Managing Expectations with Exchange Rate Policy

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Foreign Exchange Intervention (FXI)

- Central banks **purchase/sell currency** in FX market
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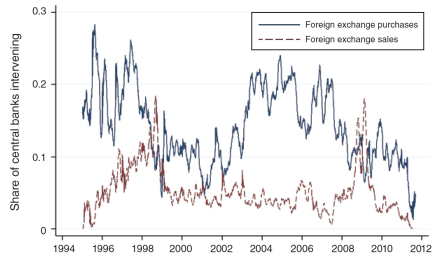
(Patel & Cavallino 19, Fratzscher et al 2019)

Figure: Daily Shares of FX Purchasing and Selling Central Banks in the Sample (Fratzscher et al, 2019)



Sample details

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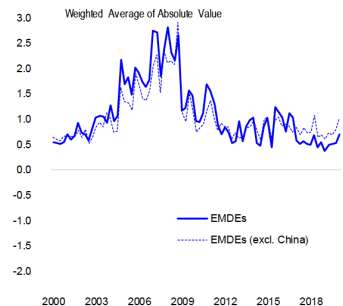
Figure: FXI in percent of GDP (Adler et al, 2021)



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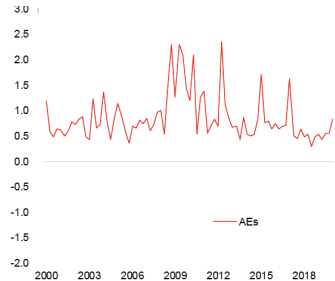

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Sample details | Indonesia example

Communication of FXI

- FX interventions often **opaque**: not publicly announced or published with lag
  (Sarno & Taylor 01, Canales-Kriljenko 03, Patel & Cavallino 19, Adler et al. 21)
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- Leading macro models of FXI silent about role of **communication** & **information**
  (Gabaix & Maggiori 15, Fanelli & Straub 21, Itskhoki & Mukhin 22)
  - Virtually all models assume full information & rational expectations

Model of FXI with departures from FIRE

- Develop Small Open Economy (SOE) macroeconomic model with two frictions

1. **Financial friction:** limited risk-bearing capacity of financiers in int'l mkt
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2. **Information friction:** dispersed information (Bacchetta & Van Wincoop 06)
   - Agents have access to private information
   - Exchange rate aggregates information $\rightarrow$ learning from price

Main Results

1. Novel **informational role of FX** in macro allocation
   - Consistent w/ evidence that FX **predicts** future fundamentals
     (Engel & West 05, Chahrour et al. 22)
   - It works *beyond* the other FX channels of **expenditure switching** & **risk sharing**

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3. Information channel of FXI can be used as **tool for optimal FX policy**
   - Rational expectations: information used optimally → Public FXI or Secret FXI
   - Extrapolation: over-react to new information → Secret FXI

Related literature

Empirics:

- Exchange rates & fundamentals: Evans & Lyons 02, Engel & West 05, Gholampour & Van Wincoop 19, Itskhoki & Mukhin 21, Chahrour et al. 22, Stavrakeva & Tang 20, Goldberg & Krogstrup 23
- Survey expectations on macro variables and FX: Coibion & Gorodnichenko 15, Kohlhas & Walther 20, Bordalo, Gennaioli, Ma & Schleifer 20, Angeletos, Huo & Sastry 20, Candian & De Leo 23, Stavrakeva & Tang 20
- Empirical properties of FX interventions: Sarno & Taylor 01, Canales-Kriljenko 03, Kuersteiner et al. 18, Patel & Cavallino 19, Fratzscher et al. 19, Adler et al. 21

Theory:

- Learning from prices: Grossman 76, Kimbrough 83 84, Bacchetta & Van Wincoop 06, Amador & Weill 10, Gaballo & Galli 22
- PE theories of FX interventions under RE: Vitale 99 03, Fernholz 15
- GE models of FX interventions under FIRE: Gabaix & Maggiori 15, Amador et al. 19, Cavallino 19, Fanelli & Straub 21, Itskhoki & Mukhin 22, Basu-Boz-Gopinath-Roch-Unsal 20
- FX interventions without RE: Iovino & Sergeyev 21
- CB communication on monetary policy: Angeletos & Sastry 20, Chahrour 14, Tang 15, Melosi 17, Kohlhas 20, Candian 21

Roadmap

Model & Information Structure

FX Interventions: Public vs. Secret

Optimal FX policy: Rational vs. Extrapolative Beliefs

Households

- Two periods: $t = [0, 1]$
- Continuum of atomistic islands $i \in [0, 1]$ in SOE (Lucas 72)
- **Households** in island i

$$\max_{C_0^i, B_1^i, K_1^i, C_1^i} \quad \frac{{C_0^i}^{1-\sigma}}{1-\sigma} + \beta \mathbb{E}_0 \left(\frac{{C_1^i}^{1-\sigma}}{1-\sigma} \right) \qquad \text{s.t.}$$

$$P_0^i C_0^i + P_0^i K_1^i + \frac{B_1^i}{R_0} = P_{N,0}^i Y_{N,0} + \mathcal{S}_0 Y_{T,0}^{i,H} + T_0^i, \quad P_1^i C_1^i = B_1^i + P_{N,1}^i Y_{N,1} + \mathcal{S}_1 Y_{T,1}^{i,H} + T_1^i.$$

- Resource constraint:

$$C_0^i + K_1^i = \left[(1-\gamma)^{\frac{1}{\theta}} {Y_{N,0}}^{\frac{\theta-1}{\theta}} + \gamma^{\frac{1}{\theta}} {Y_{T,0}^i}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, C_1^i = \left[(1-\gamma)^{\frac{1}{\theta}} {Y_{N,1}}^{\frac{\theta-1}{\theta}} + \gamma^{\frac{1}{\theta}} {Y_{T,1}^i}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

Firms

- **Firms** in island i
  - Non-tradable (Y_N): exogenous, constant endowment
  - Tradable ($Y_{T,1}^{i,H}$) produced with:

$$Y_{T,1}^{i,H} = A_1 {K_1^i}^{\alpha} \qquad \boxed{\ln(A_1) \equiv a_1 \sim N(0, \beta_a^{-1})}$$

- **Island's budget constraint**:

$$\frac{B_1^i}{R_0} = \mathcal{S}_0(Y_{T,0}^{H,i} - Y_{T,0}^i) + T_0^i$$

Aggregate Financial Sector

- Household cannot access international financial markets
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- Optimality + aggregate financial market clearing yield

$$\underbrace{r_0 - r_0^\star - \left(\bar{E}_0 s_1 - s_0\right)}_{\text{Excess return on domestic bond}} = \Gamma \left(\underbrace{(\beta^{-1} + \alpha\gamma) y_{T,0}}_{\text{Households}} + \underbrace{n_1^\star}_{\substack{\text{Noise} \\ \text{traders}}} + \underbrace{f_1^\star}_{\text{FXI}} \right) \qquad n_1^\star \sim N(0, \beta_n^{-1})$$

where $\Gamma \to 0$: UIP holds

Equilibrium Exchange Rate

- Monetary policy in small-open economy sets $P_t = 1, \forall t \quad \Rightarrow \quad q_t = s_t$.

