Dollar Liquidity Flows in Small-Open Economies

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Motivation

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- **What effects do dollar liquid asset flows have in small-open economies?**

→ SOE Domestic Banks' Dollar Liquidity Management Problem.

- **Resuscitating Monetary Approach to Balance of Payment**

→ Dollar Reserve Demand from SOE Domestic Banks.

Bird Eye View | International Payment System

- **The Daily Creation of $ Deposits Globally**
  $ Liabilities in Non-US Banks [Euro-Dollar Deposit] [US Deposits]

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  Key for International Trade [SWIFT, CLS] [CHIPS, FEDWIRE]

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- **International Settlements**
  $ as a Settlement Asset [”Nostro” account @ Correspondent] [Fed Accounts]

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- **International Settlements**
  $ as a Settlement Asset [”Nostro” account @ Correspondent] [Fed Accounts]
- **Short-term Funding under Dollar Deficit**
  Interbank Market [LIBOR/SOFR] [Federal Funds Market]
  Tap Deficit with [Credit Line @ Correspondent] [Fed Discount Window]

Motivation

1. **UIP/CIP Violations?** (e.g. Cerutti, Obstfeld and Zhou (2021), Borio et al. (2016))

$$E_t[\Delta e_{t+1}] = i_t^* - i_t + \Phi$$

→ Φ : Dollar Liquidity Premium

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2. **Domestic Spill-over?**

→ Via Banks' Liquidity Management Problem and the Domestic Lending Channel.

Preview of Results

- Dollar Inflow → Banks' Demand on Liquid Assets → EX ↑↓
- Dollar Inflow → Dynamics of Balance of Payment and Current Account
- Dollar Inflow → Inflation → Real Lending Rate Changes → Domestic Lending

Literature Review

Literature Review

- **Financial Frictions and Exchange Rate Determination**

  Jiang (2022), Alvarez, Atkeson and Kehoe (2009), Itskhoki and Mukhin (2021), Engel (2014), Gabaix and Maggiori (2015), Amador et al. (2020)

→ **Frictions coming from international settlement and dollar reserve funding risk.**

- **Liquidity Management of Banking Sector**

  Krishnamurthy and Li (2021), Jiang et al. (2021), Jiang, Krishnamurthy and Lustig (2021c), Jiang (2022), Valchev (2020), Bianchi and Bigio (2022), Altavilla et al. (2021), Bianchi, Bigio and Engel (2021)

→ **Small-Open Economy Domestic Banks' as a Core Mechanism.**

Literature Review

- **Dollar as a Dominant Currency**

  Chahrour and Valchev (2022), Jiang (2021), Jiang, Krishnamurthy and Lustig (2021*b*), Gourinchas and Rey (2007), Lustig, Roussanov and Verdelhan (2014), Maggiori (2017), Hassan and Mano (2019) and Liao (2020), Rey (2013), Rey (2016)

- **Small Open Economy with Limited Arbitrage**

  Valchev (2020), Engel (2016), Liao (2020), Jiang, Krishnamurthy and Lustig (2021*a*), Jiang, Krishnamurthy and Lustig (2021*b*), Gabaix and Maggiori (2015)

- **Identification in Macroeconomics**

  Stock and Watson (2012), Mertens and Ravn (2013), Gertler and Karadi (2015), Stock and Watson (2018), Miranda-Agrippino and Ricco (2021), Paul (2020), Jarociński and Karadi (2020)

→ **Identify the dollar supply shock and the dollar demand shock.**

Empirical Evidence

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- **Monthly Macro/Financial VAR (Peruvian Data)** with Lag 1 ⏩ VARlag

→ Response of SOE to Dollar Inflow/Outflow (June 2006 - Sep 2018) ⏩ VARspec

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* **Dollar Inflows & Exchange Rate**
  NDF: Net Dollar Flows into the Banking Sector
  EX : Sol per Dollar Exchange Rate
* **Banks' Liquidity Management**
  DollarLA/LL: Dollar Liquid Asset/Short-Term Liabilities
  SolLA/LL: Sol Liquid Asset/Short-Term Liabilities
  NDS/MGRR: FXI / Reserve Requirement Ratio - CB Policies
* **Macroeconomic Variables**
  IP/CPI: Industrial Production/CPI ⏩ VARPerf1 ⏩ VARPerf2

Empirical Evidence

- **Nature of Dollar Inflow/Outflow**
  - Dollar Demand Shock vs Dollar Supply Shock

→ **Proxy SVAR** (Gertler and Karadi (2015)) ⏩ ProxySVAR

Proxy SVAR (Gertler Karadi 2015)

- Structural VAR with the **structural shock of interest** ϵ^p (Dollar Demand/Dollar Supply)

$$AY_t = \sum B_i Y_{t-i} + \epsilon_t, \text{ where } \epsilon_t = (\epsilon_t^1, ..., \epsilon_t^p, ..., \epsilon_t^n)'$$

- Reduced Form VAR

$$Y_t = \sum C_i Y_{t-i} + V_t, \quad S = A^{-1}, \quad C_i = A^{-1} B_i, \quad V_t = S\epsilon_t$$
$$V_t^q = s_{q1}\epsilon_1 + ... + s_{qp}\epsilon_p + ... + s_{qn}\epsilon_n, \text{ for any } q$$

- Capture only the parts from the **structural shock of interest** ϵ^p by using Z (proxies/external instrument)

$$\hat{V}_t^{\,q} = \hat{\alpha} + \hat{\gamma} Z_t, \quad \hat{V}_t^{\,q} \sim \hat{s}_{qp}\epsilon^p$$
$$\text{where} \quad E(Z_t \epsilon^p) = \phi, \quad E(Z_t \epsilon^x) = 0, \quad x \neq p$$

Proxy SVAR (Gertler Karadi 2015)

- $\hat{V}_t^q \longrightarrow \hat{S}^p$
- $\hat{C}_i, \hat{S}^p \longrightarrow$ IRFs
- Wild Bootstrap $\longrightarrow$ C.I.

