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

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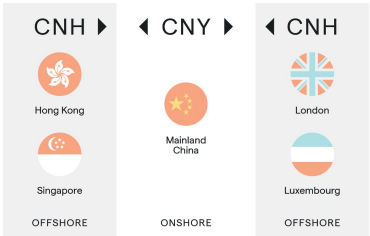
China's large-scale monetary experiment



- CNY: mainland currency, Chinese
- CNH: parallel currency, anyone
- Officially convert 1:1

Why? Internationalisation strategy

- Foreigners can use CNH freely for payments or to convert to other currencies.

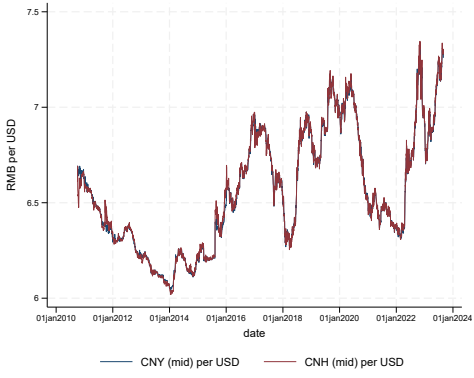
Open current account, closed capital account

- Chinese firms can export/import without restrictions in CNH and convert to CNY against invoices.
- Restrictions and quotas on conversion for capital flows that are closely monitored: FDI, investment, household transfers, bank borrowing/lending.
- Large scale parallel currencies.

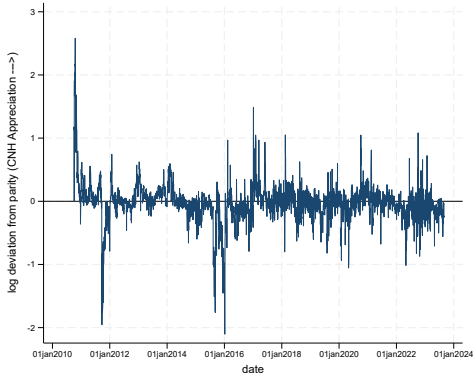
Gresham's law: the peg to parity and success

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

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



CNY to CNH (E)



$E \uparrow$ is a depreciation of CNY vs CNH; $E^{\$} \uparrow$ is a depreciation of CNY vs USD; $E^{-1}E^{\$} \uparrow$ is a depreciation of CNH vs USD.

THIS PAPER

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   - Unusual decentralisation of how to control the supply of money
   - Quantity-based monetary policy: control scarcity of M to target E

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4) Liquidity anatomy of a peg
   - Liquidity policies act over money demand to keep the pegs: discount window rates, reserve requirements, constraints on liquidity flows

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
	(u) PLP Balances
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Hong Kong Monetary Authority CNH

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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.

3. A model of capital controls and offshore money

Canonical model of a (managed) current account

- Two-period, perfect foresight, endowment economy. Home (Chinese) rep. consumer:

$$\max \quad u(c_{NT}, c_T) + \beta u(c'_{NT}, c'_T)$$

- Endowment (y_{NT}, y_T), can invest domestically (b^h) or abroad $(b^\$)$, given returns $(R, R^\$)$:

$$E^\$ c_T + c_{NT} + b^h + E^\$ b^\$ = E^\$ y_T + y_{NT}$$
$$E^{\$\prime} c'_T + c'_{NT} = E^{\$\prime} y'_T + y'_{NT} + R b^h + (1+\tau) R^\$ E^{\$\prime} b^\$ - T'$$

- $E^\$$ is the price of tradeable and τ is a capital flow subsidy (Rebated in equilibrium: $T' = \tau R^\$ E^{\$\prime} b^\$$).

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- Simplifications:
  - $\rightarrow$ $y_{NT} = y'_{NT} = 1$ so $R = \beta^{-1}$.
  - $\rightarrow$ $u(c_{NT}, c_T) = \ln(c_{NT}) + \iota \ln(c_T)$ so trade balance is $E^\$ y_T - \iota$.
  - $\rightarrow$ $\beta y_T > y'_T / R^\$$ so net saver.

Canonical model of a (managed) current account

- Take $R^{\$}$ as exogenous. UIP with a wedge:

$$E^{\$\prime} = \frac{E^{\$} R}{(1+\tau) R^{\$}}$$

- Foreign investors: equivalent tax on home investments. Same UIP condition.