- Equilibrium *aggregate* real exchange rate: fb

$$q_0 = \frac{\Gamma\omega_1}{\Gamma\tilde{\theta}\omega_1 + \omega_3}(n_1^\star + f_1^\star) - \frac{\omega_2}{\Gamma\tilde{\theta}\omega_1 + \omega_3}\bar{E}_0 a_1$$

$$\text{w/ } \tilde{\theta}, \omega_1, \omega_2, \omega_3 > 0$$

- $\bar{E}_0 a_1 \equiv \int_i E_0^i a_1$: Average expectation of future TFP across islands i

Information structure

(laissez faire)

- Guess a linear solution for the exchange rate $\rightarrow q_0 = \lambda_a a_1 + \lambda_n n_1^\star$

def. of eq. | uniqueness of eq. | dual role of $n^\star$

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- Guess a linear solution for the exchange rate $\rightarrow q_0 = \lambda_a a_1 + \lambda_n n_1^\star$
- Each island i has 3 sources of information about a_1
  1. Prior: $a_1 \sim N(0, \beta_a^{-1})$
  2. Private signal: $v^i = a_1 + \epsilon^i \quad \epsilon^i \sim N(0, \beta_v^{-1})$
  3. Public signal: $\boxed{\frac{s_0}{\lambda_a} = \frac{q_0}{\lambda_a} = a_1 + \frac{\lambda_n}{\lambda_a} n_1^\star}$

$$\frac{\lambda_n}{\lambda_a} n_1^\star \sim N\left(0, \beta_q^{-1}\right), \quad \beta_q \equiv \frac{\lambda_a^2}{\lambda_n^2}\beta_n$$

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- Agent i's rational expectations of a_1:

$$E_0^{i,RE} a_1 = \frac{\beta_v v^i + \beta_q \frac{q_0}{\lambda_a}}{\beta_a + \beta_v + \beta_q}$$

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$\mathcal{I}_R$: information content of FX

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Information content of FX

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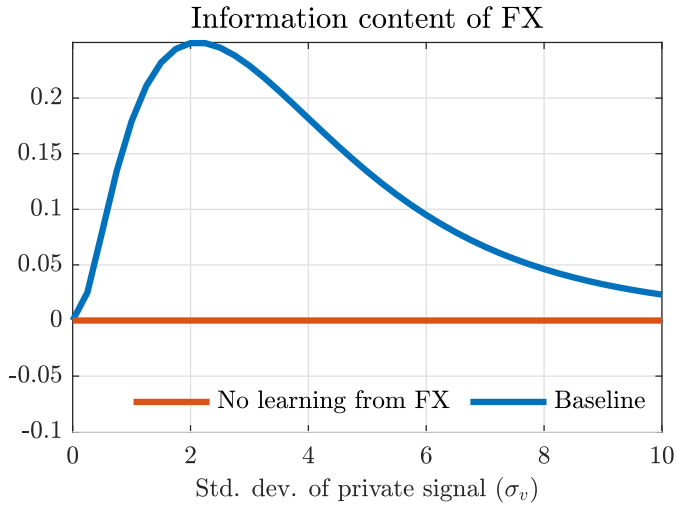
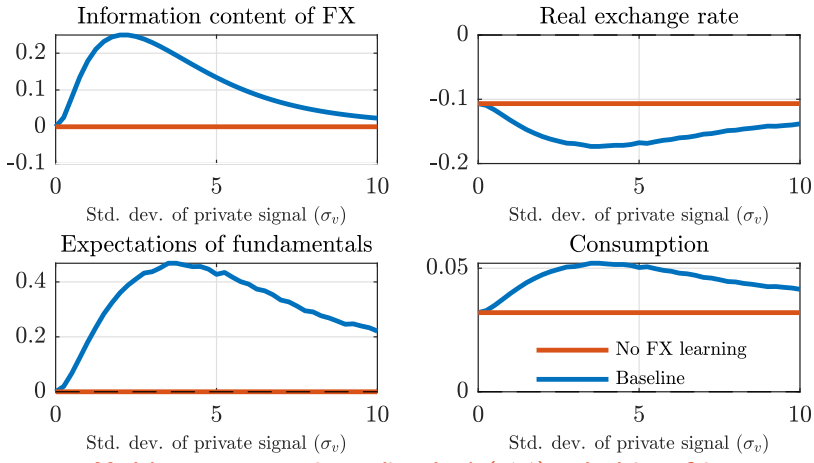


FX information channel: noise trading shock



Model responses to noise trading shock ($n_1^\star \downarrow$) under laissez faire

Fundamental shock

Extrapolative Beliefs
(laissez faire)

- We introduce *extrapolation bias* in belief formation
  - Empirically well documented in survey of expectations and experiments
    (Bordalo et al. 19, 20; Afrouzi et al. 23)
  - Especially relevant to explain exchange rate puzzles
    (Candian & De Leo 23)
- We use the *diagnostic expectations* belief model
  (Gennaioli & Shleifer 10, Bordalo et al. 18)
- ...but extending it to a setting with **endogenous signals**

Extrapolative Beliefs
(laissez faire)

(1) Agents extrapolate the *private* signal v^i

$$E^i[a_1|v^i] = (1+\delta)E_0^{i,RE}[a_1|v^i] \qquad \text{where } \delta \geq 0\text{: degree of extrapolation}$$

$\rightarrow$ **Over-reaction** to *private* signal

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(2) Agents think everyone is rational in forming "higher order beliefs"

- They think that FX aggregates rational belief $\rightarrow$ extracted biased signal from FX

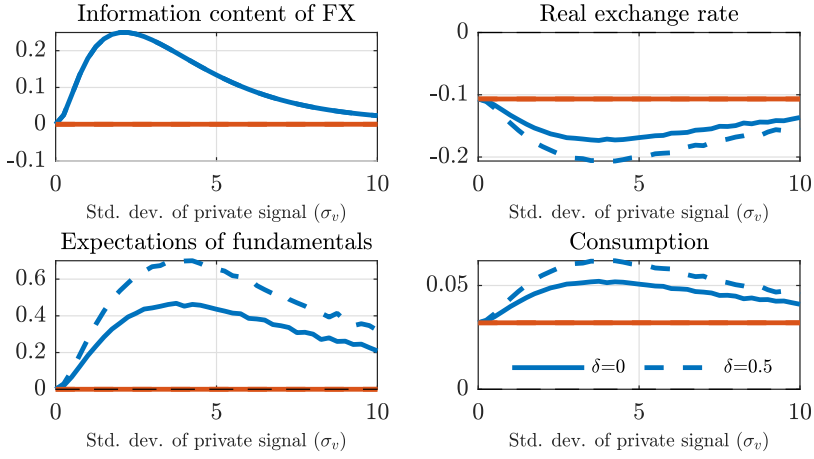
$$\frac{q_0}{\lambda_a} = (1+\delta)a_1 - \frac{\lambda_b}{\lambda_a}n_1^\star$$

- They misinterpret amplification due to $\delta \geq 0$ as large fluctuations in a_1

$\rightarrow$ **Over-reaction** to *public* signal

Extrapolation amplifies information channel of FX

(laissez faire)



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Roadmap

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FX Interventions: Public vs. Secret

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Foreign Exchange Interventions

