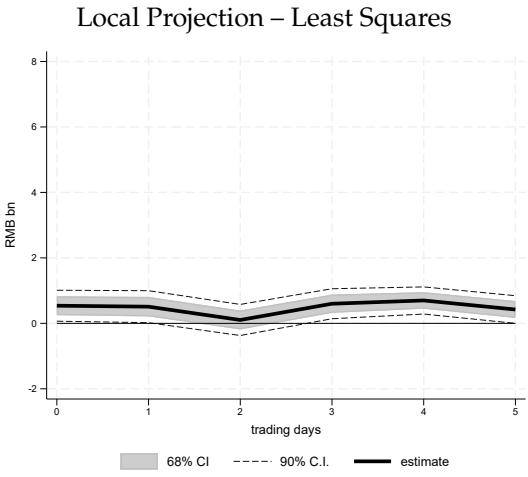
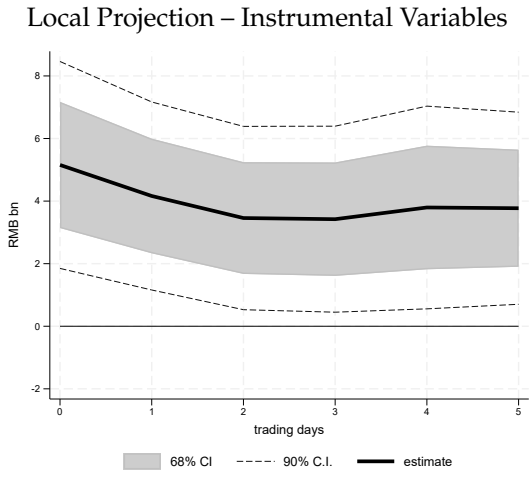
E contaminated by high frequency policy changes (and other supply shocks). IV strategy based on CNY:

- CNY-USD exchange rate ($\tilde{E}$) trades in a 2% corridor around a central parity rate ($\bar{E}$).
- $\bar{E}$ set in the morning and not set in response to E. Jermann et al (2022)
- Most of time $\bar{E}$ tracks the previous close of CNY-USD. Sometimes it does not. Unfilled pressure on CNY rate to change.
- CNH is not controlled. When the central parity rate deviates from market rate, CNH adjusts in anticipation of CNY, for reasons unrelated to CNH monetary policy.
- Use deviation of $\bar{E}$ today from $\tilde{E}$ yesterday as instrument for E, F-stat is 20.

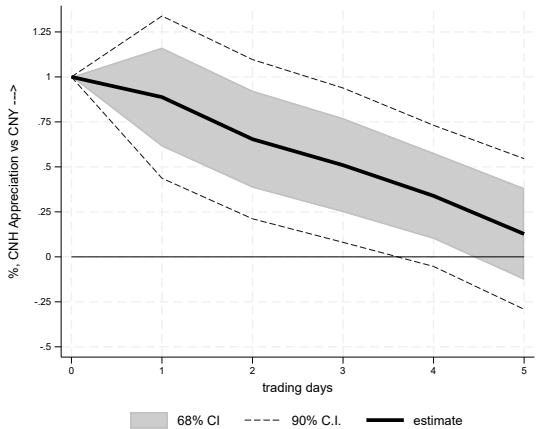
Response of M to E (PLP lending)





If z is PLP drawing, then plot from regression $y_{t+h} = \beta_h e_t + \gamma_h e_{t-1} + \delta_h y_{t-1} + \text{error}$

Is the money response enough to restore parity?



After 5 days, 0.83 of 1% increase in the exchange rate has reverted. Channels:

- 0.53 can be accounted for by the shock dissipating (incl CNY adjustment),
- ¥5bn money response: using earlier estimate accounts for 0.05
- Remaining 0.25: other liquidity policies that shift $\phi(M/D)$

5. A liquidity anatomy of the peg

MODEL: DIGGING DEEPER ON THE LIQUIDITY COSTS $\phi(.)$

- Microfoundations from Bianchi-Bigio (2022)

- Expected liquidity costs $\phi(.)$: random withdrawal shock $\Omega(\omega)$, match in interbank market with prob. $\Psi_+(\theta), \Psi_-(\theta)$, tightness θ, pay bargained rate $R^f(\theta)$, or go to discount window R^z.

