Learning from Exchange Rates and Foreign Exchange Interventions

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  2. FXIs often **opaque**: not publicly announced or published with lag
     (Sarno & Taylor 01, Canales-Kriljenko 03, Adler et al. 21) Data on FXI

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- **This paper**: Develop a dynamic GE model to:
  - Formalize **informational role** of the exchange rate
  - Study informational effects of **public vs secret FX interventions**

A macro model of the informational role of FX and FXI

A model **segmented int'l asset markets** + **dispersed information**

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3. **Optimal communication** depends on **expectations' formation**
   - Rational expectations: more information is desirable $\rightarrow$ ***Public* FXI is optimal**
   - Extrapolation: agents use information sub-optimally $\rightarrow$ ***Secret* FXI can be optimal**

Related literature

Empirics:

- **Exchange rates & fundamentals:** Evans & Lyons 02, Engel & West 05, Itskhoki & Mukhin 21, Chahrour et al. 22, Stavrakeva & Tang 20a, 20b, 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
- **Empirical properties of FXI:** 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 FXI under RE:** Vitale 99 03, Fernholz 15
- **GE models of FXI under FIRE:** Gabaix & Maggiori 15, Amador et al. 19, Cavallino 19, Fanelli & Straub 21, Itskhoki & Mukhin 22
- **FXI without RE:** Iovino & Sergeyev 21
- **CB communication on monetary policy:** Angeletos & Sastry 20, Chahrour 14, Tang 15, Melosi 17, Kohlhas 20, Candian 21

Summary of Model

- Small open economy, two periods: $t = [0, 1]$ | Real model

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- Non-tradable (y_N): exogenous endowment | Tradable ($y_{T,1}^{i,H}$) technology:

$$y_{T,1}^{i,H} = a_1 + \alpha k_1^i \qquad \boxed{a_1 \sim N(0, \beta_a^{-1})}$$

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- Segmented int'l markets | **Financiers** in island i are subject to position limits

$$r_0^i - r_0^\star - \left(E_0^i q_1^i - q_0^i\right) = \Gamma\left(n_1^{i\star} + f_1^{i\star} - b_1^{i\star}\right)$$

$$\int_i n_1^{i\star} \mathrm{d}i = n_1^\star \sim N(0, \beta_n^{-1})$$

Households Firms Financiers

Equilibrium exchange rate

- Equilibrium *aggregate* real exchange rate:

Island equilibrium

$$q_0 = \frac{\Gamma\omega_1}{\Gamma\tilde{\theta}\omega_1 + \omega_3}({n_1}^{\star} + f_1^{*}) - \frac{\omega_2}{\Gamma\tilde{\theta}\omega_1 + \omega_3}\bar{E}_0 a_1 \qquad \tilde{\theta}, \omega_1, \omega_2, \omega_3 > 0$$

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

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

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- Deviations of q_0 from q_0^F:

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

Information structure (Laissez faire)

Dispersed information Bacchetta & Van Wincoop 06

- HHs receive a private signal v^i about a_1

$$\boxed{v^i = a_1 + \epsilon^i} \quad \epsilon^i \sim N(0, \beta_v^{-1}), \quad \text{w/} \quad \boxed{\text{prior} \;\; a_1 \sim N(0, \beta_a^{-1})}$$

- Agents observe q_0 as they share same currency

Over-extrapolation Bordalo et al. 20

- HH over-extrapolate new information compared to RE

$$E_0^i a_1 = (1+\delta)(E_0^{i,RE} a_1)$$

Learning from the exchange rate (Laissez faire)

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- 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: $\boxed{\frac{q_0}{\lambda_a} = a_1 + \frac{\lambda_n}{\lambda_a} n_1^\star}$ $\quad \frac{\lambda_n}{\lambda_a} n_1^\star \sim N\left(0, \beta_q^{-1}\right), \quad \beta_q \equiv \frac{\lambda_a^2}{\lambda_n^2} \beta_n$

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$$E_0^i a_1 = (1+\delta)\frac{\beta_v v^i + \beta_q \frac{q_0}{\lambda_a}}{\beta_a + \beta_v + \beta_q}$$