- Current account (trade balance) is equal to Chinese net foreign assets $B^{\$}$:

$$CA = NFA \;\Rightarrow\; E^{\$} y_T - \iota = E^{\$} B^{\$} \quad \text{and} \quad E^{\$\prime} y'_T - \iota + R^{\$} E^{\$\prime} B^{\$} = 0$$

- Combining the three conditions we obtain the equilibrium value of $E^{\$}$ for τ.

$$E^{\$} = \frac{(1+\tau) R^{-1} + 1}{R^{\$-1} \frac{y'_T}{y_T} + 1} \frac{\iota}{y_T}$$

- Conclusion: Choosing higher τ will (i) raise the UIP wedge between returns, (ii) depreciate the exchange rate, (iii) raise current account surplus. *But how to implement this τ?*

Capital controls with offshore banking

- Capital controls on households: cannot have net savings abroad, but can hold useful offshore money to make payments abroad.

$$u(c_{NT}, c_T) + \mu ln(d^h) + \beta u(c'_{NT}, c'_T)$$
$$E^\$ c_T + c_{NT} + b^h + E d^h = E^\$ y_T + y_{NT}$$
$$E^{\$\prime} c'_T + c'_{NT} = E^{\$\prime} y'_T + y'_{NT} + R b^h + R^d E' d^h + T'$$

(d^h are deposits in offshore currency, E is the offshore currency exchange rate, R^d is the return in offshore units, μ is a demand shifter). Chinese households' demand for deposits:

$$d^h = \mu \left(E - \frac{E' R^d}{R} \right)^{-1} \qquad \text{so interest semi-elasticity: } \varepsilon_d = R^d E' d^h / \mu E$$

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- Capital controls on foreigners: cannot invest in domestic bonds, can in offshore deposits (D^f)

$$E^{\$\prime} = \frac{E^{\$} R^d}{R^{\$}} \times \frac{E'}{E}$$

Offshore Banks

- Free entry: raise offshore deposits from domestic households and foreign investors, invest in home bonds (b^l) and offshore reserves (m) to maximize.

$$\max \; Rb^l + E' \left(R^m m - R^d d - \phi(m/d, \lambda) d \right)$$

- Key ingredient $\phi(m/d, \lambda)$: liquidity cost per deposit
  - $\rightarrow$ function of offshore reserve-deposit ratio, m/d, and liquidity policies, λ.
  - $\rightarrow$ bounded $0 = \phi(1, \lambda) \leq \phi(m/d, \lambda) d \leq \infty$
  - $\rightarrow$ decreasing with diminishing marginal benefit $\partial^2 \phi(.)/\partial(m/d)^2 \leq 0$

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- Banks at optimum are indifferent between bonds and reserves at equilibrium

$$\left(\frac{E'}{E} \right) \left(R^m - \phi'(m/d, \lambda) \right) = R \quad \Rightarrow \quad R^m - \phi'(x, \lambda) = RE$$

  → $E' = 1 \Rightarrow$ credible peg.

  → In equilibrium $M = m, D = d$ and $x = M/D$ is the aggregate offshore reserve-to-deposit ratio.

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

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

THE MARKETS FOR DEPOSITS AND GOODS

- Bank deposit supply

$$R^d + \phi(m/d, \lambda) - \left(\frac{m}{d}\right)\phi'(m/d, \lambda) = (E/E')R \quad \Rightarrow \quad R^d + \psi(x, \lambda) = RE$$

$\rightarrow$ $\phi(M/D, \lambda) - \left(\frac{M}{D}\right)\phi'(M/D, \lambda) \equiv \psi(x, \lambda)$ is liquidity cost of issuing a deposit in equilibrium.

$\rightarrow$ Credible peg $E' = 1$ and equilibrium domestic rate $R = \beta^{-1}$

THE MARKETS FOR DEPOSITS AND GOODS

- Bank deposit supply

$$R^d + \psi(x, \lambda) = RE$$

- Market clearing: supply by banks equals demand from Chinese households and foreigners

$$D = d^h + D^f \qquad \Rightarrow \qquad \frac{\mu R}{\psi(x, \lambda)} = \frac{M}{x} - D^f$$

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- Government: chooses foreign savings position $B^\$$. Issues M and domestic bonds ($= b^l + b^h$). In period 1, receives net proceeds and $\phi(x)D$, lump-sum transfers to households.

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- Balance of payments conditions:

$$E^\$ y_T - \iota = E^\$ B^\$ - ED^f \quad \text{and} \quad E^{\$'} y'_T - \iota = R^d D^f - E^{\$'} R^\$ B^\$$$

foreign offshore deposits adjust net savings abroad to current account balance given policy $B^\$$.