- Central bank observes aggregates $\bar{E}[a_1], q_0 \rightarrow$ Central bank is fully informed

- **FX interventions**: central bank purchases foreign-currency bond $f_1^\star$ according to:

$$f_1^\star = \kappa_a \bar{E}[a_1] + \kappa_n n_1^\star$$

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- Consider two limit cases:

1. **Public FX interventions**: Agents perfectly observe FX intervention $f_1^\star$
2. **Secret FX interventions**: Agents do not observe FX intervention $f_1^\star$

Agents always know the central bank's reaction function (κ_a, κ_n)

Public FX interventions have a signaling channel

- Suppose central bank adopts a **public FX intervention**, according to:

$$f_1^\star = \kappa_a \bar{E}[a_1] + \kappa_n n_1^\star$$

- $f_1^\star$ becomes an **additional public signal**

$$\frac{f_1^\star}{\kappa_a} = \bar{E}[a_1] + \frac{\kappa_n}{\kappa_a} n_1^\star$$

- Two signals ($f_1^\star$ and q_0) and two unknowns ($n_1^\star$ and $\bar{E}[a_1]$)
- Agents can perfectly extract $\bar{E}[a_1]$ and therefore $a_1 \quad \Rightarrow \quad$ **Full Information**

Secret FX interventions can alter info content of FX

- Suppose central bank adopts a **secret FX intervention**, according to

$$f_1^\star = \kappa_a \bar{E}[a_1] + \kappa_n n_1^\star$$

- $f_1^\star$ alters stochastic properties of $q_0 = \lambda_a a_1 + \lambda_n n_1^*$

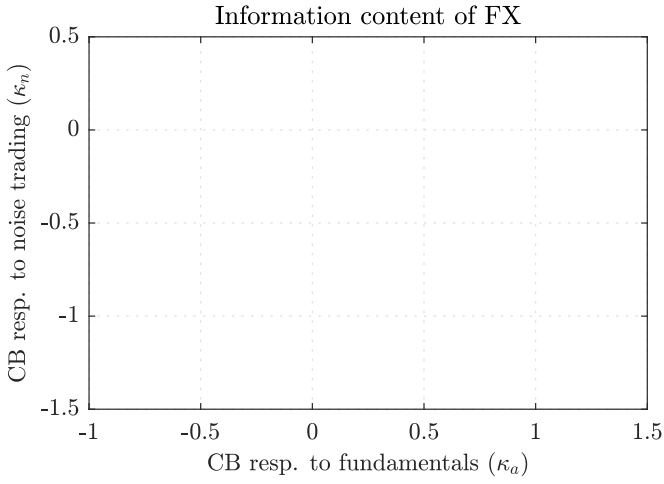
- Central bank can **manage information content of FX**:

$$\left(\frac{\lambda_a}{\lambda_n}\right)^2 = \left(\frac{\omega_2 - \Gamma\omega_1\kappa_a}{\Gamma\omega_1(1+\kappa_n)}\right)^2 \frac{\beta_v^2}{(\beta_a + \beta_v + \Lambda^2\beta_n)^2}$$

- Precision of public signal q_0 depends on chosen (κ_a, κ_n)

Managing expectations with exchange rate policy

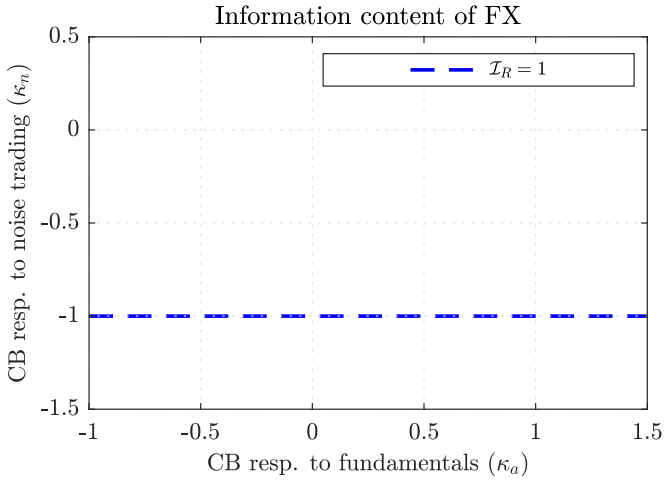
$$q_0 = \lambda_a a_1 + \lambda_n n_1^*$$



Managing expectations with exchange rate policy

$$q_0 = \lambda_a a_1 + \lambda_n n_1^*$$

Full Info ($\lambda_n = 0$): $\kappa_n = -1$



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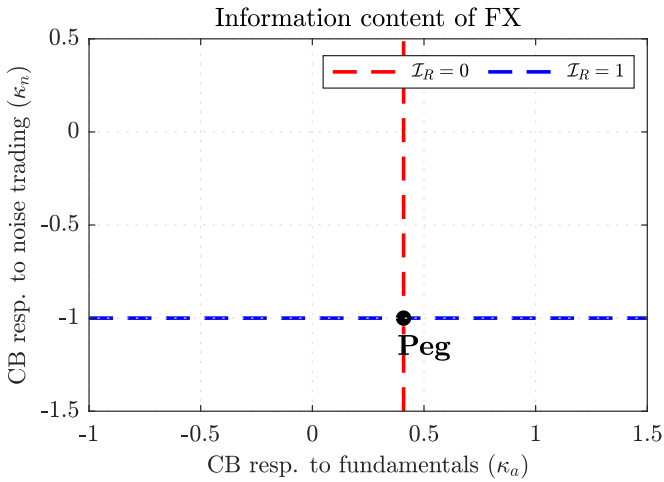
Peg ($\lambda_a = \lambda_n = 0$)



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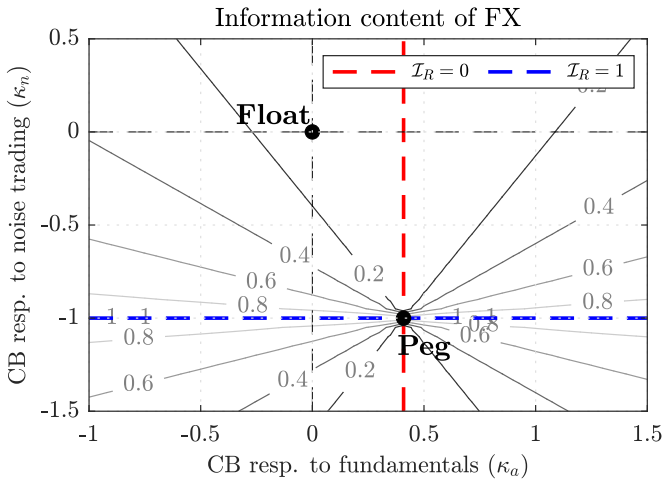
Float: $\kappa_n = 0, \kappa_a = 0$

fx vol



Roadmap

Model & Information Structure

FX Interventions: Public vs. Secret

Optimal FX policy: Rational vs. Extrapolative Beliefs

Optimal FX Policy

- CB maximize welfare by deciding
  - policy rule (κ_a, κ_n)
  - communication *(public/secret)*

