Systematic Foreign Exchange Intervention and Macroeconomic Stability: A Bayesian DSGE Approach

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- Most effects of any systematic policy are a consequence of changing the expectation formation.
- Reduced-form estimations alone may not suffice to explain the role of a systematic FXIs (i.e., the Lucas critique).

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  1. Estimating structural parameters and shocks by a Bayesian method using Vietnamese data, and
  2. Conducting a counterfactual simulation under different policies.

Literature

- **Determinants of real FX rates**: Asea and Mendoza (1994), Berka et al. (2018), Canzoneri et al. (1999), Chong et al. (2012), Devereux (1999), Engel (1999), Meza and Urrutia (2011)

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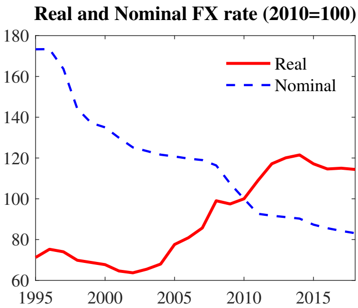
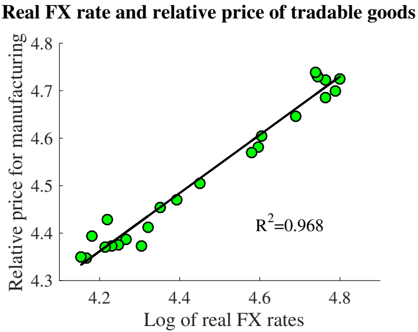
- **Systematic monetary policy**: Clarida et al. (2000), Dotsey (2004)

Foreign Exchange Rate and Intervention in Vietnam

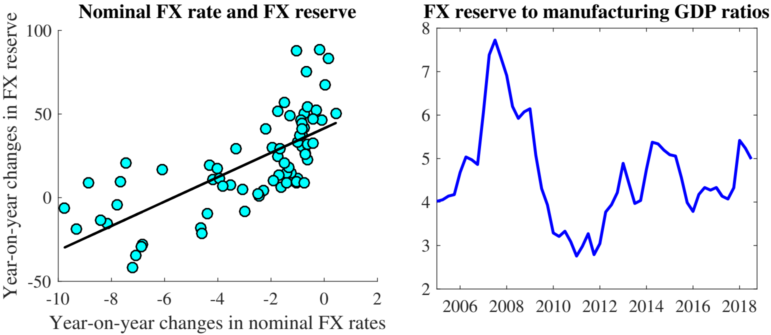
Developments in Real and Nominal Foreign Exchange Rate





- There is a secular trend of appreciation (depreciation) for the real (nominal) FX rate.
- The real FX rate has been mostly tracked by the relative price of manufacturing sector (i.e., Law of one price).

Policy Rule for Foreign Exchange Intervention



- FX reserve positively responds to changes in FX rates to lean against the wind ("systematic managed floating").
- FX reserve relative to manufacturing GDP have moved around a certain level (the error correction?).

Policy Rule for Foreign Exchange Intervention

- The FX policy rule is estimated by quarterly Vietnamese data:

$$\Delta Res_t = \beta_0 + \beta_1 \Delta FX_t + \beta_2 \frac{Res_{t-2}}{GDP_{t-2}} + \varepsilon_t$$

where Res_t: FX reserve, FX_t: FX rate vis-à-vis USD.

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- Estimation results show that changes in FX reserve will:
  1. decline by 8.6% in response to 1%pt FX depreciation, and
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- They are used as prior means for the Bayesian estimation.

Small Open Economy Model

Overview

- The model mostly follows a standard small open economy DSGE model (e.g., Uribe and Schmitt-Grohe 2017)
- There are two features that distinguish it from a conventional model to fit the EMEs.
  - ⋆ The real FX rate is non-stationary and cointegrated with the relative productivity growth (the Balassa-Samuelson effect).
  - ⋆ FXIs are modeled as a systematic FX policy and possibly have effects on the FX rate by frictions.