- If $\delta > 0$ agents over-extrapolate relative to RE

Bordalo et al. 20

Definition of equilibrium Uniqueness of equilibrium

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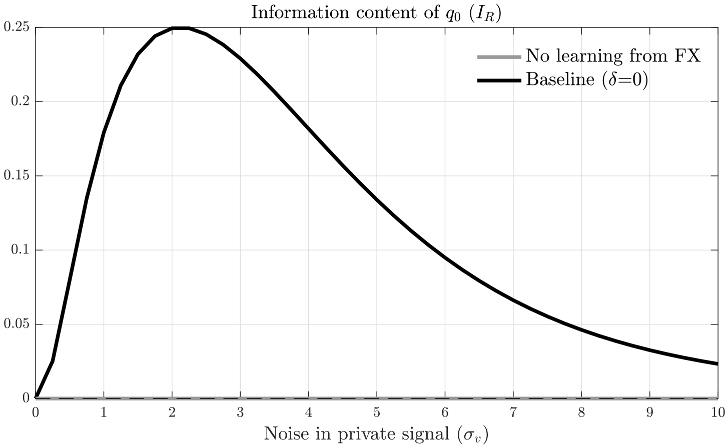
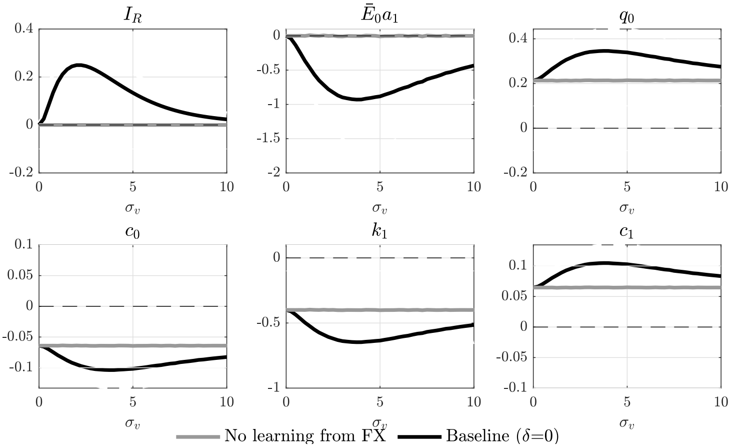
Information content of exchange rate (Laissez faire)



Noise trading shock ($n_1^\star$) (Laissez faire)



Full information economy | Incomplete information economy | Information content of exchange rate | Parameterization

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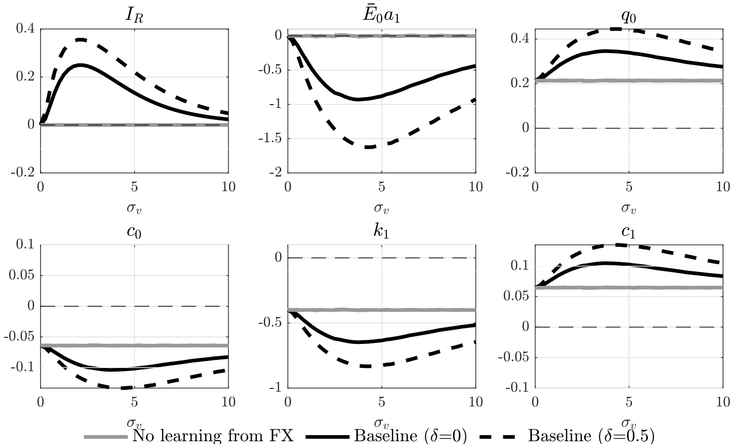

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Foreign exchange interventions

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

Central bank's Information

- FXI: central bank purchases foreign-currency bond $f_1^\star$ according to:

$$f_1^\star = \kappa_a a_1 + \kappa_n n_1^\star$$

- Consider two limit cases

Public vs. Secret FXI

1 **Public FXI**: Agents perfectly observe FX intervention $f_1^\star$

2 **Secret FXI**: Agents do not observe FX intervention $f_1^\star$

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

Public foreign exchange interventions

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

$$f_1^\star = \kappa_a a_1 + \kappa_n n_1^\star$$

$\rightarrow$ $f_1^\star$ becomes an additional public signal

Public discretionary FXI

$$\frac{f_1^\star}{\kappa_a} = a_1 + \frac{\kappa_n}{\kappa_a} n_1^\star \qquad \frac{q_0}{\lambda_a} = a_1 + \frac{\lambda_n}{\lambda_a} n_1^\star$$