- Two wedges relative to frictionless benchmark ($\Gamma = 0$, FIRE):

$$\text{Intermediation wedge} = (1 + \kappa_n) n_1^\star + \left(\frac{\tilde{\theta}\omega_2}{\omega_3} + \kappa_a (1 + \delta) \right) a_1$$

$$\text{Belief wedge} = \bar{E}_0 a_1 - a_1$$

- Frictionless allocation achieved only if Intermediation wedge = Belief wedge = 0

Optimal Policy Under Rational Beliefs

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▷ **Public FX interventions**

  * Economy is in full information (FIRE) $\rightarrow$ belief wedge $= 0$ $\forall(\kappa_a, \kappa_n)$
  * Set (κ_a, κ_n) to close intermediation wedge (Itskhoki & Mukhin 22)

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▷ **Secret FX interventions**

* Set $\kappa_n = -1$ offsetting $n_1^\star \rightarrow$ FIRE in equilibrium $\rightarrow$ belief wedge $= 0$
* Set κ_a to close intermediation wedge

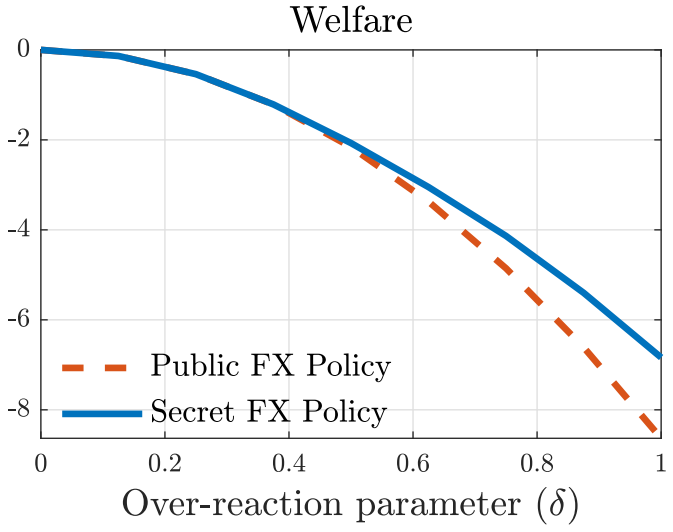
Optimal Policy under Extrapolative Beliefs

- **Under extrapolative expectations**:
  - Higher information amplifies the overreaction bias $\rightarrow$ excessive volatility
  - full information equilibrium still results in a non-zero belief wedge

- If degree of **extrapolation** δ **low**, FI still the best allocation

- If degree of **extrapolation** δ **high** $\rightarrow$ lower info to dampen extrapolation bias
  - CB exploits int. wedge to address belief wedge
  - Letting some *noise trading* & partly offset *fundamental* $\Rightarrow$ lower FX informativeness

Optimal Policy under Extrapolative Beliefs



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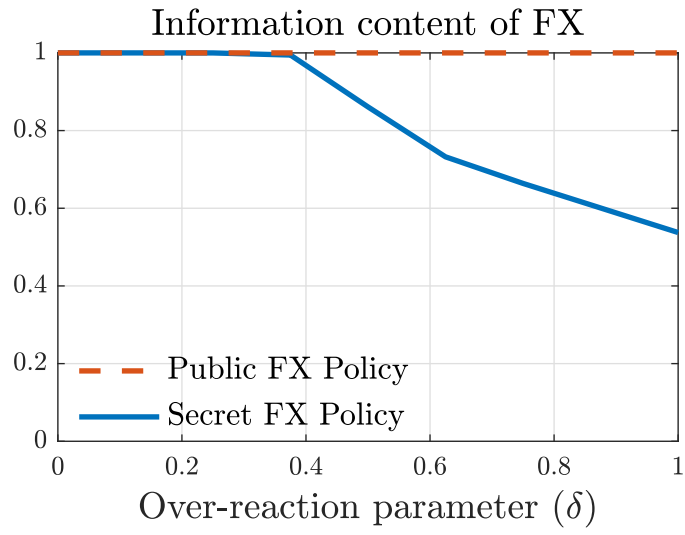
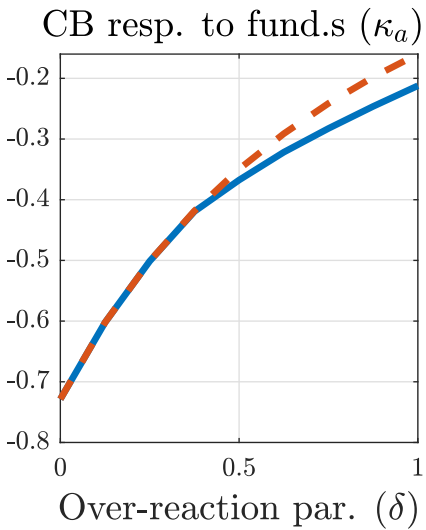
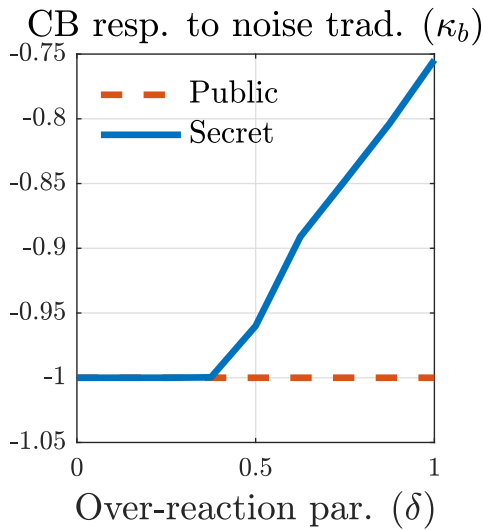


Optimal Policy under Extrapolative Beliefs





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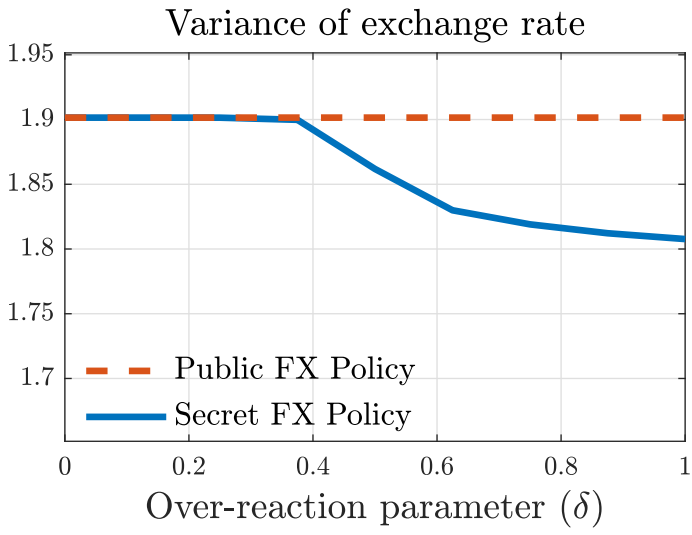


Optimal Policy under Extrapolative Beliefs

A. Low extrapolation δ:

* set $\kappa_n = -1$: belief wedge is minimized under full information
* set κ_a to optimally trade off int. wedge & (non-zero) belief wedge

$\rightarrow$ same policy under **public** & **secret** FX interventions

B. High extrapolation δ:

* optimal **secret** FX policy $\succ$ optimal **public** FX policy
* Secret FX policy lowers belief wedge by making exchange rate less informative

  lower FX informativeness to tame over-reactions...