EQUILIBRIUM AND IMPLEMENTATION

- An equilibrium for the aggregate reserve deposit ratio, offshore exchange rate, foreign exchange rate $x, E, E^{\$}$ solves the following three equations as a function of the policy variables $(M, \lambda, B^{\$})$.
  - $\rightarrow$ From optimal behavior by banks and clearing in the reserve market

$$R^m - \phi'(x, \lambda) = \beta^{-1} E$$

  - $\rightarrow$ From optimal behavior of banks, households, foreigners and deposits market clearing:

$$\frac{\mu R}{\psi(x, \lambda)} = \frac{M}{x} - E^{-1} \left(E^{\$}(y_T - B^{\$}) - \iota \right)$$

  - $\rightarrow$ The balance of payments and adjusted UIP holds in periods 0 and 1

$$E^{\$} = \frac{1 + \left(R - \frac{\psi(x,\lambda)}{E} \right)^{-1}}{1 + R^{\$-1} \frac{y'_T}{y_T}} \frac{\iota}{y_T}$$

Equilibrium and implementation

- An equilibrium for the aggregate reserve deposit ratio, offshore exchange rate, foreign exchange rate $x, E, E^{\$}$ solves the following three equations as a function of the policy variables $(M, \lambda, B^{\$})$.

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$$\frac{\mu R}{\psi(x,\lambda)} = \frac{M}{x} - E^{-1}\left(E^{\$}(B^{\$} - y_T) + \iota\right)$$

$$E^{\$} = \frac{1 + \left(R - \frac{\psi(x,\lambda)}{E}\right)^{-1}}{1 + R^{\$-1}\frac{y'_T}{y_T}} \frac{\iota}{y_T}.$$

- **Proposition:** *Given a choice of $(M, \lambda, B^{\$})$, the policymaker can implement the same equilibrium for $E^{\$}$ as was achieved by a choice of τ in the canonical economy.*

$$E^{\$} = \frac{1 + \left(1 - \frac{R\psi(x,\lambda)}{E}\right)^{-1} R^{-1}}{1 + R^{\$-1}\frac{y'_T}{y_T}} \frac{\iota}{y_T} \quad \text{versus} \quad E^{\$} = \frac{1 + (1+\tau)R^{-1}}{1 + R^{\$-1}\frac{y'_T}{y_T}} \frac{\iota}{y_T}$$

Scarce liquidity creates a wedge (lowering deposit rate) that works just as the tax worked before.

4. Analysis: money shocks

ANALYSIS: IMPACT OF M ON E

Taking $E^{\$}$ as given, equilibrium (E, x) is at the intersection of reserve and deposit market conditions.

$$R^m - \phi'(x, \lambda) = E$$

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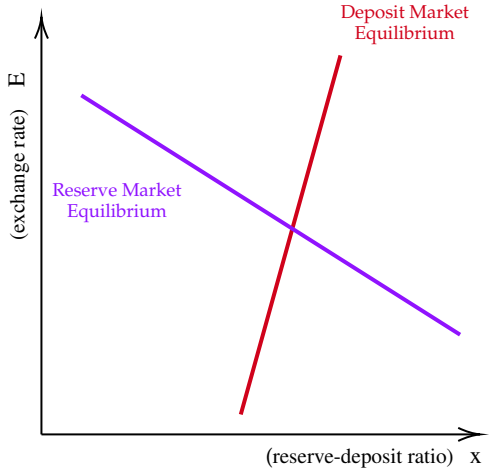

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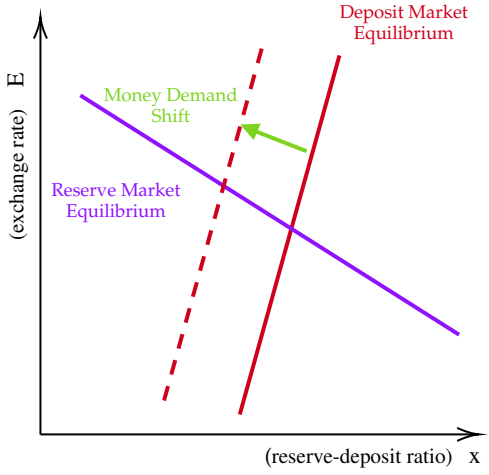