Household

- Consumption basket with tradable and non-tradable goods

$$C_t = \left[\iota^{\frac{1}{\eta}} C_{T,t}^{\frac{\eta-1}{\eta}} + (1-\iota)^{\frac{1}{\eta}} C_{N,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

- Budget constraint

$$P_t C_t + \frac{B_t}{R_t} + P_t \frac{b_t^*}{Q_t(r_t^* + \zeta_t)} = B_{t-1} + P_t \frac{b_{t-1}^*}{Q_t} + \sum_{j=T,N} W_{j,t} L_{j,t} + D_t - \frac{\Phi\left(\Delta b_t^*\right)}{Q_t(r_t^* + \zeta_t)} + T_t$$

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- Adjustment cost for changing foreign bond holdings, $\Phi(\Delta b_t^*)$ where $\Delta b_t^* \equiv b_t^* - b_{t-1}^*$, satisfying $\Phi'(\cdot) > 0$ and $\Phi''(\cdot) > 0$

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- Maximize the life-time utility: $E_0 \sum_{t=0}^{\infty} \beta^t U\left(C_t, L_{T,t}, L_{N,t}\right)$

Firms

- Demand function: $Y_{j,t}(i) = \left(\frac{P_{j,t}(i)}{P_{j,t}}\right)^{-\nu} Y_{j,t},\ j = T, N$
- Production function: $Y_{j,t}(i) = Z_t A_{j,t} L_{j,t}(i)^{\alpha},\ j = T, N,.$

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- Here, $\log Z_t$ and $a_{j,t} \equiv A_{j,t}/A_{j,t-1}$ follow AR(1):

$$\begin{aligned} \log Z_t &= \rho_z \log Z_{t-1} + \varepsilon_{z,t}, \quad \text{and} \\ \log a_{j,t} &= (1-\rho_{aj}) \log \bar{a}_j + \rho_{aj} \log a_{j,t-1} + \varepsilon_{aj,t},\ j = T, N. \end{aligned}$$

- Note that both $A_{T,t}$ and $A_{N,t}$ are non-stationary.

Firms (cont'd)

- Maximize by choosing $P_{j,t+k}(i)$,

$$\sum_{k=1}^{\infty} \frac{\Lambda_{t+k}}{\Lambda_t P_{t+k}} \begin{bmatrix} P_{j,t+k}(i) Y_{j,t+k}(i) - W_{t+k} L_{j,t+k}(i) \\ -\frac{\gamma_j}{2} \left(\frac{P_{j,t+k}(i)}{P_{j,t+k-1}(i)} - \pi_{t+k-1}^{\xi_j} \pi^{*1-\xi_j} \right)^2 P_{t+k} Y_{t+k} \end{bmatrix}$$

  where γ_j and ξ_j are for price stickiness and indexation.

- Λ_{t+k}/Λ_t is a stochastic discount factor from t to $t+k$.
- A NKPC for the tradable and non-tradable sector is obtained.

Central Bank

- R_t follows the Taylor-type rule with interest rate smoothing and responds to the nominal FX rate and the FX reserve

$$R_t = (R_{t-1})^{\rho_R} \left[R^* \left(\frac{\pi_t}{\bar{\pi}} \right)^{\phi_\pi} \left(\frac{Y_t}{Y_{t-1}} \right)^{\phi_y} \left(\frac{Q_t/P_t}{Q_{t-1}/P_{t-1}} \right)^{\phi_q} \left(\frac{Res_t}{\bar{Res}_t} \right)^{\phi_{res}} \right]^{1-\rho_R} v_{m,t},$$

- Here, $\phi_{res} > 0$ captures non-sterilized FXIs.

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- FXIs (ΔRes_t) follow a feedback rule:

$$\Delta Res_t = \Delta \bar{Res}_t \left(\frac{Q_t/P_t}{Q_{t-1}/P_{t-1}} \right)^{\theta_q} \left(\frac{Res_t/Y_{T,t}}{\bar{Res}_t/\bar{Y}_T} \right)^{\theta_{res}} v_{f,t}$$

- Central bank's balance sheet identity: $P_t \frac{Res_t}{Q_t(r_t^* + \zeta_t)} = \frac{B_t}{R_t}$

Market Clearing

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- Market clearing conditions
  - Non-tradable goods: $Y_{N,t} = C_{N,t}$
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- Note that the market clearing condition for the tradable goods is equivalent to the balance of payment identity.

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Proposition

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Which one, (i) or (ii), should be assumed?

Balanced Growth Path (cont'd)

Corollary

On the balanced growth path, if the condition (i) in Proposition 1 is satisfied, the real FX rate is non-stationary and cointegrated with the relative productivity between tradable and non-tradable sector, $A_{T,t}/A_{N,t}$. If the condition (ii) in Proposition 1 is satisfied, the real FX rate is stationary on the balanced growth path.