Empirical Evidence (1)

Effect of Dollar Inflow: Dollar Supply Shock

Exogeneity of Instruments

1. **World Copper Price** (P_t^{copper})
   - **22.8** percent of exports (2020)
   - Given the *EX* and i_t, i_t^*, larger dollar flows via Exports

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   - Foreign Demand on Dollar or World Dollar Shortage (Bianchi and Bigio (2022), Altavilla et al. (2021))
   - Given the EX and i_t, i_t^*, less available dollar

Proxyspec Proxygraph

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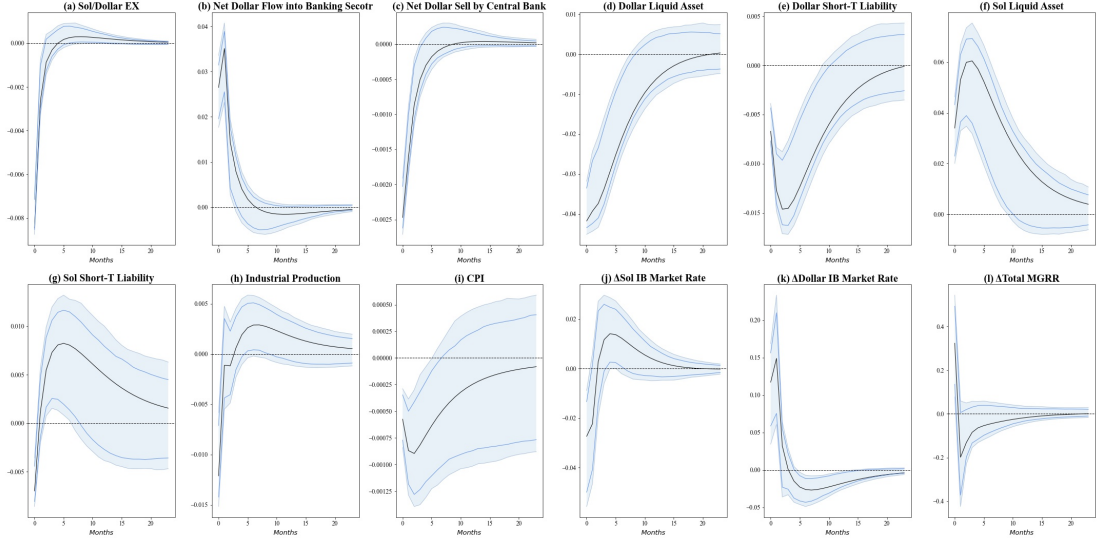
⏩ Proxyspec ⏩ Proxygraph

→ Correlations across Proxies ⏩ Proxycorr

Dollar Supply Shock: P_t^{copper} - F.stat = 10.76 (*DollarLA*)



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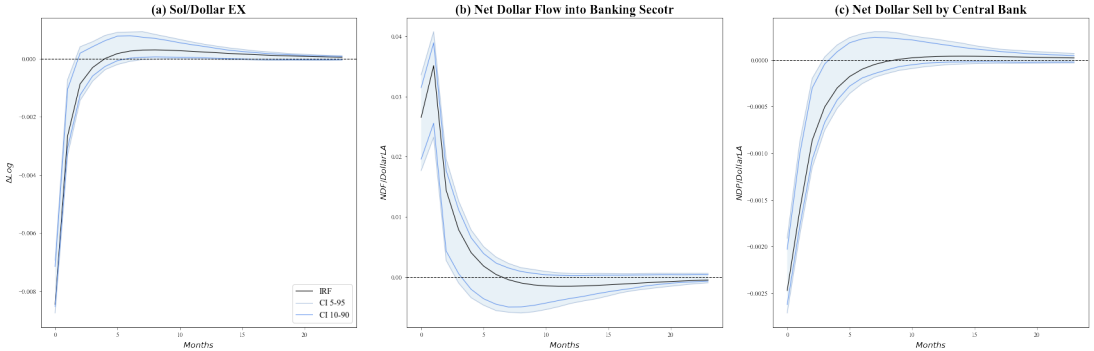

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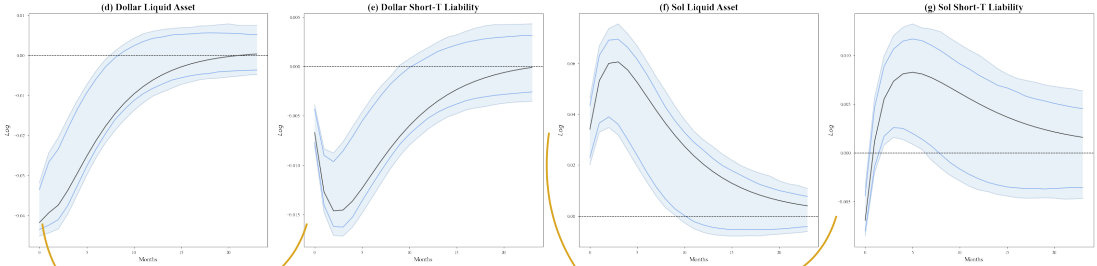

−4% *vs* −1.5% → $ LR ↓

4% *vs* −0.5% → Sol LR ↑

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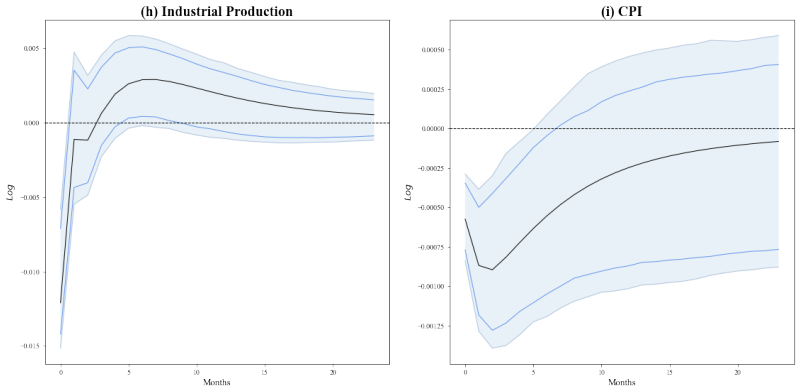