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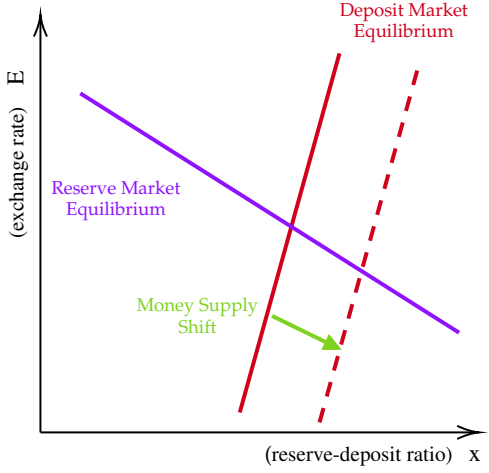

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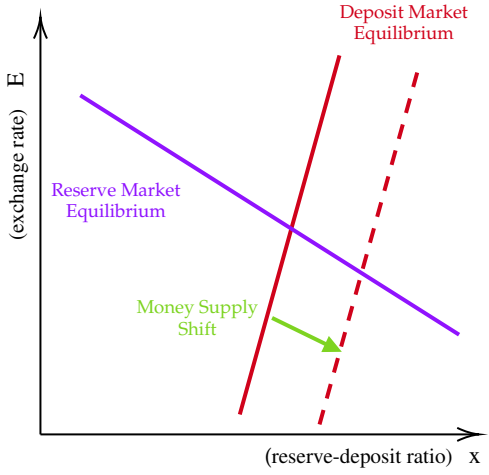
Around $E = 1$ and $E^{\$} y_T - \iota = B^{\$}$ (NFA=FX reserves)

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



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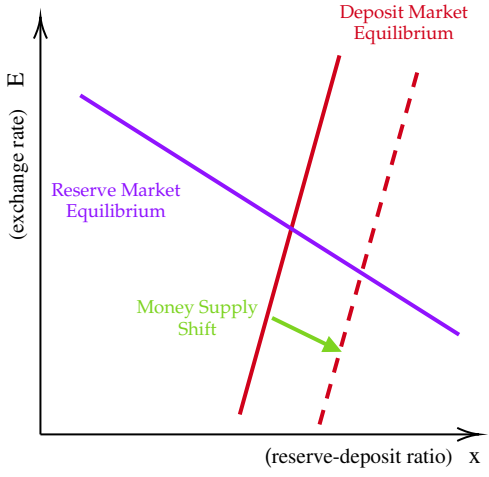
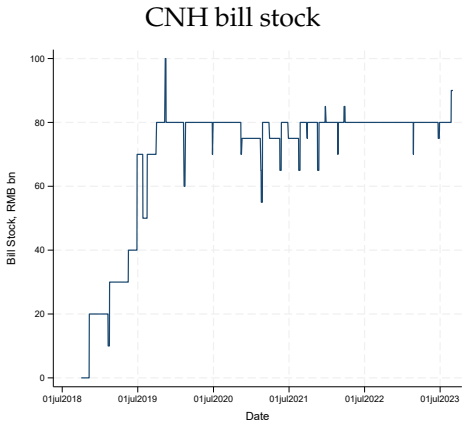
$$\frac{d\log(E)}{d\log(M)} = (\varepsilon_m + x\varepsilon_d)^{-1}$$

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

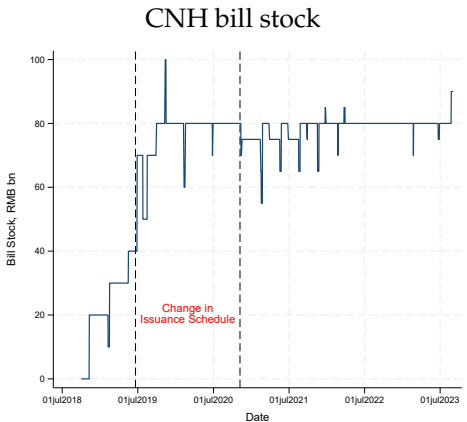


ESTIMATING $d\log(E)/d\log(M)$



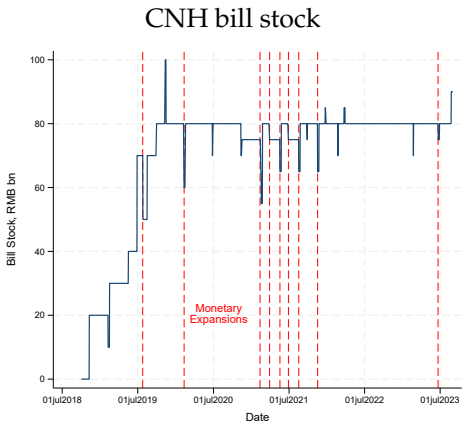
Bill issuance: November 2018 goal was 40bn of 3M bills and 10bn of 12M bills.