  ... by letting in some inefficient capital flows by not fully offsetting noise traders

Optimal secret FX policy resembles "systematic managed floating" (Frankel 19)

... and results in lower equilibrium FX volatility

Conclusions

- **Motivation** about information effect of FXI:
  - Stated objective of affecting **market expectations**
  - ...but implemented with **opaque communication**
- Develop a theoretical framework
  - **Positive:** *secret* FX interventions have an **information effect**
  - **Normative:** *secret* FX interventions are the optimal tool to **manage information**
- Rationalizes **signaling effects**, **opacity** and **"fear of floating"** in FX policy

Appendix

Sample of Fratzscher et al (2019)

- Argentina, Australia, Azerbaijan,Bolivia, Canada, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Denmark,the European Monetary Union (EMU), Georgia, Hong Kong, Iceland, Israel,Japan, Kenya, Kyrgyzstan, Mexico, Moldova, New Zealand, Norway, Peru, Poland,Slovakia, South Africa, Sweden, Switzerland, Turkey, the United Kingdom, the United States, and Venezuela

- Sample covers 83% of AEs and 40% of EMEs

- For 9 countries, 17 years from January 1995 to December 2011. Fore other 9, at least 15 years, for remaining 15, at least 10 years

Return

Sample of Adler et al (2021)

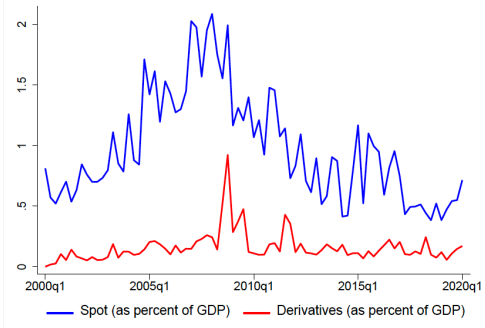
- Published official FXI data covering 39 countries at monthly and 43 countries at quarterly frequency
- Proxied FXI data for 122 countries at monthly and quarterly frequency.

Return

FX Interventions: spot and derivative markets (Adler et al 21)

- Interventions remain dominated by transactions in spot markets

Figure 8. Spot versus Derivatives
(absolute value, percent of GDP)



Sources: International Reserves and Foreign Currency Liquidity Template; and authors' calculations.
Notes: Spot and Derivatives denote quarterly sum of the respective absolute values across countries as a share of their (3-year moving average) group GDP.

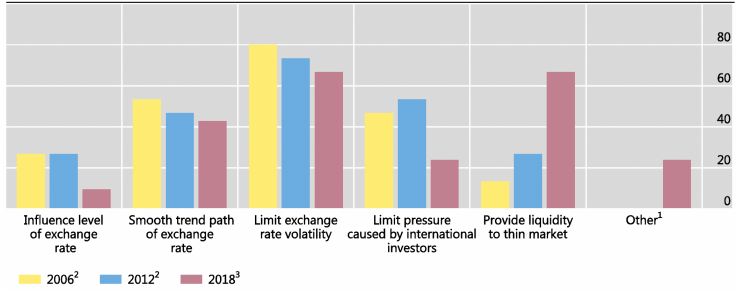
Return

Stated intermediate objectives (Patev & Cavallino 19)

Intermediate objectives of FX intervention: Increasing role of liquidity provision

As a percentage of respondents

Graph 2



[1] Mostly non-floating exchange rate arrangements. The "Other" option was not provided in 2006 and 2012. [2] 15 central banks. [3] 19 central banks.

Source: BIS surveys in 2012 and 2018.

Return

FXI communication (Patev & Cavallino 19)

Public information provided

As a percentage of respondents[1] Table 3

	Normally		Rarely		Never/no response	
	2012[2]	2018[3]	2012[2]	2018[3]	2012[2]	2018[3]
Does the central bank pre-announce FX interventions?	18	32	9	0	73	68
Latin America	50	83	17	0	33	17
Asia	0	13	0	0	0	88
Emerging Europe	0	20	25	0	75	80
Other emerging economies	33	0	0	0	67	100

Return

Final good aggregator

- Consumption and period-1 capital are composites of tradable and non-tradable goods:

$$C_0^i + K_1^i = G(Y_N, Y_{T,0}^i), \qquad C_1^i = G(Y_N, Y_{T,1}^i)$$

  where $G(Y_N, Y_T) = \left[(1-\gamma)^{\frac{1}{\theta}} Y_N{}^{\frac{\theta-1}{\theta}} + \gamma^{\frac{1}{\theta}} Y_T{}^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}$ is homogenous of degree 1.
- θ denotes the elasticity of substitution between tradable and non-tradable goods in the production of final goods
- γ is related to the share of tradable goods in the final composite good
- $Y_{T,t}^i$ represents domestic absorption of the tradable good, which is the sum (difference) of production and imports from (exports to) the rest of the world $Y_{T,t}^i = Y_{T,t}^{i,H} + Y_{T,t}^{i,F}$.
- We assume that each island trades with the rest of the world but not with other islands to avoid full information revelation by inter-island interactions.

Return

Island equilibrium

Demand for tradables: $q_0^i = -\frac{1-\gamma}{\theta} y_{T,0}^i \qquad q_1^i = -\frac{1-\gamma}{\theta} y_{T,1}^i$

Modified UIP condition: $r_0^i = E_0^i q_1^i - q_0^i + \frac{\tilde{\Gamma}(1+\phi)}{\beta} y_{T,0}^i + \tilde{\Gamma} n_1^{i\star} + \tilde{\Gamma} f_1^{i\star}$

Res. constraint + Euler eq.: $r_0^i = \sigma\gamma E_0^i y_{T,1}^i - (\sigma\gamma)(1+\phi) y_{T,0}^i + \sigma\phi k_1^i$

Country budget constraint: $\frac{(1+\phi)}{\beta} y_{T,0}^i = a_1 + \alpha k_1^i - y_{T,1}^i$

Demand for capital: $k_1^i = \frac{1}{1-\alpha} E_0^i q_1^i + \frac{1}{1-\alpha} E_0^i a_1 - \frac{1}{1-\alpha} r_0^i$

Return

Relative information content of exchange rate (Laissez faire)

Definition (Relative information content of exchange rate)

Define the relative information content of the exchange rate as its relative accuracy as a signal about the fundamental shock a_1 compared to prior and private signal. That is, the Bayesian weight on public signal: $\mathcal{I}_R = \frac{\Lambda^2 \beta_n}{\beta_a + \beta_v + \Lambda^2 \beta_n}$.

Return

Incomplete information economy (Laissez faire)

Corollary (Incomplete information economy)

In the case of perfectly inaccurate private signals, $\beta^{\nu} \to 0$, the exchange rate coefficients equal $\lambda_a = 0$ and $\lambda_n = \frac{\Gamma\omega_1}{\Gamma\bar{\theta}\omega_1+\omega_3}$. The relative information content of the exchange rate is nil, i.e. $\mathcal{I}_R = 0$ and the overall posterior accuracy is nil, i.e. $D = 0$.