$$\phi(m/d)d = -\underbrace{\Psi_+(\theta)}_{\text{prob. find borrower}} \times \underbrace{(R^f(\theta) - R^m)}_{\text{lending profit}} \times \underbrace{\int_{\bar{\omega}}^{\infty} s(\omega) d\Omega(\omega)}_{\text{liquidity surpluses}}$$

$$- \left[\underbrace{\Psi_-(\theta)(R^f(\theta) - R^m)}_{\text{interbank borrowing}} + \underbrace{(1 - \Psi_-(\theta))(R^z - R^m)}_{\text{CB borrowing}} \right] \underbrace{\int_{-1}^{\bar{\omega}} s(\omega) d\Omega(\omega)}_{\text{liquidity deficits}}$$

- Liquidity policies:
  - → Reserve requirements – onshore, not offshore
  - → Price liquidity ($R^z, R^f(\theta)$) – see paper. results
  - → Controls on flows of liquidity to/from onshore (capital controls) – for today

LIQUIDITY POLICIES: CONTROLS

- Control on deposit flows

$$d \int_{-1}^{\infty} \omega d\Omega(\omega) = W^d$$

  W_d is net conversion of CNY in CNH – policy choice.

- Control on reserve flows: W^m lending from onshore market to offshore market.

- Control bill stock:
  - $\rightarrow$ swap CNH reserves for bills, E appreciation.
  - $\rightarrow$ swap CNY bills for CNH bills (or helicopter drop), E depreciation – effectively FXI.

- Tightness now:

$$\theta = \frac{-\int_{-1}^{\bar{\omega}} s(\omega) d\Omega(\omega; W^d)}{\int_{\bar{\omega}}^{\infty} s(\omega) d\Omega(\omega, W^d) - G + W^m}.$$

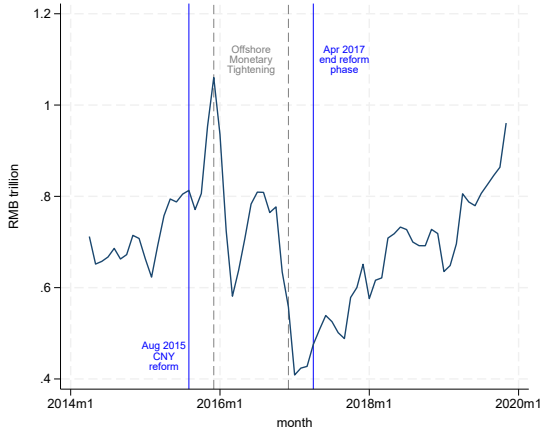
- Tightening controls by having lower W^d, lower W^m or lower G raises the marginal benefit of reserves ($-\phi'(M/D)$ higher).

- Can test with illustrative episodes.