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



8 Aug 2019: new goal of 20bn of 3M and 6M and 40bn of 12M. 6 Nov 2020: switch to 10bn of 3M and 6M and 60bn of 12M

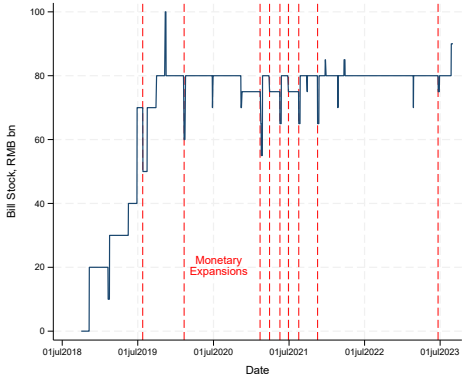
ESTIMATING $d\log(E)/d\log(M)$



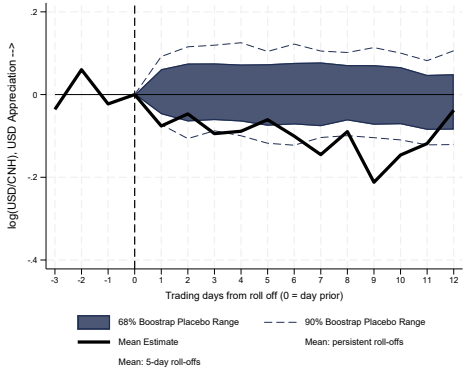
Temporary gaps in issuance.

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

CNH bill stock



Response of E to M



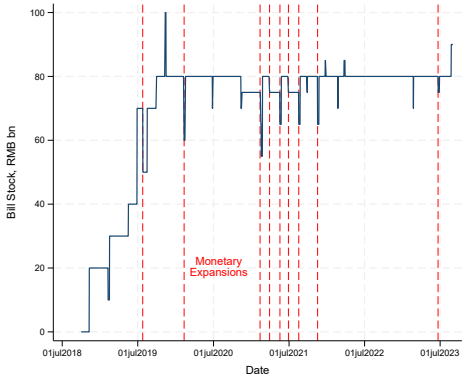
Monetary expansion of 5.5% depreciates the exchange rate by 0.11%.

$$\varepsilon_m \approx \frac{11/196}{0.0011} - \left(\frac{196}{730}\right)\varepsilon_d = 48. \tag{1}$$

Similar to US estimate in 2007 under scarce reserve system. Afonso et al (2023)

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

CNH bill stock



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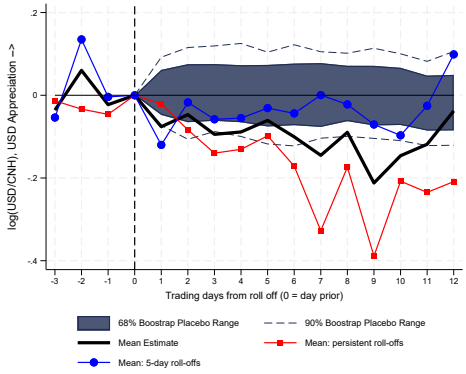


More persistent exchange rate response to persistent shocks.

Analysis: impact of M on $E^{\$}$

- E and $E^{\$}$ negatively comove (for a fixed λ).

$$E^{\$} = \frac{1 + \left(R - \frac{\psi(x,\lambda)}{E}\right)^{-1}}{1 + R^{\$-1}\frac{y'_T}{y_T}} \frac{\iota}{y_T}$$

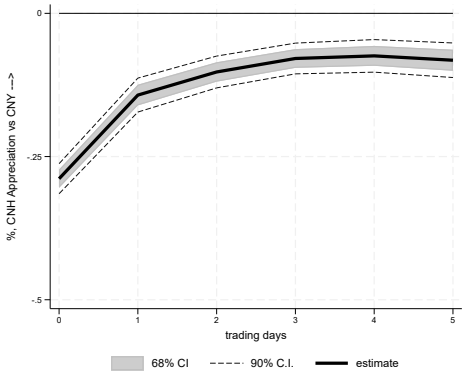
- Why? Scarce liquidity is what creates a wedge that allows policymaker to manipulate the current account and the foreign exchange rate. But varying liquidity also comes with movements in offshore exchange rate.