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In Vietnam:

- The real FX rate has a non-stationary upward trend, and
- The trend in the real FX rate is cointegrated with the share of tradable goods (the Balassa-Samuelson relationship)

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$\Rightarrow$ The consumption basket is assumed to be Cobb-Douglas

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  - ⋆ Meza & Urrutia (2011) compute a transition path with $\eta < 1$.

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- "Nonbalanced" growth with $\eta < 1$ (Ngai & Pissarides 2007) may be more plausible...?
  - ⋆ Meza & Urrutia (2011) compute a transition path with $\eta < 1$.
- Even on the Non-BGP, the path of $\frac{P_{T,t}}{P_t}$ would be similar to the case of $\eta = 1$.

  $\Rightarrow$ Implications for the real FX rate would not be changed.

Equilibrium

- Utility function: $U\left(C_t, L_{T,t}, L_{N,t}\right) = \frac{\left(\frac{C_t}{A_{T,t}^{\iota}A_{N,t}^{1-\iota}} - \chi \sum_{j=T,N} \frac{L_{j,t}^{1+\omega}}{1+\omega}\right)^{1-\sigma}}{1-\sigma}$
- Adjustment cost: $\Phi(\Delta b_t^*) \equiv \frac{\psi}{2}\left(\frac{b_t^*}{A_{T,t}} - \frac{b_{t-1}^*}{A_{T,t-1}}\right)^2 Y_{T,t}$

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The equilibrium conditions:

- Labor supply: $W_{j,t}/P_t = \chi L^{\omega}_{j,t}, \quad j = T, N$
- Euler equation: $U_C(t) = \beta R_t \mathbb{E}_t\left[\frac{U_C(t+1)}{\pi_{t+1} a^{\iota}_{T,t+1} a^{1-\iota}_{N,t+1}}\right]$
- Augmented UIP condition:

$$\mathbb{E}_t\left[\frac{R_t}{\pi_{t+1}}\right] = (r^*_t + \zeta_t)\mathbb{E}_t\left[\frac{Q_t}{Q_{t+1}}\left(1 + \psi\left(\frac{b^*_t}{A_{T,t}} - \frac{b^*_{t-1}}{A_{T,t-1}}\right) Y_{T,t}\right)^{-1}\right]$$

Quantitative Analysis

Estimation

- Some parameters are calibrated to conventional values, and the rest of them are estimated by a Bayesian method
- The estimation uses the Vietnamese data from 2005Q1 to 2018Q3 for the following seven variables:
  1. GDP growth for the whole economy,
  2. GDP growth for the manufacturing sector,
  3. the inflation rate,
  4. the nominal interest rate (the discount rate),
  5. the reserve to the manufacturing GDP ratio,
  6. the FX rate vis-á-vis the US dollar, and
  7. the real interest rate in the U.S. (FF rate deflated by CPI).

Estimation Results

parameter	post. mean	90% CI	prior dist.	prior mean	prior stdev
γ	8.53	[4.02 12.64]	Gamma	60	30
ψ	29.7	[9.5 49.41]	Gamma	10	10
ϕ_{res}	-0.12	[-0.19 -0.04]	Norm	0.0	0.2
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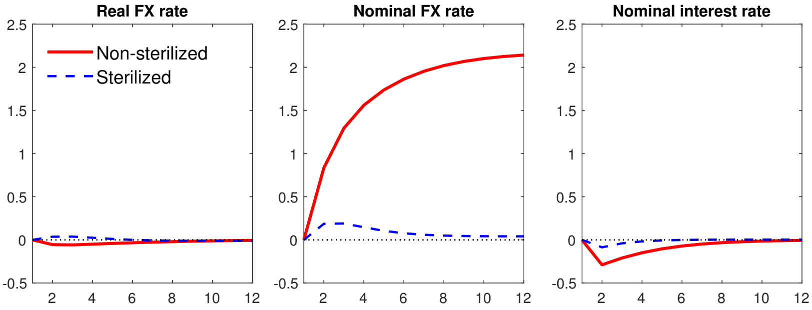
- The cost of price changes, γ, are very small, implying that the Phillips curve is quite steep.
- The adjustment cost, ψ, is positive and statistically significant. $\Rightarrow$ Sterilized FXIs are effective in Vietnam.
- Nominal interest rates increase when the FX reserve decreases ($\phi_{res} < 0$) or the nominal FX rate depreciates ($\phi_q < 0$)

Impulse Response to the FX intervention (1%pt of GDP)



- With non-sterilization, the nominal FX rate appreciates by 2%.
- Appreciation in the real FX rate is small, reflecting the steep Phillips curve.