Return

Full information economy (Laissez faire)

Corollary (Full Information economy)

In the case of perfectly accurate private signals, $\beta_v \to \infty$, the exchange rate coefficients equal $\lambda_a = -\frac{\omega_2}{\Gamma\tilde{\theta}\omega_1+\omega_3}(1+\delta)$ and $\lambda_n = \frac{\Gamma\omega_1}{\Gamma\tilde{\theta}\omega_1+\omega_3}$. The relative information content of the exchange rate is nil, i.e. $\mathcal{I}_R = 0$, while the overall posterior accuracy is infinite, i.e. $D \to \infty$.

Return

Definition of equilibrium (Laissez faire)

Definition (Market equilibrium with laissez-faire)

Given shocks realization $\{a_1, n_1^{i\star}\}$ and agents' prior and signals $\{v^i, q_0\}_{i\in[0,1]}$, a symmetric linear market equilibrium is defined as

- an allocation $(\{c_0^i, c_1^i, k_1^i, y_{T,0}^i, y_{T,1}^i, b_1^{i\star}, d_1^{i\star}\}_{i\in[0,1]})$
- a vector of prices $(\{q_0^i, r_0\}_{i\in[0,1]})$
- A aggregate real exchange rate as a linear function of the states $q_0 = \lambda_a a_1 + \lambda_n n_1^\star$

solving equations (**??**)-(**??**) with expectations respecting (**??**) and (**??**).

Return

Uniqueness of equilibrium

Proposition

Let $\Lambda \equiv \frac{\lambda_a}{\lambda_n}$. The symmetric linear market equilibrium is unique and the equilibrium exchange rate is described by coefficients

$$\begin{aligned} \lambda_a &= -\frac{\omega_2}{\Gamma\tilde{\theta}\omega_1 + \omega_3}(1+\delta)\frac{\beta_v + \Lambda^2\beta_n}{\beta_a + \beta_v + \Lambda^2\beta_n} \\ \lambda_n &= \frac{\Gamma\omega_1}{\Gamma\tilde{\theta}\omega_1 + \omega_3}\frac{\beta_v + \Lambda^2\beta_n}{\beta_v} \end{aligned} \tag{1}$$

where Λ^2 is unique and implicitly defined by

$$\Lambda^2 = \left(\frac{\omega_2}{\Gamma\omega_1}\right)^2 (1+\delta)^2 \frac{\beta_v^2}{(\beta_a + \beta_v + \Lambda^2\beta_n)^2} \tag{2}$$

Return

Public discretionary FXI

Proposition (Public discretionary FXI)

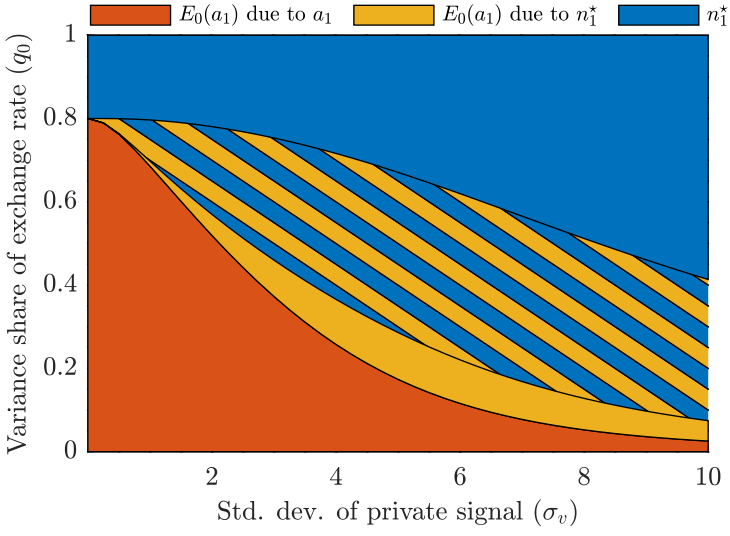
Suppose the central bank adopts a public discretionary FX intervention, i.e. $f_1^\star = \varepsilon_1^{f^\star}$ *and* $\sigma^2_{\eta_f} \to 0$. *A more volatile FX intervention does not affect the relative information content of the exchange rate* $\mathcal{I}_R$ *nor the overall agents' posterior accuracy about fundamental* D. *The equilibrium exchange rate is given by* (**??**) *with the same* λ_a *and* λ_n *as in the laissez-faire equilibrium* (1).

Proof.

See Appendix **??**. □

Return

The dual role of noise trading



Decomposition of effects driving the exchange rate ($\delta = 0$)

Return

Secret discretionary FXI

Proposition (Secret discretionary FXI)

Suppose the central bank adopts a secret discretionary FX intervention, i.e. $f_1^\star = \varepsilon_1^{f^\star}$ *and* $\sigma^2_{\eta_f} \to \infty$. *A more volatile FX intervention decreases the relative information content of the exchange rate* $\mathcal{I}_R$ *and agents' posterior accuracy about fundamental D. The equilibrium exchange rate is given by* (**??**) *with* λ_a *and* λ_n *described in Apppendix* **??**.

Proof.

See Appendix **??**. □

Return

Discretionary FXI

- Suppose the central bank adopts a "discretionary" FX intervention, according to:

$$f_1^\star = \varepsilon_1^{f^\star}$$

- Public FX interventions
  - FXI does not affect the relative information content of the exchange rate $\mathcal{I}_R$
  - The equilibrium exchange rate features the same λ_a and λ_n as in laissez-faire
  - Discretionary FXI is uninformative on state of the economy

- Secret FX interventions
  - FXI decreases the information content of the exchange rate $\mathcal{I}_R$
  - Discretionary FXI adds non-fundamental noise to the exchange rate q_0

Return

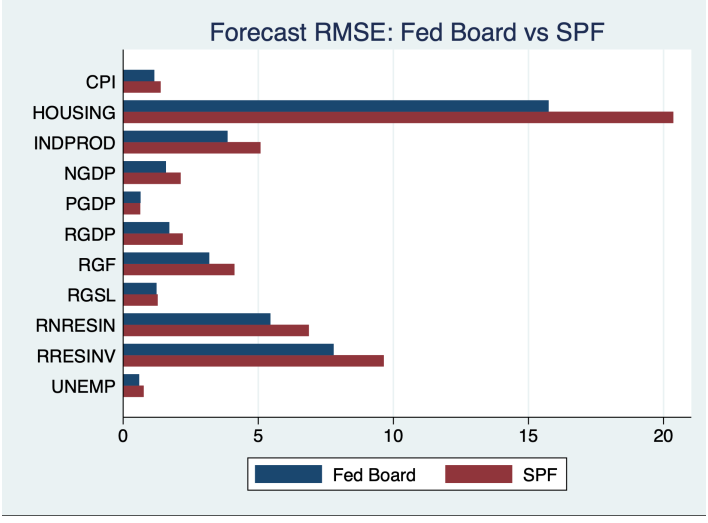
Expectations' over-reaction to FX fluctuations
(laissez faire)

- Agent i's expectations of a_1:

$$E_0^i a_1 = \frac{(1+\delta)\beta_v v^i + \beta_q \frac{q_0}{\lambda_a}}{\beta_a + \beta_v + \beta_q}, \qquad \text{where} \quad \frac{q_0}{\lambda_a} = (1+\delta)a_1 - \frac{\lambda_b}{\lambda_a} n_1^\star$$