- Alternative intuition, the escape valve: When yuan depreciates against USD, CNH depreciates more than CNY. Failure to perfectly maintain the peg is a tool to slow an FX adjustment.

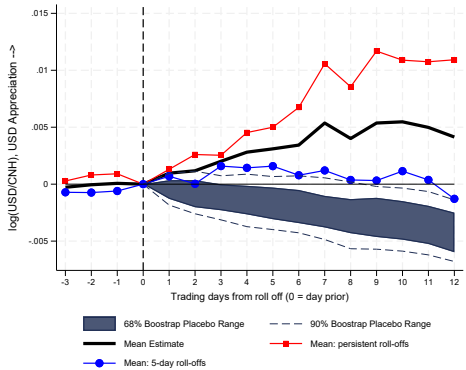
- Limit to the valve: Gresham's law, cannot have $E \neq 1$ too much or too long.

TESTING THE CO-MOVEMENT BETWEEN E AND $E^{\$}$

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



Response of $E^{\$}$ to M



4. Analysis: monetary anatomy of the peg

ESTIMATING THE POLICY RULE FOR MONEY SUPPLY

- We posit the following policy rule:

$$\log(M'/M) = \eta \log(E)$$

  Is (i) $\eta \neq 0$ and, if so, (ii) is η big enough to maintain the peg $E = 1$?

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

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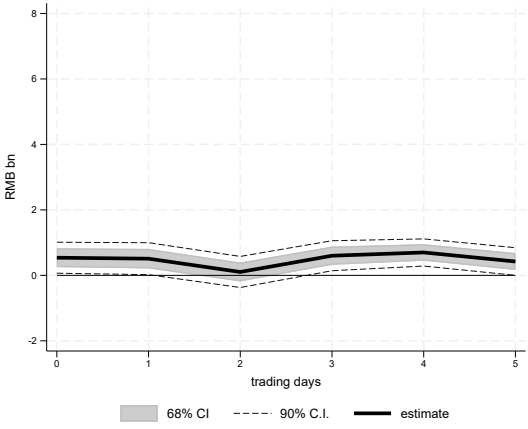
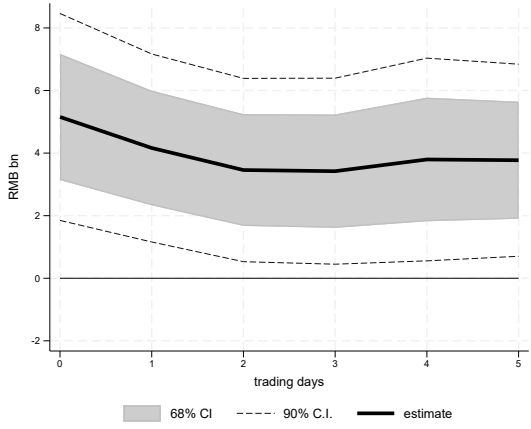
- E contaminated by high frequency policy and other supply shocks. IV strategy based on CNY:
  - → CNY-USD exchange rate ($E^{\$}$) trades in a 2% corridor around a central parity rate ($\bar{E}^{\$}$).
  - → $\bar{E}^{\$}$ set in the morning and not set in response to E. Jermann et al (2022)
  - → Most 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 $E^{\$}$ yesterday as instrument for E, F-stat is 20.

Response of M to E (PLP lending)

Local Projection – Least Squares

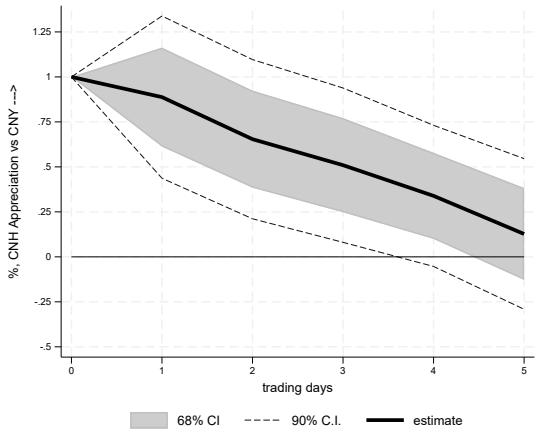


Local Projection – Instrumental Variables



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

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: must be the λ, the other liquidity policies that shift $\phi(x, \lambda)$

Intuition: PBoC wants to manage both E and $E^{\$}$, if CNH is freely convertible it will need multiple tools.