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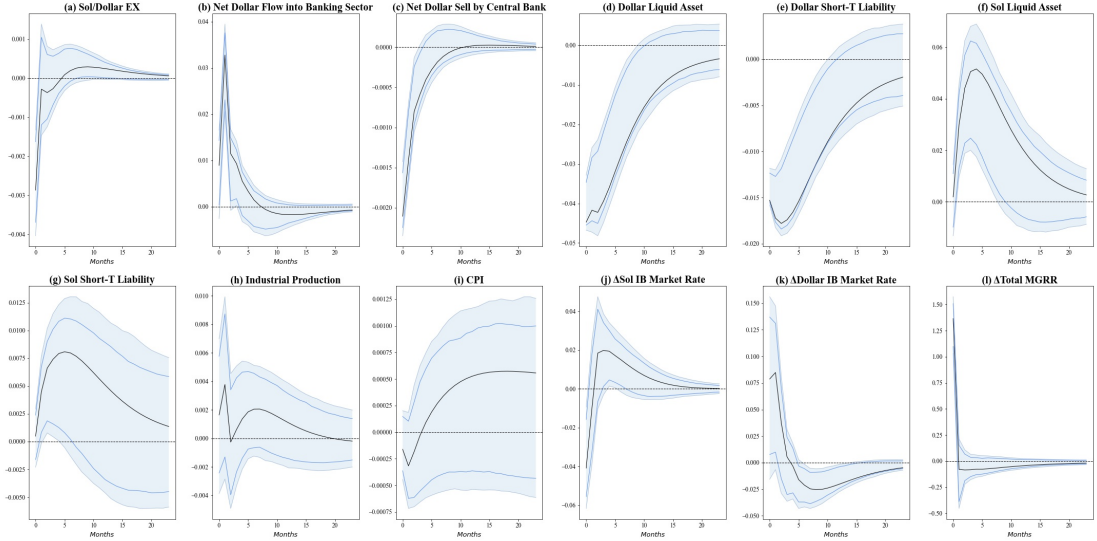

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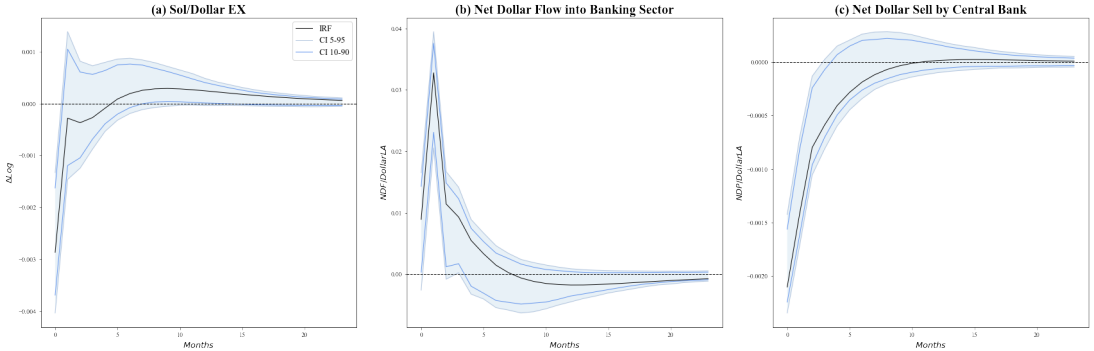

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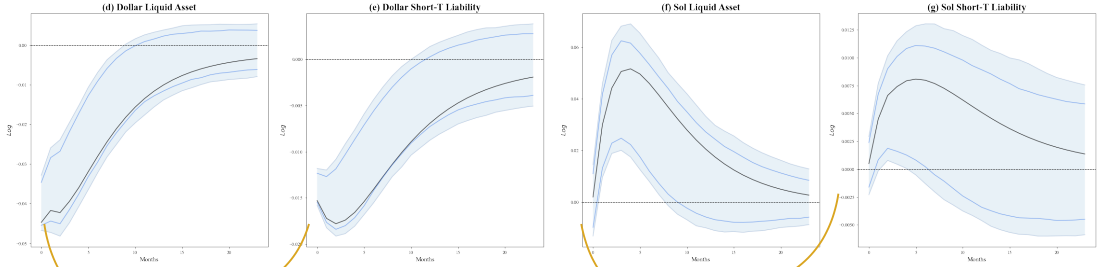

−4.3% *vs* −1.5% → $ LR ↓

2% *vs* 0.25% → Sol LR ↑

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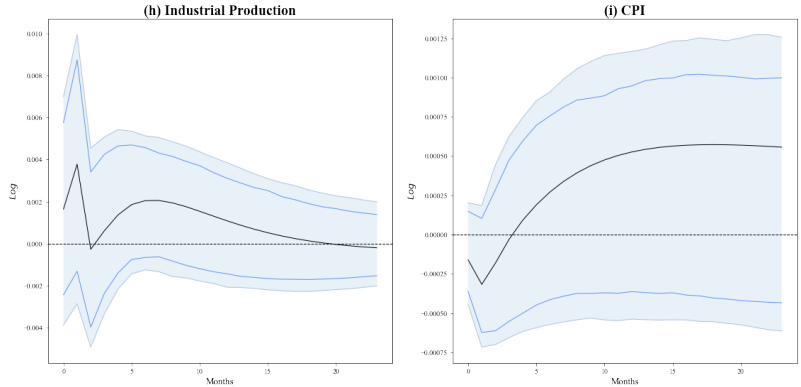