- Two signals ($f_1^\star$ and q_0) and two shocks ($n_1^\star$ and a_1) $\Rightarrow$ **Full Information**

Public FXI and wedges

$$q_0 - q_0^F = \frac{\Gamma\omega_1}{\Gamma\tilde{\theta}\omega_1 + \omega_3} \underbrace{\left[(1+\kappa_n){n_1}^\star + \left(\frac{\tilde{\theta}\omega_2}{\omega_3} + \kappa_a(1+\delta)\right) a_1\right]}_{\text{Intermediation wedge}} - \frac{\omega_2}{\Gamma\tilde{\theta}\omega_1 + \omega_3} \underbrace{(\bar{E}_0 a_1 - a_1)}_{\substack{\text{Belief} \\ \text{wedge} \\ = \delta a_1}}$$

- Public FXI can close intermediation wedge with $\left(\kappa_a = -\frac{\tilde{\theta}\omega_2}{\omega_3(1+\delta)}, \kappa_n = -1\right)$
- Implies full information: $\bar{E}_0 a_1 = (1+\delta)a_1$
  - RE ($\delta = 0$): it closes also belief wedge (a form of "divine coincidence")
  - Extrapolation ($\delta \neq 0$): belief wedge persists under full information

Secret foreign exchange interventions

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

$$f_1^\star = \kappa_a a_1 + \kappa_n n_1^\star$$

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

- The endogenous precision of q_0 as a public signal is proportional to:

$$\left(\frac{\lambda_a}{\lambda_n}\right)^2 = \left[\frac{\omega_2 - \Gamma\omega_1\tilde{\kappa}_a}{\Gamma\omega_1(1+\tilde{\kappa}_n)}(1+\delta)\frac{\beta_v}{\beta_a + \beta_v + \Lambda^2\beta_n}\right]^2$$

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- $\tilde{\kappa}_n \to -1$ offset noise traders, $\lambda_n \to 0 \Rightarrow$ **higher information $\mathcal{I}_R \uparrow$**
  $\hookrightarrow$ $\tilde{\kappa}_n = -1$, $q_0 = \lambda_a a_1$ perfectly informative, $\mathcal{I}_R \to \infty \Rightarrow$ *Full Information*

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- $\tilde{\kappa}_a \to \frac{\omega_2}{\Gamma\omega_1}$ offset fundamental shock $\lambda_a \to 0 \Rightarrow$ **lower information** $\mathcal{I}_R \downarrow$
  - $\hookrightarrow$ $\kappa_a = \frac{\omega_2}{\Gamma\omega_1}$, $q_0 = \lambda_n n_1^*$ perfectly uninformative, $\mathcal{I}_R \to 0$

Secret discretionary FXI

Secret FXI and wedges

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- Rational expectations ($\delta = 0$)
  - Offsetting noise traders $\kappa_n = -1 \Rightarrow$ endogenous full information, close belief wedge
  - Then close the intermediation wedge with $\kappa_a < 0 \Rightarrow$ same "divine coincidence"

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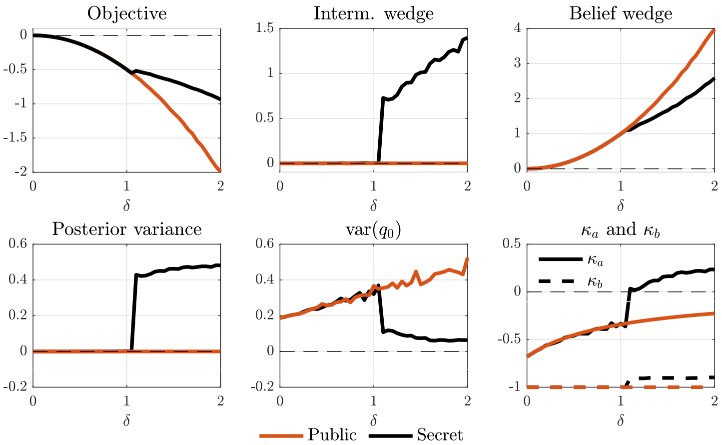
  - Then close the intermediation wedge with $\kappa_a < 0 \Rightarrow$ same "divine coincidence"
- Extrapolation ($\delta > 0$)
  - if $\delta > \hat{\delta}$, central bank needs to lower info to reduce belief wedge
  - Offset noise traders $\kappa_n \to -1$ to lower intermediation wedge, **but**
  - Offset fundamental $\kappa_a > 0$ to lower information and belief wedge