Episode 1): the 11/8/2015 depreciation and liquidity controls

CNH/USD and CNY/USD exchange rates

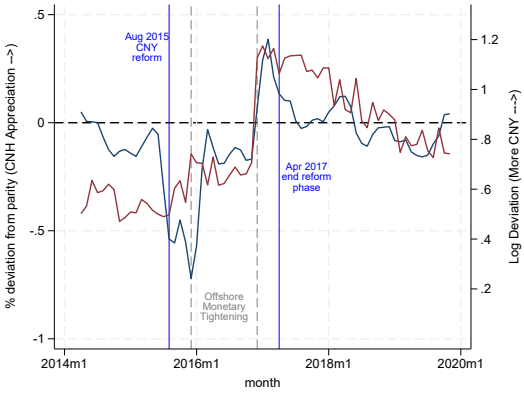
RMB flows from onshore to offshore



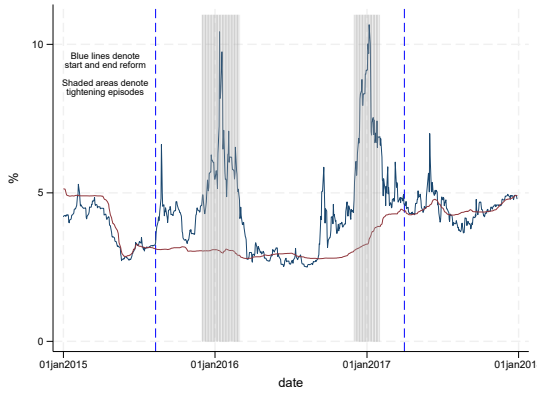
EPISODE 1): THE 11/8/2015 DEPRECIATION AND LIQUIDITY CONTROLS

Deposits fall, interbank rate rises

Relative stock of CNH-CNY deposits and e

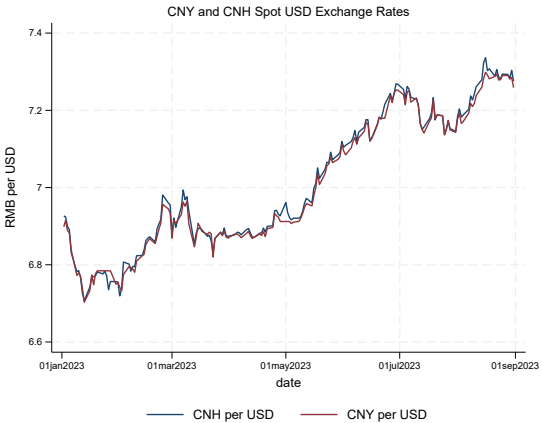


3-month interbank rates for CNH and CNY

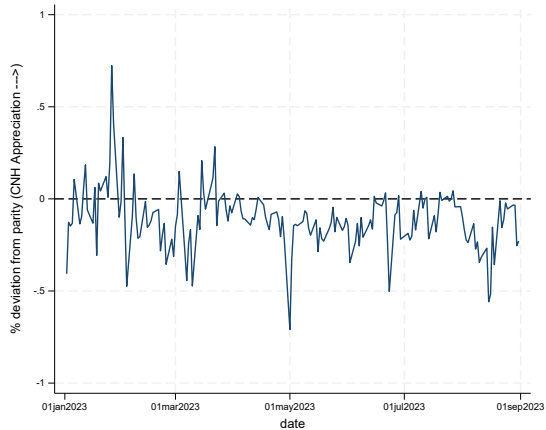


Episode 2) Summer 2023 and monetary/liquidity policies

CNH/USD and CNY/USD exchange rates



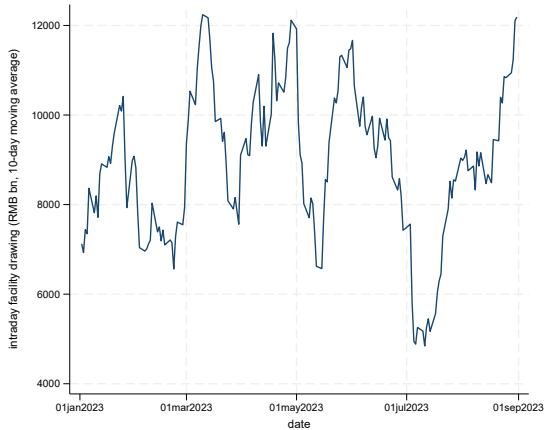
CNH/CNY exchange rate



Episode 2) Summer 2023 and monetary/liquidity policies

3-month interbank rates for CNH and CNY

Intraday liquidity facility borrowing



5. Conclusion

Conclusion

- China has offshore currency to enforce capital controls while allowing for an open current account and internationalization of the yuan.

- Monetarist anatomy of a peg to prevent Gresham's law: onshore-offshore is a pressure valve; transitory exogenous increase in money supply depreciate the exchange rate, elasticity of money demand is 0.13, increase in money demand comes with increase in money supply to keep the peg.

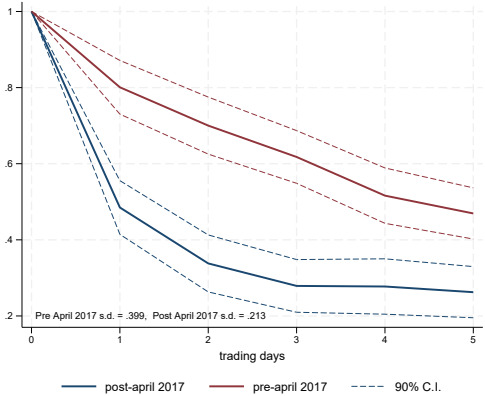
- Liquidity anatomy of a peg to prevent Goodhart's law: liquidity variables confirm anatomy, financial innovation is another source of shocks, liquidity policies and controls over discount window and controls on flows can offset shocks