- Extrapolation δ amplifies FX fluctuations due to a_1
  1. Extrapolation of private signal
  2. Wrong signal extraction due to higher order belief bias

Central bank's information



Return

Financiers' problem (1)

- Continuum of risk-neutral financiers, $j \in [0, \infty)$, in each island i.
- Financiers hold a zero-capital portfolio in H and F bonds $(d^i_{j,1}, {d^i_{j,1}}^\star)$.
- Financier's investment decisions s.t. two restrictions:
  - First, each intermediary is subject to a net open position limit $D > 0$.
  - Second, intermediaries face heterogeneous participation costs.
    Each intermediary j active in the foreign bond market at t is obliged to pay a participation cost of exactly j per unit of FC invested.
- Intermediary j in island i optimally invests $\frac{{d^i_{j,1}}^\star}{R_0^\star}$ in F bonds:

$$\max_{\frac{{d^i_{j,1}}^\star}{R_0^\star} \in [-D, D]} \frac{{d^i_{j,1}}^\star}{R_0^\star} E^i_0 \left(\tilde{R}^{i\star}_1 \right) - j \left| \frac{{d^i_{j,1}}^\star}{R_0^\star} \right|,$$

where $\tilde{R}^{i\star}_1$ is the return on one foreign-currency unit holding expressed in foreign currency: $\tilde{R}^{i\star}_1 \equiv {R_0}^\star - R_0 \frac{S_0}{S_1}$.

Financiers' problem (2)

- Intermediary j's expected cash flow conditional on investing is $D\left|E_0^i\left(\tilde{R}_1^{i\star}\right)\right|$ while participation costs are jD.
- Investing is optimal for all intermediaries $j \in [0, \bar{j}]$, with the marginal active intermediary $\bar{j}$ given by $\bar{j} = \left|E_0^i\left(\tilde{R}_1^{i\star}\right)\right|$.
- The aggregate investment volume is then

$$\frac{D_1^{i\star}}{R_0^\star} = \bar{j}D \text{ sign}\left\{E_0^i\left(\tilde{R}_1^{i\star}\right)\right\}.$$

- Defining $\Gamma \equiv D^{-1}$ and substituting out $\bar{j}$, we obtain the total demand for foreign-currency bonds in island i, $D_1^{i\star} = \int d_{j,1}^{i\star} \mathrm{d}j$:

$$\frac{D_1^{i\star}}{R_0^\star} = \frac{1}{\Gamma}E_0^i\left(R_0^\star - R_0^i\frac{\mathcal{Q}_0^i}{\mathcal{Q}_1^i}\right)$$

Financiers' problem (3)

- Zero-capital portfolio of each financier implies:

$$\frac{D_1^i}{R_0^i} + \mathcal{Q}_0^i \frac{D_1^{i\star}}{R_0^\star} = 0.$$

- Income from the carry trade of the financiers in island i is:

$$\pi_1^{i,D\star} \equiv D_1^{i\star} + \frac{D_1^i}{\mathcal{Q}_1^i} = \cdots = \tilde{R}_1^{i\star} \frac{D_1^{i\star}}{R_0^\star}.$$

- Intermediaries' demand for foreign bonds has a finite (semi-)elasticity to the expected excess return.
- Changes in home bond demand, e.g., induced by FX interventions, can indeed affect q_0
- Γ is a critical parameter
- Participation costs constitute transfers to households in the H island economy | no extra cost terms enter the household's budget constraint.

Return

Concentration in currency markets

- Detailed data on risk taking in this international and opaque over-the-counter market are relatively scarce, which favors specialization and concentration. (Gabaix Maggiori, 15)
- Transaction volume data also portray a highly concentrated market: (Euromoney 14)
  - the top 10 banks accounted for 80 percent of all flows in 2014
  - with the top two banks (Citigroup and Deutsche Bank) accounting for 32 percent of all flows .
- Currency risk also accounts for a large fraction of their overall respective risk taking. (Deutsche Bank 13; Citigroup 13)
  - Regulatory filings reveal that currency risk accounted for 26-35 percent of total (stressed) value at risk at Deutsche Bank in 2013
  - and between 17 percent and 23 percent at Citigroup in the same period

Return

Exchange rate in frictionless benchmark

- Exchange rate in frictionless benchmark: ($\Gamma = 0$, FIRE)

$$q_0^F = -\frac{\omega_2}{\omega_3} a_1$$

- Deviations of q_0 from q_0^F:

$$q_0 - q_0^F = \frac{\Gamma \omega_1}{\Gamma \tilde{\theta} \omega_1 + \omega_3} \underbrace{\left[(n_1^\star + f_1^\star) + \frac{\tilde{\theta} \omega_2}{\omega_3} a_1 \right]}_{\text{Intermediation wedge}} - \frac{\omega_2}{\Gamma \tilde{\theta} \omega_1 + \omega_3} \underbrace{\left(\bar{E}_0 a_1 - a_1 \right)}_{\text{Belief wedge}}$$

return

Data on FXI (1/2)

- Information on FXI scant for most countries (only 16% of EMEs publish data.) $\rightarrow$ research on FXI has often relied on **coarse proxies**
  - typically, Δ in CB's reserves or reserve flows from B-o-P statistics
- But coarse proxies of FXI are contaminated by
  - (I) valuation changes and investment income flows;
  - (II) CB's FC transactions with residents & nonresidents that affect the amt of reserves but are not FXI (exchange of LC & FC assets).
- How to address:
  - Fratzscher et al. 19 AEJ:Macro: Confidential data from 33 central banks (includes secret FXI)
  - $+$ Identifying FXI via news reports: New data
  - Adler et al. 21: Official FXI data from reports + Proxy FXI data
  - $\hookrightarrow$ download from Rui Mano's website

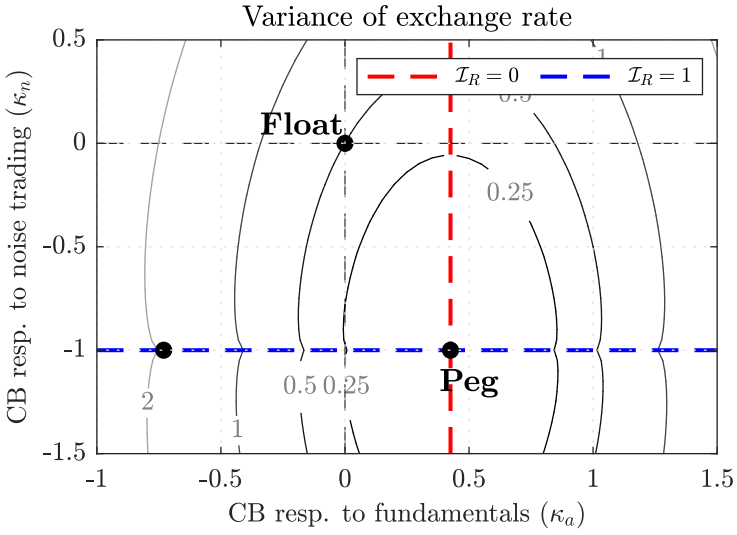
Return to Intro

Data on FXI: Adler et al 21 (2/2)

- FXI: 'any transaction changing central bank's FC position'.
  - I active transactions (no valuation effects)
  - II transaction by CB (no other public sector entities)
  - III focus on FC position (no distinction sterilized v. unsterilized)
  - IV no focus on stated intent (eg. reserve accumulation, etc...)
    include both spot & derivative market operations
- Adler et al 21 address shortcomings of coarse proxies using:
  - ▶ available info on composition of reserve assets $\rightarrow$ estimate valuation Δs
  - $+$ info on market rates & interest payment $\rightarrow$ estimate investment income
  - $+$ other adjustments to "vis-a-vis" proxies.