$\Rightarrow$ **Tradeoff** between intermediation and belief wedge $\to$ can't close both

Discretionary FXI

Optimal FX Interventions

Central bank decide optimal κ_a, κ_n to maximize welfare



Conclusions

- Formalize the **informational role of FX** in macro allocation in SOE
- The information channel of FXI depend on **communication**:
  1. **Public FXI** akin to public announcement
  2. **Secret FXI** tool to affect exchange rate informativeness
- Rationalizes a **signaling channel** of FXI as well as the **opaqueness** in many central banks' practices.

Appendix

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

Parameterization (Laissez faire)

Parameter	Interpretation	Value	Reference
β	Discount factor	0.99	Standard
σ	IES	1	Standard
α	Capital share	0.3	Standard
γ	Trade openness	0.3	Standard
θ	Trade elasticity	1	Standard
Γ	Slope of currency demand	3	Pandolfi & Williams 19
σ_a	Std. dev. of a_1	1	
σ_n	Std. dev. of $n_1^\star$	0.2	Chahrour et al. 22
σ_v	Std. dev. of v^i	TBD	Chahrour et al. 22

Incomplete information economy (Laissez faire)

Corollary (Incomplete information economy)

In the case of perfectly inaccurate private signals, $\beta^v \to 0$, the exchange rate coefficients equal $\lambda_a = 0$ 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. $\mathcal{I}_R = 0$ 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 local prices $(\{q_0^i, r_0^i\}_{i\in[0,1]})$
- 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 exchange rate is described by* (**??**) *with 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*

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

while the explicit solution of Λ *is reported in Appendix* **??**.

Proof.

See Appendix **??**.

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* $\sigma_{\eta_f}^2 \to 0$*. 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

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

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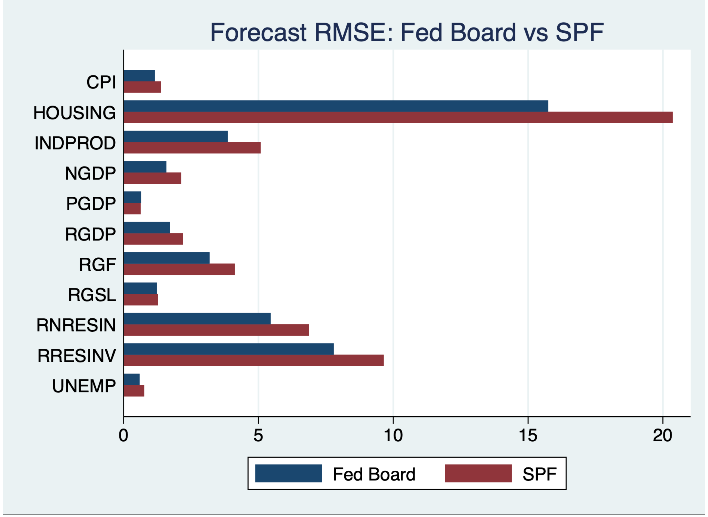
Central bank's information



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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:

$$\max_{\frac{{d^i_{j,1}}^\star}{R_0^\star} \in [-D, D]} \frac{{d^i_{j,1}}^\star}{R_0^\star} E^i_0\left(\tilde{R^i_1}^\star\right) - j\left|\frac{{d^i_{j,1}}^\star}{R_0^\star}\right|,$$

where $\tilde{R^i_1}^\star$ is the return on one foreign-currency unit holding expressed in foreign currency: $\tilde{R^i_1}^\star \equiv {R_0}^\star - R^i_0 \frac{\mathcal{Q}^i_0}{\mathcal{Q}^i_1}$.