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Impulse Response to the FX intervention

- If “sterilized” FXIs are defined as the ones which do not influence the nominal interest rate, then...
- ...they include the effects of non-sterilized FXIs in the model!
- Non-Sterilized FXIs raise inflation, thus leading to a rise in the interest rate due to the systematic policy response.
- We cannot identify between “sterilized” and “non-sterilized” FXIs by looking at the influence on the interest rate.

Variance Decomposition

	Productivity ($\varepsilon_{aT}, \varepsilon_{aN}, \varepsilon_z$)	External ($\varepsilon_q, \varepsilon_{rr}$)	FX policy (ε_f)	Monetary (ε_m)
Real FX rate	84.2	15.6	0.1	0.3
Nominal FX rate	40.3	20.7	28.0	11.0
Inflation rate	74.0	2.6	16.3	7.1
Output growth	58.2	12.1	21.0	8.7
FX reserve	34.5	28.3	10.0	27.2

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- 84 percent of the real FX rate is explained by the productivity shocks in line with the Balassa-Samuelson relation.

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	Productivity ($\varepsilon_{aT}, \varepsilon_{aN}, \varepsilon_z$)	External ($\varepsilon_q, \varepsilon_{rr}$)	FX policy (ε_f)	Monetary (ε_m)
Real FX rate	84.2	15.6	0.1	0.3
Nominal FX rate	40.3	20.7	28.0	11.0
Inflation rate	74.0	2.6	16.3	7.1
Output growth	58.2	12.1	21.0	8.7
FX reserve	34.5	28.3	10.0	27.2

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- For inflation and nominal FX rates, the FX and monetary policy shock play a significant role.
- FX reserve has been mostly driven by a systematic response.

Counterfactual Simulation for a New Policy Framework

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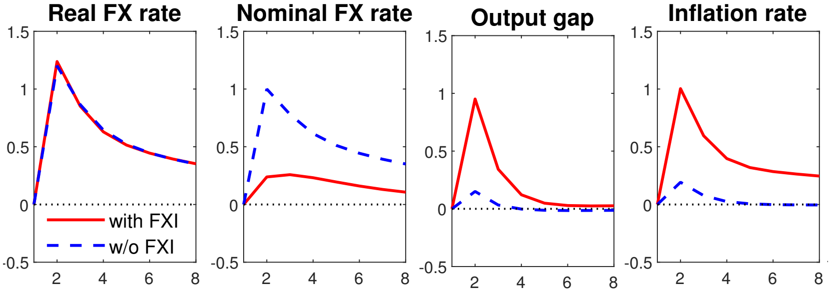
- The counterfactual cases are compared with the baseline results to quantify the effects of FXIs.
- A more stringent inflation-targeting regime (i.e., $\varepsilon_{m,t} = 0$ for all t) is also examined.

Impulse Response I: Productivity Shock

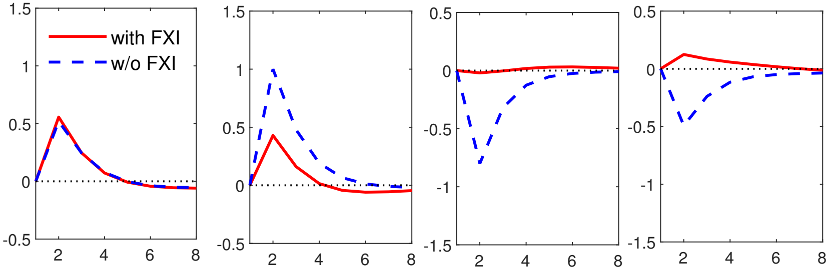
(1) Real FX rate, (2) Nominal FX rate, (3) Output gap, (4) Inflation rate



- The sizes of the responses of output and inflation are larger for the case with than for the case without FIXs.
- FX flexibility, rather than FXIs, can work as a shock absorber.

Impulse Response II: UIP Shock

(1) Real FX rate, (2) Nominal FX rate, (3) Output gap, (4) Inflation rate



- The systematic FXI policy dampens the responses rather than amplifies them.