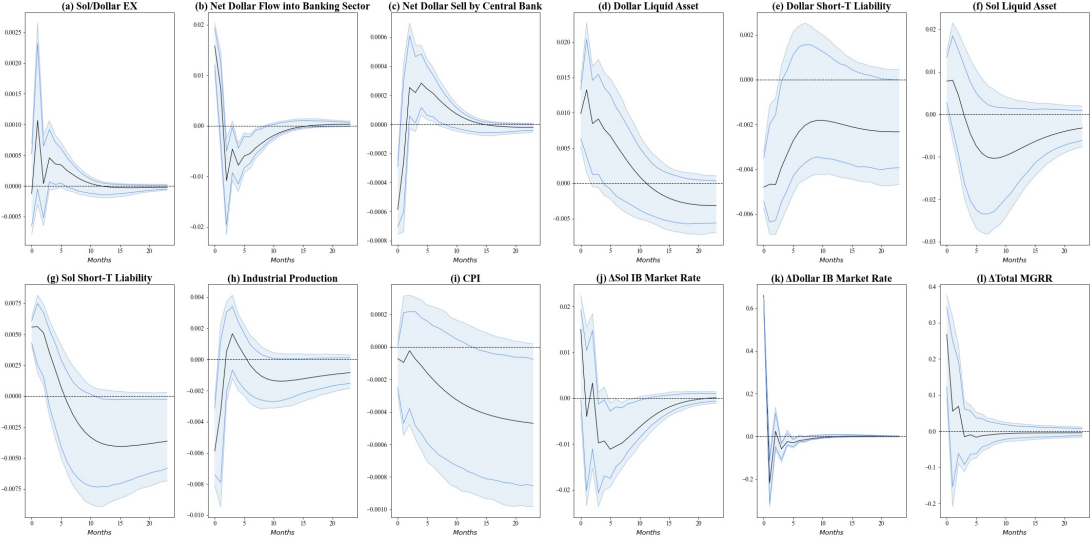
Empirical Evidence (2)

Effect of Dollar Inflow: Dollar Demand Shock

Exogeneity of Instruments

1. **Spread between FFR and PDIB** (*FFR — PDIB*)
   - Federal Fund Rate (FFR) - Peruvian Dollar Interbank Market Rate (PDIB)
   - Relatively strong domestic dollar demand decreases the spread.

Dollar Demand Shock: *FFR — PDIB* **- F.stat = 4.73** (*DollarSL*)



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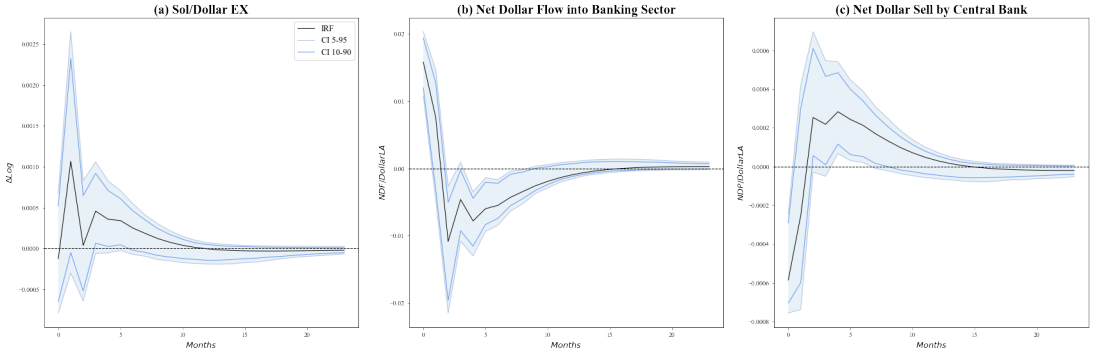

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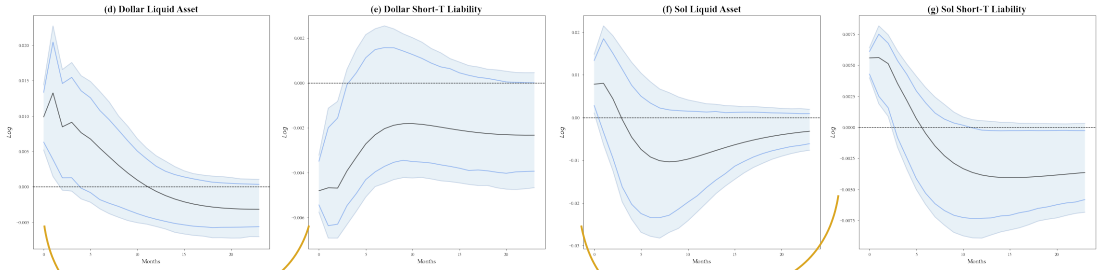

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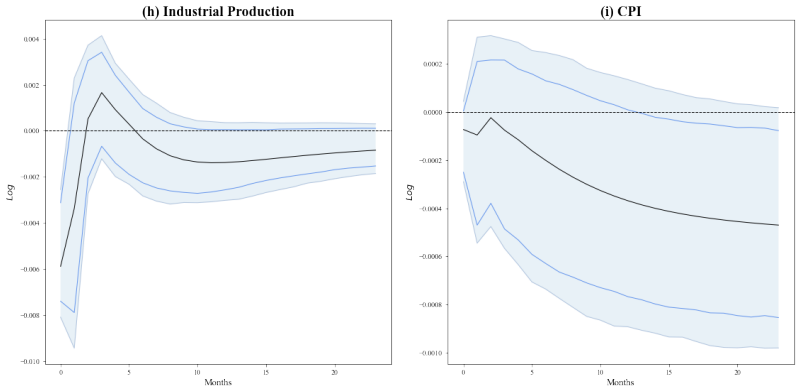

Empirical Evidence (3)

Additional Empirical Patterns

Reserve vs Bond Flows (Dollar)

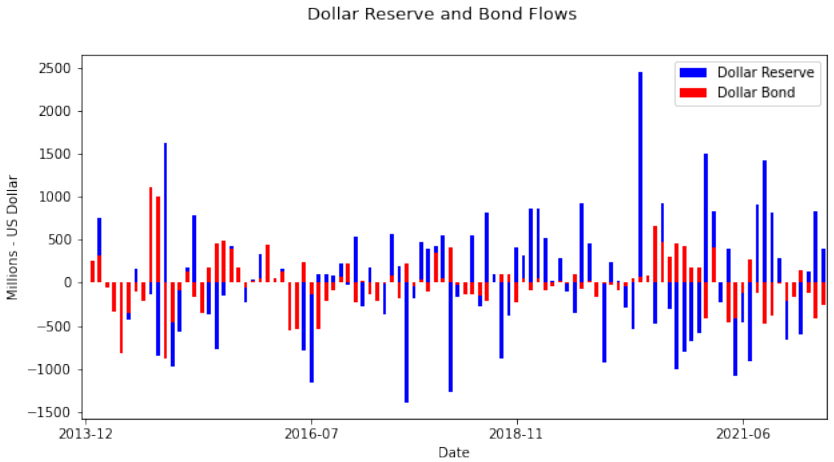

Figure Dollar Reserve vs Bond Flows

Reserve vs Bond Flows (Sol)