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

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

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

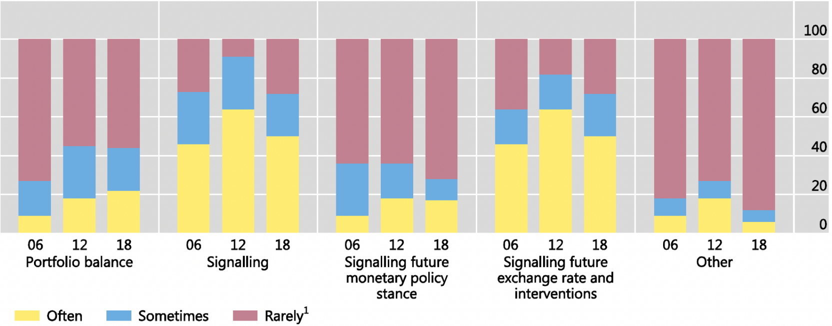
- FXI: 'any transaction changing central bank's FC position'.
  - I active transactions (no valuation effects)
  - II transaction by CB (no other public sector entities)
  - III focus on FC position (no distinction sterilized v. unsterilized)
  - IV no focus on stated intent (eg. reserve accumulation,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

↪ download from Rui Mano's website

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.

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How to model secret v. public interventions

- Central bank is fully informed about a_1

Central bank's Information

- FXI: central bank purchases foreign-currency bond $f_1^\star$ according to:

$$f_1^\star = \kappa_n n_1^\star + \kappa_a a_1 + \varepsilon_1^{f\star} \quad \varepsilon_1^{f\star} \sim N(0, \sigma^2_{\eta_f})$$

- FXI is intermediated by financiers in each island:

$$f_1^{i\star} = f_1^\star + \eta_f^i \quad \eta_f^i \sim N(0, \sigma^2_{\eta_f})$$

Consider two limit cases

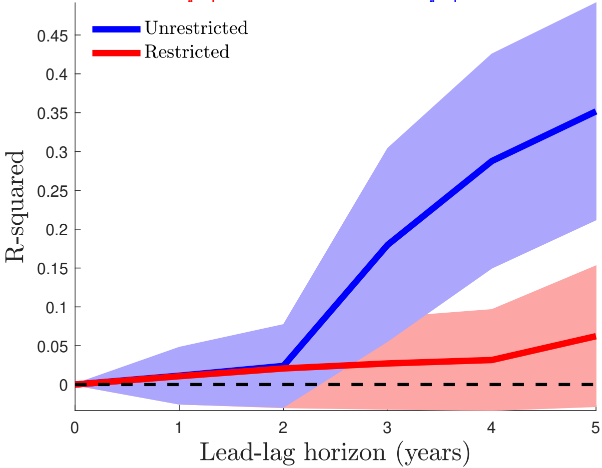
1. **Public FXI**: Agents perfectly observe FX intervention $\sigma^2_{\eta_f} \to 0$
2. **Secret FXI**: Agents do not observe FX intervention $\sigma^2_{\eta_f} \to \infty$

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

Return

CCDGV: Bivariate Regression

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



Model environment

- Two periods: $t = [0, 1]$
- Real model | Monetary policy in SOE sets $P_t = 1 \ \forall t$
- Continuum of atomistic islands $i \in [0, 1]$ in SOE (Lucas 72)
- **Households** in island i

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

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

- Resource constraint:

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

Model environment

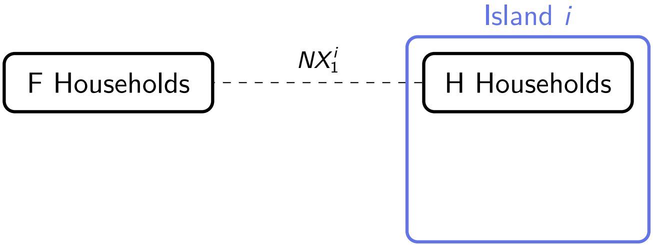
- **Firms** in island i
  - Non-tradable (Y_N): exogenous, constant endowment
  - Tradable ($Y^{i,H}_{T,1}$) produced with:

$$Y^{i,H}_{T,1} = A_1 {K^i_1}^{\alpha} \qquad \boxed{\ln(A_1) \equiv a_1 \sim N(0, \beta_a^{-1})}$$