5. Analysis: A liquidity anatomy of the peg

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

- Microfoundations from Bianchi and 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.

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

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

- Identifies the liquidity policies λ:
  - $\rightarrow$ Reserve requirements: onshore, not offshore
  - $\rightarrow$ Price of liquidity: discount window rate and efficiency of offshore interbank market ($R^z, R^f(\theta)$)
  - $\rightarrow$ Controls on flows of liquidity within bank onshore-offshore

TESTING THE MECHANISM: THE PRICE OF LIQUIDITY

Proposition: A rise in the demand for offshore money that is only partially offset by a rise in money supply (so that 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 tightening in controls on liquidity preventing flows from onshore to offshore will raise E.

A) INTERBANK MARKET TIGHTNESS: BILL AUCTION SUBSCRIPTIONS

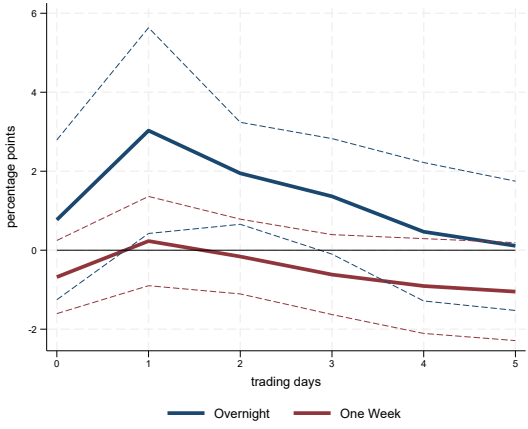
Regression of bill auction subscription rate (bids / bills auctioned) on the exchange rate

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

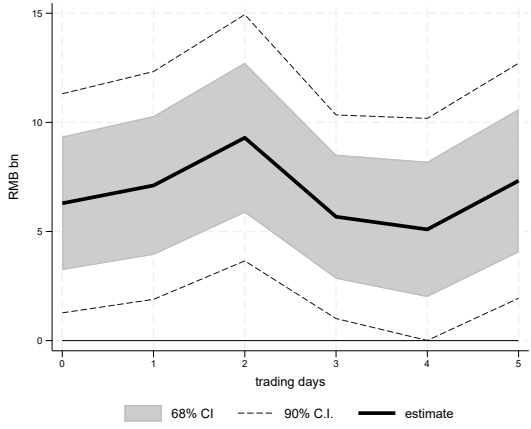
Heteroskedasticity robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

B/C) Interbank rate and discount window response to money demand

Interbank Rates



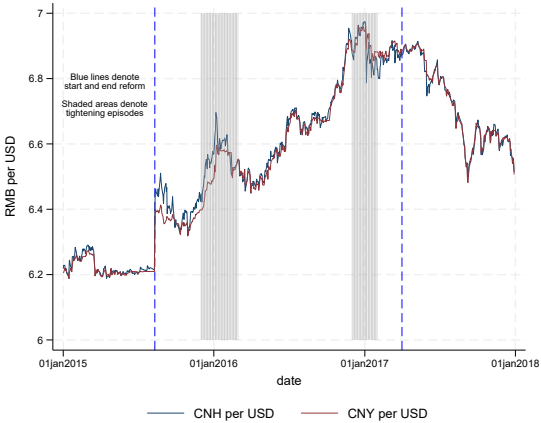
Discount Window Borrowing



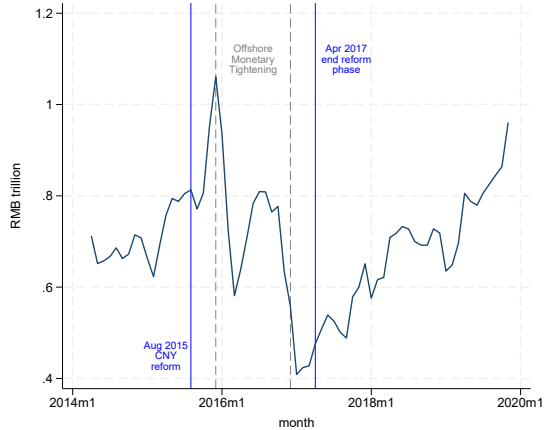
z is interbank rate + discount window drawing, plot from LP-IV: $z_{t+h} = \beta_h e_t + \gamma_h e_{t-1} + \delta_h z_{t-1} + \text{error}$