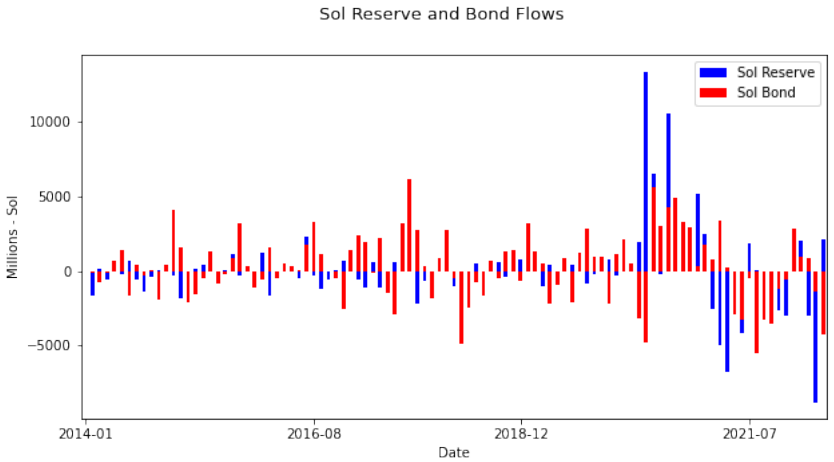

Figure Sol Reserve vs Bond Flows

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- **SOE Model with Banking Sector (Based on Bianchi, Bigio and Engel (2021))**

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→ **Idiosyncratic Domestic Deposit Withdrawal Shock**

→ **Domestic Interbank Market or Discount Window Loan**

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→ **Aggregate Dollar Deposit Supply Shock**

→ **Dollar Credit Line**

Domestic Sector

Households Problem

$$V^H = \max_{c^m, c^l, D^H, h} U^m(c^m) + U^{b,*}(c^{b,*}) + c^l - \frac{h^{1+\nu}}{1+\nu} + \beta E(V^H)$$

$$s.t. \quad Pc^l + Pc^{b,*} + P^m c^m + D^H + B^{h,*} + T = (1 + i^d_{-1}) D^H_{-1} + (1 + i^{b,*}_{-1}) B^{h,*}_{-1} + Zh + P \sum_{k}^{[m,x,b,d]} \pi^k_{-1}$$

$$U^m(c^m) = (\bar{M})^{\gamma_m} \frac{(c^m)^{1-\gamma^m}}{1-\gamma^m}$$

$$U^{b,*}(c^{b,*}) = (\bar{B^*})^{\gamma_{b,*}} \frac{(c^{b,*})^{1-\gamma^{b,*}}}{1-\gamma^{b,*}}$$

$$Pc^{b,*} \leq (1 + i^{b,*}_{-1}) B^{h,*}_{-1} e^*$$

Domestic Sector

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$$Pc^{b,*} \leq (1 + i^{b,*}_{-1}) B^{h,*}_{-1} e^* \qquad \rightarrow R^d = 1/\beta$$

Domestic Sector

Non-tradable Good Producers Problem

$$\max_{h^d, L^D} P' A^d (h^d)^{\alpha^d} - (1 + i^l) L^D \quad s.t. \quad Z h^d = L^D$$

Domestic Sector

Non-tradable Good Producers Problem

$$\max_{h^d, L^D} P' A^d (h^d)^{\alpha^d} - (1 + i^l) L^D \quad s.t. \quad Z h^d = L^D$$

$$\rightarrow \frac{L^D}{P} = \Theta^l (R^l)^{\epsilon^l}$$

Exporter/Importer

Importers

$$\max_{L^{M,*}} P^{m'} \frac{L^{M,*}}{P^{m,*}} - E[e']\{(1+i^{l,*})L^{M,*} - (1+i^{d,*})D^{M,*} + D^{M,*}\}$$

$$L^{M,*} = D^{M,*} \quad \rightarrow \frac{L^{M,*}}{P^*} = \Theta^{l,*}(R^{l,*} - R^{d,*})^{\epsilon^{l,*}}$$

Exporter/Importer

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$$L^{M,*} = D^{M,*} \quad \rightarrow \frac{L^{M,*}}{P^*} = \Theta^{l,*} (R^{l,*} - R^{d,*})^{\epsilon^{l,*}}$$

Deviation from Law of One Price $(i^{d,*} = 0)$z

$$P^m / (P^{*,m} e) = (1 + i^{l,*}_{-1})$$

Exporter/Importer

Importers

$$\max_{L^{M,*}} P^{m'} \frac{L^{M,*}}{P^{m,*}} - E[e'] \{ (1 + i^{l,*}) L^{M,*} - (1 + i^{d,*}) D^{M,*} + D^{M,*} \}$$

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$$P^m / (P^{*,m} e) = (1 + i^{l,*}_{-1})$$

Exporters

$$x \sim exp(\mu_e, \sigma_e)$$

International Investor/Central Banks

International Investors

$$M^{C,*}\frac{e}{P} = max\{\Phi^{F}(R^{d} - R^{m,*})^{\epsilon^{F}}, 0\} + C^{*}$$

International Investor/Central Banks

International Investors

$$M^{C,*}\frac{e}{P} = max\{\Phi^{F}(R^{d} - R^{m,*})^{\epsilon^{F}}, 0\} + C^{*}$$

Central Banks

$$M + T - W + F^{*}_{-1}e_{-1}(1 + i^{m,*}_{-1}) = F^{*}e + M_{-1}(1 + i^{m}_{-1}) - W_{-1}(1 + i^{w}_{-1})$$

$$F^{*} = \Phi^{F}NFA$$

Banks

1. **Portfolio Stage**
   - Make a portfolio choice l, l^*, d, b^*, m, m^* while expecting shocks in the next stage.
2. **Settlment Stage**
   - Idiosyncratic domestic deposit withdrawal shock w realizes
   - Aggregate dollar deposit supply shock x realizes
   - If there is any reserve deficit positions, banks are forced to use