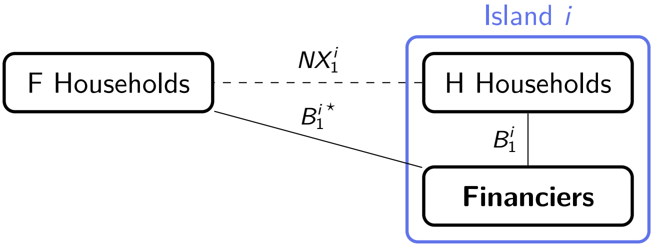
- **Island's budget constraint**:

$$\frac{B^i_1}{R^i_0} = \mathcal{Q}^i_0 (Y^{H,i}_{T,0} - Y^i_{T,0}) + T^i_0$$

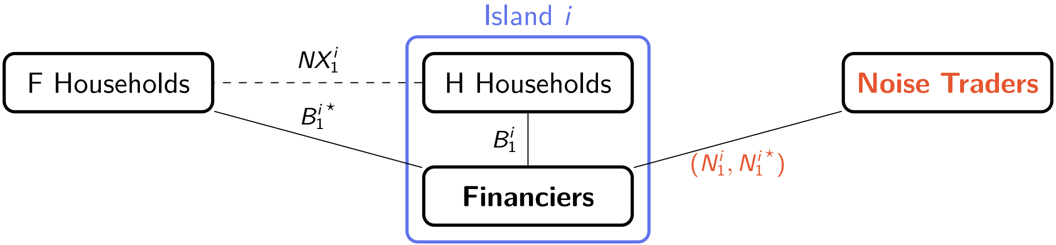
Financial sector



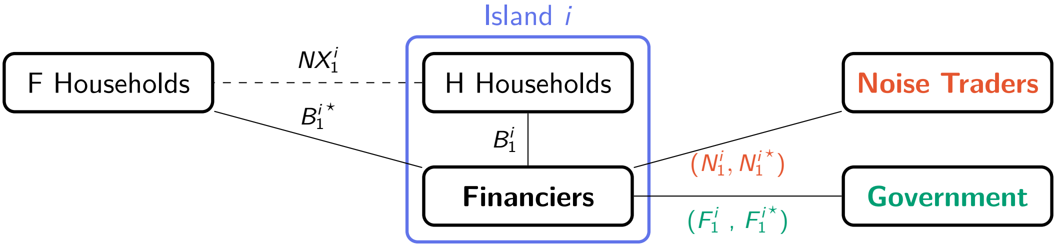
Financial sector



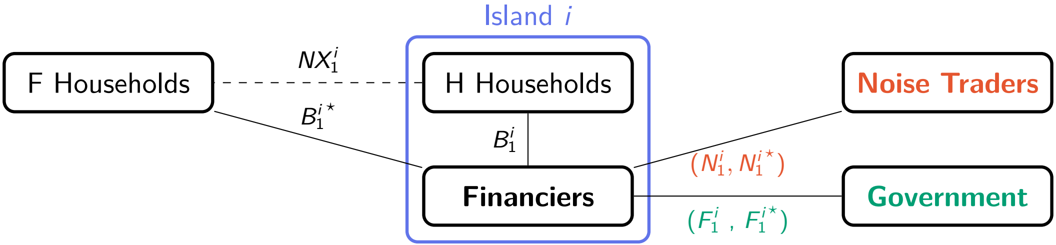
Financial sector



Financial sector



Financial sector



- **Financiers** in island i are subject to position limits

Financiers' problem

$$r_0^i - r_0^\star - \left(E_0^i q_1^i - q_0^i\right) = \Gamma \left(n_1^{i\star} + f_1^{i\star} - b_1^{i\star}\right)$$

$$\int_i n_1^{i\star} \mathrm{d}i = n_1^\star \sim N(0, \beta_n^{-1})$$

↪ $\Gamma \to 0$: no frictions; $\Gamma \to \infty$: autarky

- Financiers owned by households in respective island

FX market concentration
Island equilibrium