THE 11/8/2015 DEPRECIATION AND LIQUIDITY CONTROLS

CNH/USD and CNY/USD exchange rates



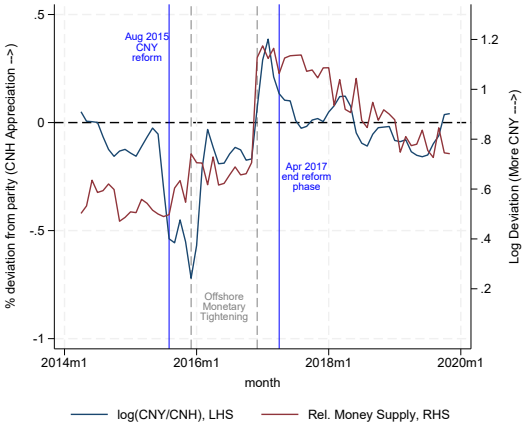
RMB flows from onshore to offshore



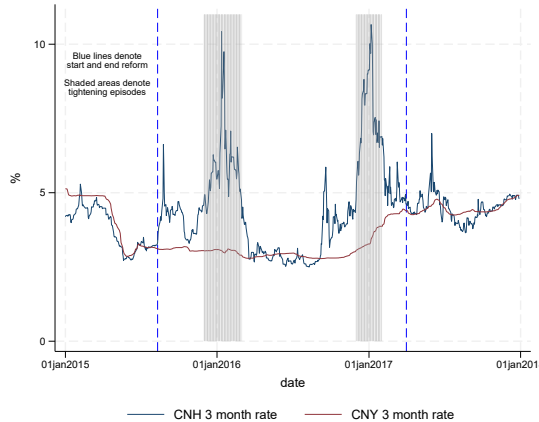
THE 11/8/2015 DEPRECIATION AND LIQUIDITY CONTROLS

Deposits fall, interbank rate rises

Relative stock of CNH-CNY deposits and E



3-month interbank rates for CNH and CNY



6. Conclusion

Conclusion

- Key lesson: an offshore currency with capital controls is a way to create a UIP-wedge (like tax on capital flows) while having an open current account and internationalization of the yuan.

- Along the way, revisited fundamental pillars of monetarism:
  - → If you raise the money supply, you will reduce the value of currency.
  - → If you want to peg this value, respond to rises in it by printing money.
  - → Liquidity policies to steer money demand must complement control of money supply.
  - → Parallel currencies survive by keeping a tight peg between their value.

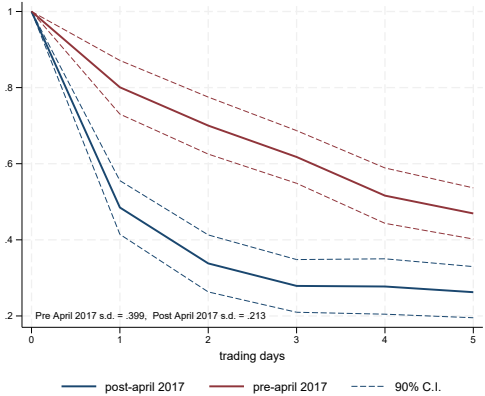
- China's "weird" offshore system allowed us to test these and find that:
  - → Yes, and elasticity of money demand driven by reserves (elasticity of 50)
  - → Yes, but only one sixth, remaining five sixths are liquidity policies
  - → Yes, and include reserve requirement, discount window rate, liquidity restrictions
  - → Yes, and successful if have a whole coherent framework

Appendix

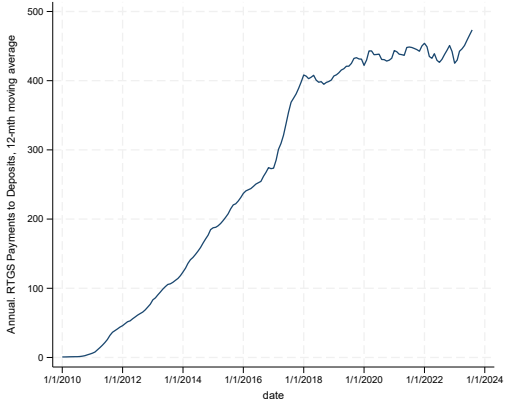
Success of peg and CNH usage

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



back

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.

back

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

back