Impulse Response III: Monetary Policy Shock

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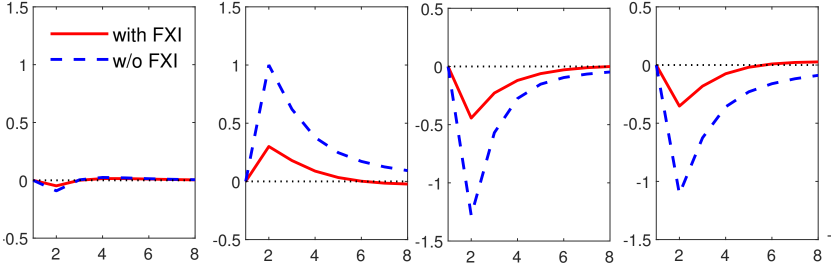

- The systematic FXI policy dampens monetary policy effects by counteracting the appreciation pressure in the FX market.

Variance of Output, Inflation and Nominal FX Rates

	With FXI (Baseline)	Without FXI	Flexible IT
Real FX rate	1.00	0.99	0.98
Nominal FX rate	1.00	2.11	1.76
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- Without FXIs, output, inflation and nominal FX rates would have been much more volatile.
  $\Rightarrow$ FXIs have significantly stabilized the economy!
- How the systematic FXIs stabilize the economy is analogous to systematic monetary policy (i.e., Clarida et al. 2000).

Variance Decomposition II (without FXI)

	Internal ($\varepsilon_{aT}, \varepsilon_{aN}, \varepsilon_z$)	External ($\varepsilon_q, \varepsilon_{rr}$)	FX policy (ε_f)	Monetary (ε_m)
Real FX rate	85.3	14.3	0.0	0.4
Nominal FX rate	46.8	22.7	0.0	30.5
Inflation rate	47.0	8.7	0.0	44.3
Output growth	41.5	23.9	0.0	34.6
FX reserve	61.3	29.2	0.0	9.5

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- The share of the monetary policy shock rises remarkably.
- FXIs contribute to macroeconomic stability by dampening the effects of their own monetary policy shock.

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- Many other EMEs adopt an inflexible FX system to reduce inflation due to excessive monetary easing (e.g., Argentina).
- The central bank can stabilize the economy, even without FXIs, by following a stricter IT regime? Yes.

Conclusion and Policy Implications

- FXIs have contributed to stabilizing the economy in Vietnam.
- The stabilization has been mainly through mitigating the adverse effects of excessive monetary easing.
- There are some caveats:
    1. The role of FXIs depends on which shocks are dominant.
    2. The analysis ignores the history of dollarization.
- One of future works is to apply the model to other CLMV countries. Any other?

Estimation Results

parameter	posterior mean	90% CI	prior dist.	prior mean	prior stdev
γ	8.53	[4.02 12.64]	Gamma	60	30
ξ	0.06	[0.01 0.11]	Beta	0.5	0.2
ψ	29.7	[9.5 49.41]	Gamma	10	10
ι	0.29	[0.19 0.39]	Beta	0.5	0.2
$\bar{Rev}$	0.02	[0.01 0.02]	Gamma	0.04	0.02
$\bar{a}_N$	1.018	[1.015 1.021]	Gamma	1.016	0.002
$\bar{a}_T$	1.023	[1.017 1.029]	Gamma	1.024	0.004
$\bar{r^*}$	0.999	[0.997 1.001]	Gamma	0.998	0.002
ρ_R	0.88	[0.84 0.93]	Beta	0.5	0.2
ϕ_π	1.83	[0.97 2.67]	Gamma	1.5	0.7
ϕ_y	0.91	[0.36 1.44]	Gamma	1.0	0.5
ϕ_{res}	-0.12	[-0.19 -0.04]	Norm	0.0	0.2
ϕ_q	-0.40	[-0.66 -0.15]	Norm	0.0	0.2
θ_{res}	-0.09	[-0.13 -0.05]	Norm	-0.1	0.03
θ_q	8.54	[5.98 11.09]	Gamma	8.6	2.00
$\rho_{a,N}$	0.31	[0.11 0.48]	Beta	0.5	0.15
$\rho_{a,T}$	0.90	[0.85 0.96]	Beta	0.5	0.15
ρ_z	0.77	[0.68 0.85]	Beta	0.5	0.15
ρ_m	0.77	[0.61 0.94]	Beta	0.5	0.15
ρ_q	0.92	[0.88 0.96]	Beta	0.5	0.15
ρ_f	0.41	[0.25 0.57]	Beta	0.5	0.15
ρ_{rr}	0.46	[0.26 0.67]	Beta	0.5	0.15