1) Domestic Interbank Market or Discount Window Loan
2) Dollar Credit Line

Banks - Portfolio Stage

Banks

$$\max_{l,l^*,d,b^*,m,m^*} E[R^l l + R^m m - R^d d + R^{l,*} l^* + R^{m,*} m^* + R^{b,*} b^* - R^{d,*} d^* + \chi(m,d) + \Omega^*(m^* + b^*, d^*)]$$

$$\text{s.t.} \quad l + m^* + m + b^* = d,$$

$$l^* = d^*,$$

$\chi(m,d)$: Domestic Currency Liquidity Payoff

$\Omega^*(m^*, d^*)$: Dollar Liquidity Payoff

Banks - Settlement Stage

Assets	Liabilities	Assets	Liabilities
m	d	$m + w_j d$	$d + w_j d$
l		l	
m^*	d^*	$m^* - l^* + \psi b^* + x$	$d^* - l^* + \psi b^* + x$
b^*		b^*	
l^*		l^*	

Table Changes in Bank T-Account (Left to Right)

NOTE. w_j follows two-sided exponential distributions while x follows the two-parameter exponential distribution.

Banks - Liquidity Payoffs

1. **Domestic Currency**

   If $\tilde{s} = m + w_j d < 0 \rightarrow$ Interbank Market and Discount Window Loan.

   $\chi(m, d) = \chi^{+}\tilde{s}[\tilde{s} > 0] + \chi^{-}\tilde{s}[\tilde{s} < 0]$

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   $\chi^{+} = \Psi^{+}(\theta)(R^{f} - R^{m})$

   $\chi^{-} = \Psi^{-}(\theta)(R^{f} - R^{m}) + (1 - \Psi^{-}(\theta))(R^{w} - R^{m})$

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2. **Dollar**

   If $m^{*} + \psi b^{*} + x < l^{*} \rightarrow$ Dollar Credit Line with $r^{ps,*} > r^{ms,*}$.

Banks - Liquidity Payoffs

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   $\chi^{-} = \Psi^{-}(\theta)(R^{f} - R^{m}) + (1 - \Psi^{-}(\theta))(R^{w} - R^{m})$

2. **Dollar**

   If $m^{*} + \psi b^{*} + x < l^{*} \rightarrow$ Dollar Credit Line with $r^{ps,*} > r^{ms,*}$.

   $\tilde{m^{*}} = m^{*} - l^{*} + \psi b^{*} + x$

   $\Omega^{*}(m^{*}, d^{*}) = r^{ms,*}(\tilde{m^{*}})1[\tilde{m^{*}} > 0] + r^{ps,*}(\tilde{m^{*}})1[\tilde{m^{*}} \leq 0]$

Banks - First Order Conditions

- **Domestic Assets**

: $R^l = R^d - \bar{\chi}_d$ (Deposit Liquidity Premium)

: $R^l = R^m + \bar{\chi}_m$ (Domestic Reserve Liquidity Premium)

- **Dollar Assets**
- $R^{l,*} = R^{d,*} - \bar{\Omega}_{d^*}$ (Dollar Loan Liquidity Premium)
- $R^l = R^{m,*} + \bar{\Omega}_{m^*}$ (Dollar Reserve Liquidity Premium)
- $R^l = R^{b,*} + \psi\bar{\Omega}_{m^*}$ (Dollar Bond Liquidity Premium)

Banks - Tradeoff

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Dynamics of *NFA* and Market Clearings

- **Reserve Market Clearing**

  $(NFA + M^{C,*} - F^*)/P^* = m^* + b^{S,*}$ (Dollar Reserve)

  $M/P = m$ (Domestic Reserve)

  $P/P^* = e$ (Exchange Rate Determination)

- **Net Foreign Asset Position**

$$NFA'/p^{*\prime} = R^{b,*}(b^* + b^{h,*}) + R^{m,*}m^* + R^{m,*}f^* - R^d mc^* + r^{ms,*}(m^* - l^* + x + \psi b^*)$$
$$+ x\frac{p^*}{p^*_{-1}} - l^*\frac{p^*}{p^*_{-1}}$$

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- **Other Market Clearings**

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Exchange Rate Determination

- **UIP Deviation**
  $E[\frac{1}{(1+\pi')}((1+i^m) - \frac{e'}{e}(1+i^{m,*}))] = E[(\Omega^*)]_{m^*} - E[(\chi)]_m$.

→ If there was no role of dollar as a international transaction currency,
$E[(\Omega^*)]_{m^*} = 0$.

→ If there was no role of domestic currency,
$E[(\chi)]_m = 0$.

Data vs Model: IRFs

Shocks of Interest

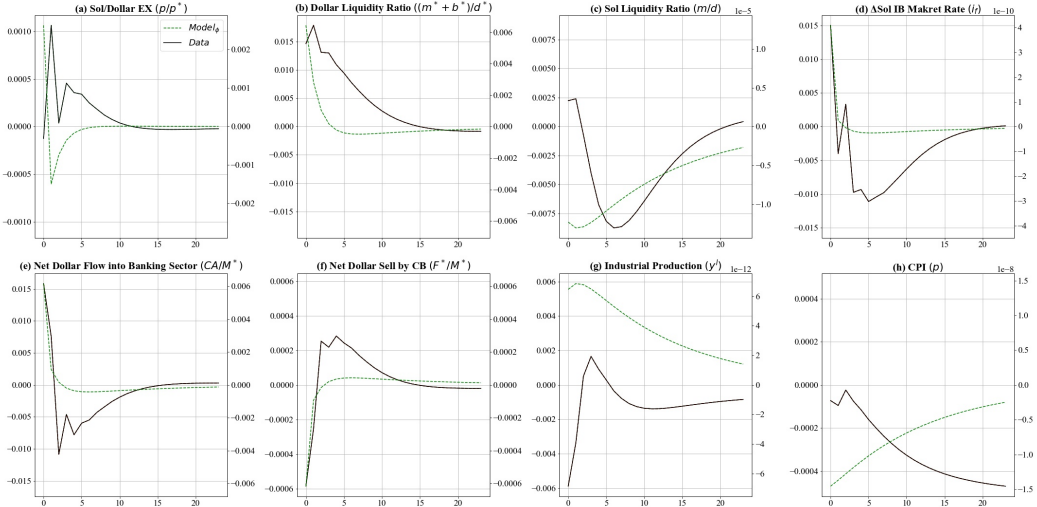
1. **Unexpected Increase in Credit Line Rate** : r^{ps}
2. **Unexpected Increase in Export Dollar Flows**: x