Appendix

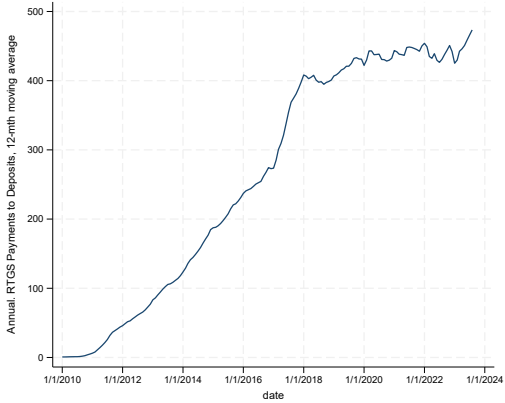
Success of peg and CNH usage

Since 2017, not very persistent deviations, and CNH velocity is as high as the USD

Persistence of e pre and post April 2017



CNH velocity



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Capital controls and CNH as means of payment

- Separate currencies, each with its settlement system, even if both convert one to one to physical currency.
- No limits in using CNH for payments or in converting to foreign currency or in who holds it.
- Only Chinese can use CNY, needed to invest in domestic assets and source of resources to invest abroad.
- Conversion is one to one but there are many limits to arbitrage:
  - $\rightarrow$ quotas for FDI and investment,
  - $\rightarrow$ quotas for household transfers
  - $\rightarrow$ firms can transfer CNH revenues to CNY against export invoices.
  - $\rightarrow$ some banks can borrow/lend in CNY/CNH with limits.

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OTHER CURRENCIES: CNY, USD, HKD

- CNY monetary policy
  - → Combination of interest rates, money supply, and other tools. See Jermann, Yue and others.
  - → Ratio of CNY to CNH M1 is approx 200
  - → CNY policy focussed on onshore goals, does not respond to e.
- USD exchange rate
  - → With CNH is $\hat{e}$, "managed" by the PBoC to ensure smooth movement.
  - → Central parity rate: set $\bar{e}$ at start of day so that $|\hat{e} - \bar{e}| < 0.02$.
  - → In 2015-17, band was 1%, and before that, more of a peg.
  - → How it happens? Freely sell CNH for USD. While for CNY, sell my CNY for CNH first.
- HKD
  - → Currency of Hong Kong, completely separate, but also pegged to USD

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Predictions on the interbank markets and discount window drawings

A rise in money demand that is only partially offset by a rise in money supply (E rises) leads to:

a) an increase in the tightness in the interbank market θ;

b) an increase in the interbank rate $R^f(\theta)$;

c) greater use of the discount window liquidity facilities.

A) INTERBANK MARKET TIGHTNESS: BILL AUCTION SUBSCRIPTIONS

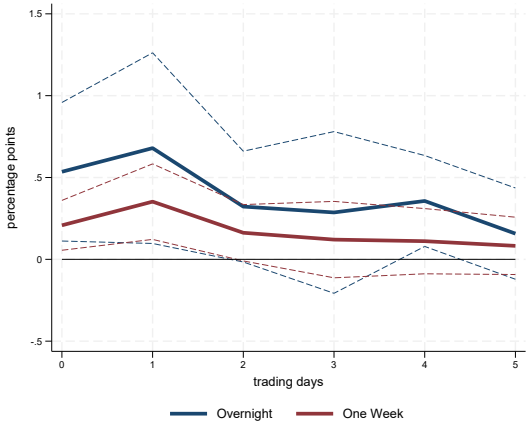
Regression of bill auction subscription rate (bids / bills auctioned) on the exchange rate

Bill maturities	All	12M	6M	3M
	(1)	(2)	(3)	(4)
$\frac{1}{5}\sum_0^4 \log(E_{t-h})$	-2.76***	-3.38***	-2.78***	-3.38***
	(0.93)	(1.10)	(0.93)	(1.12)
Number of Auctions	35	19	16	19
R^2	0.142	0.335	0.131	0.324