$\hookrightarrow$ download from Rui Mano's website

Secret FX policy & exchange rate volatility

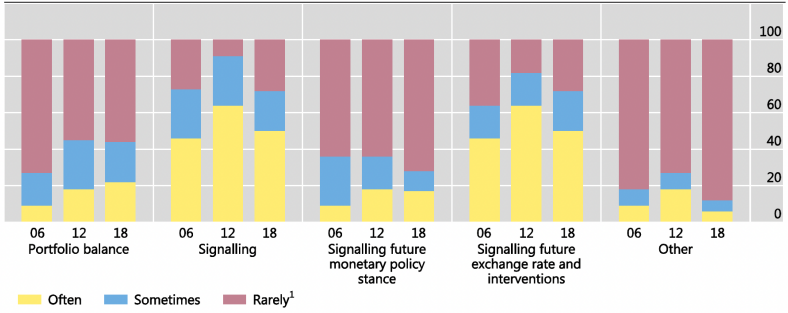


FX variance across (κ_a, κ_n) under secret FX policy and $\delta = 0$

Stated channels (Patel & Cavallino 22)

Signalling remains most important channel of FX intervention

As a percentage of respondents — Graph 3



2006: corresponds to the "Up to 2007" period in the 2012 survey, based on the responses of 11 central banks. 2012: corresponds to the "After 2008" period in the 2012 survey, based on the responses of 11 central banks. 2018: based on the responses of 18 central banks.

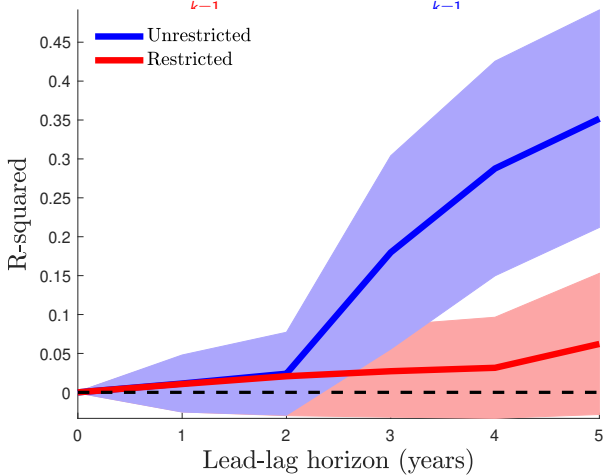
[1] Central banks which did not provide an answer for a channel category but did fill out at least one other category are assumed as "Rarely".

Source: BIS surveys in 2012 and 2018.

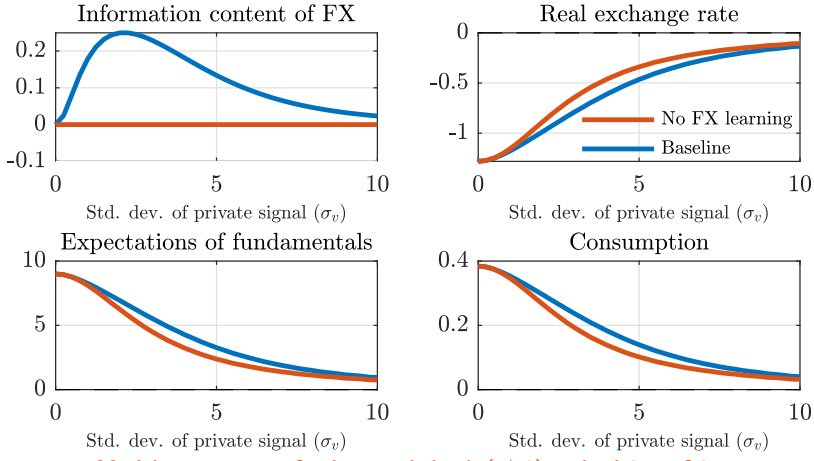
Return to Intro

CCDGV: Bivariate Regression

$$\Delta_4 q_t = \alpha + \beta_0 \Delta_4 TFP_t + \sum_{k=1}^{h} \beta_{-k}^{lag} (\Delta_4 TFP_{t-k}) + \sum_{k=1}^{h} \beta_k^{lead} (\Delta_4 TFP_{t+k}) + \varepsilon_t$$



FX information channel: fundamental shock (laissez faire)

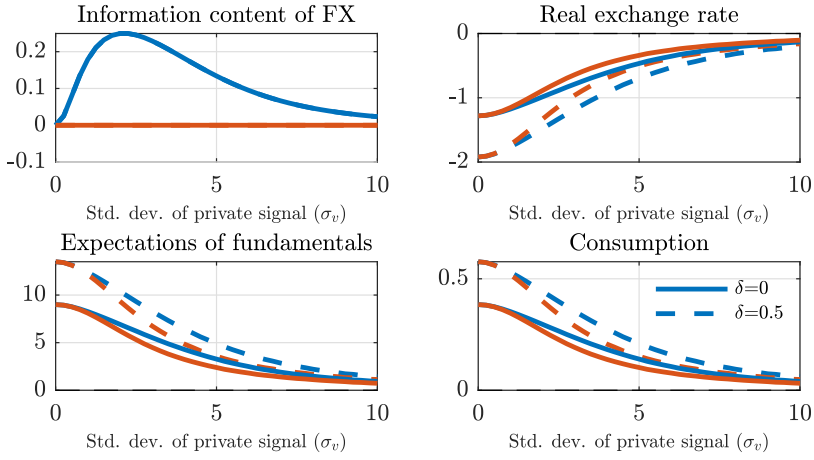


Model responses to fundamental shock ($a_1^\star \uparrow$) under laissez faire

Return

Extrapolation amplifies information channel of FX

(laissez faire)

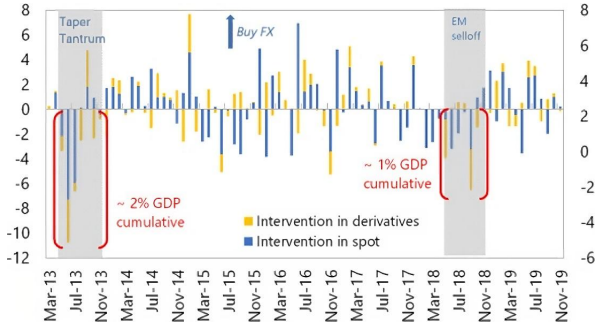


Model responses to fundamental shock ($a_1^\star \uparrow$) under laissez faire

Return

FXI in Indonesia (IMF 2021)

- Bank of Indonesia does not pre-announce nor publish FXI
- Compute using change in reserve holdings net of valuation effects



Return