Calibration

Parameter	Value	Reference
$R^d = 1/\beta$	0.9637	Sol 3M Deposit Rate (w/o π)
ϕ	0.02639	Spread (US 2 Year - Peru 2 Year)
$i^{d,*}$	0.0158	Dollar 3M Deposit Yearly Rate
$i^{m,*}$	0.0292	3M LIBOR Market Rate 2000-2020
$i^{ms,*}$	0.015	-
i^w	0.043	Sol Discount Window Loan Rate 2000-2020
i^m	0.035	Sol Reserve Rate 2000-2020

Table Calibration

1. Unexpected Increase in Credit Line Rate with SVAR



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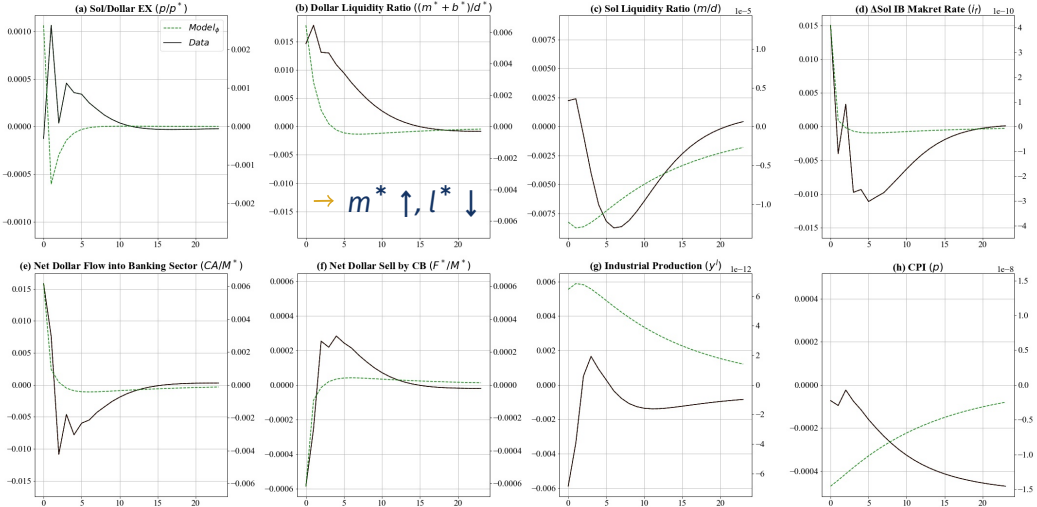

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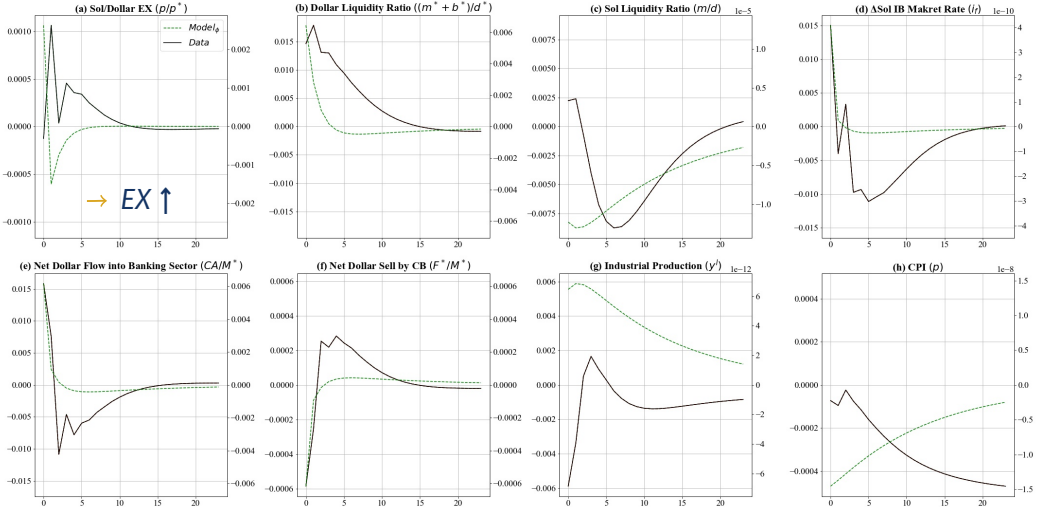

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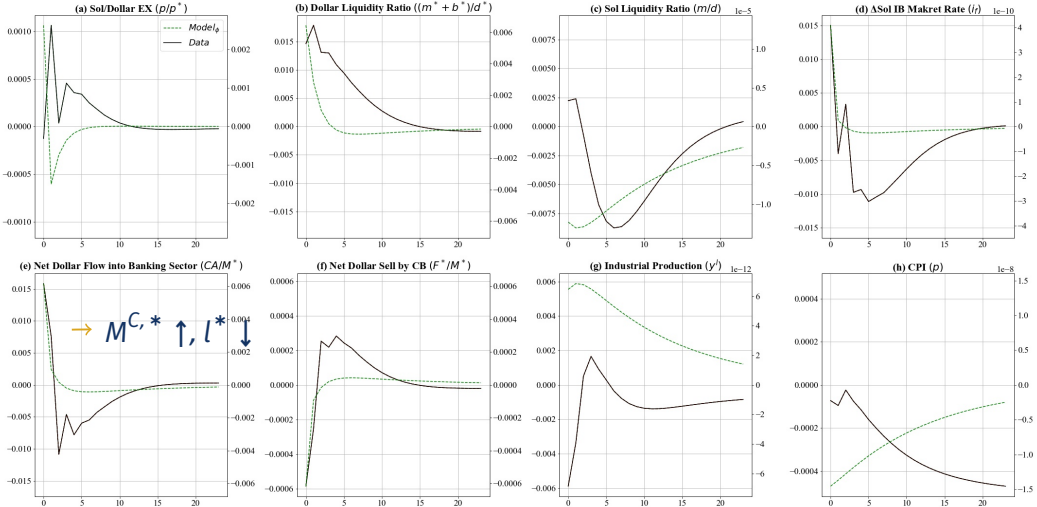