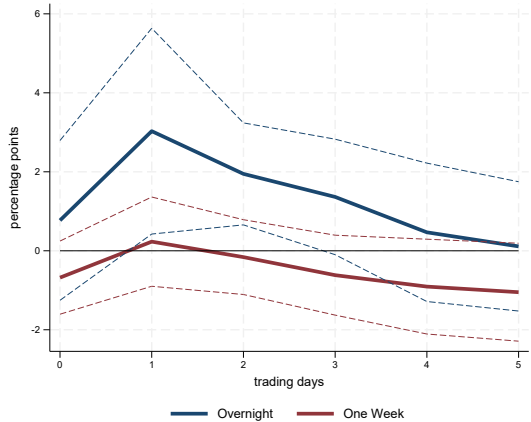
Heteroskedasticity robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

B) INTERBANK RATE RESPONSE TO A MONEY DEMAND SHOCK

Local Projection - Least Squares

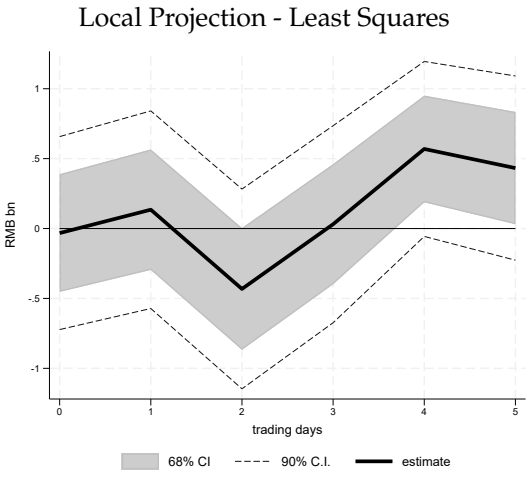


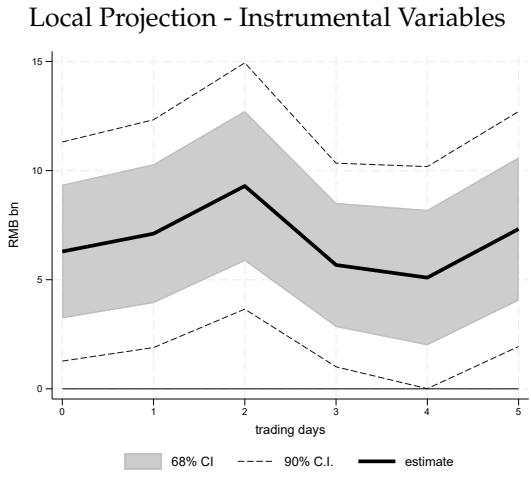
Local Projection - Instrumental Variables



z is interbank rate facility drawing, plot from regression $z_{t+h} = \beta_h e_t + \gamma_h e_{t-1} + \delta_h z_{t-1} + \text{error}$

C) Discount window drawings





z is intraday facility drawing, plot from regression $z_{t+h} = \beta_h e_t + \gamma_h e_{t-1} + \delta_h z_{t-1} + \text{error}$

DOES THE EXCHANGE RATE RESPOND TO R^z?

- Prior to 5th of April of 2016 R^z was set as previous day's overnight R^f plus 50bp:
- On 5th of April of 2016, the rule was changed to the average of the previous three days overnight rate plus 50bp:

$$\begin{aligned}\log(E_t) = & \underbrace{-0.04}_{(0.23)} R^f_{t-1} - \underbrace{0.62^{***}}_{(0.23)} R^f_{t-2} - \underbrace{0.51^{***}}_{(0.12)} R^f_{t-3} - \underbrace{0.01}_{(0.17)} R^f_{t-4} \\ & + Post_t \times (\underbrace{0.57^{**}}_{(0.28)} R^f_{t-1} - \underbrace{0.52}_{(0.37)} \times R^f_{t-2} + \underbrace{\mathbf{1.25^{***}}}_{\mathbf{(0.29)}} \times \boldsymbol{R^f_{t-3}} + \underbrace{0.15}_{(0.27)} \times R^f_{t-4}) \\ & + \text{controls}_t + \text{error}_t. \end{aligned} \tag{4}$$

- On 22nd of July of 2022, the spread was cut to 25bp: comparing 10 days before to 10 days: 2bp reduction in E and a 10bp reduction in R^f

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