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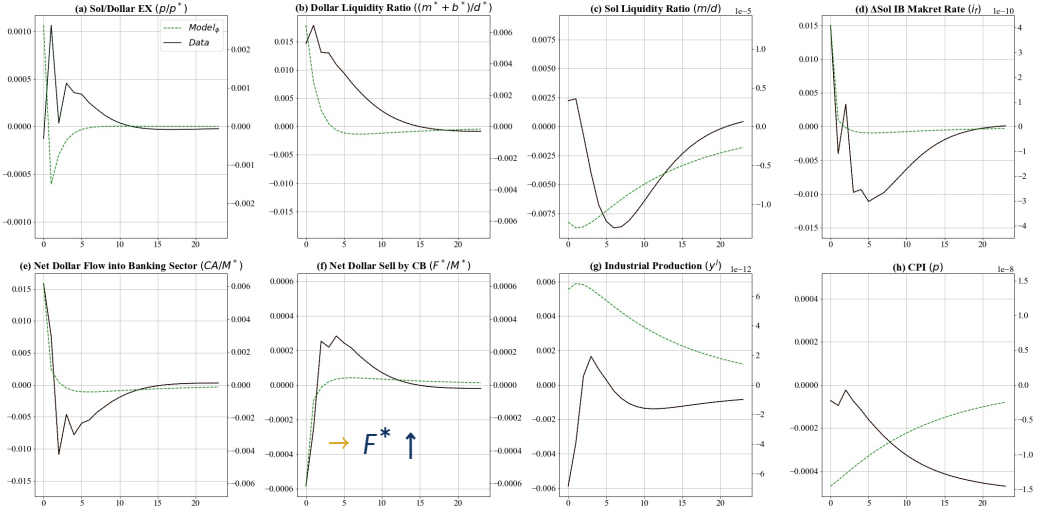

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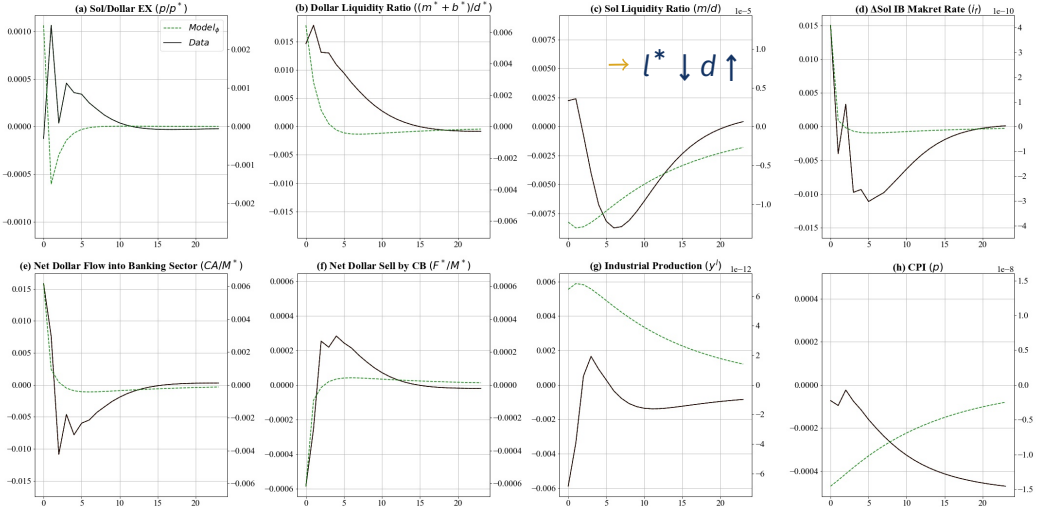

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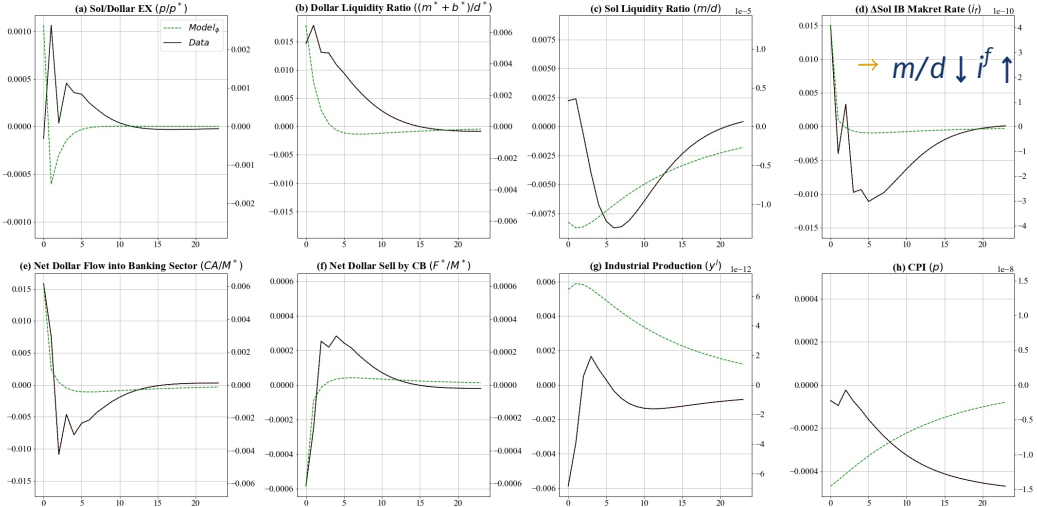

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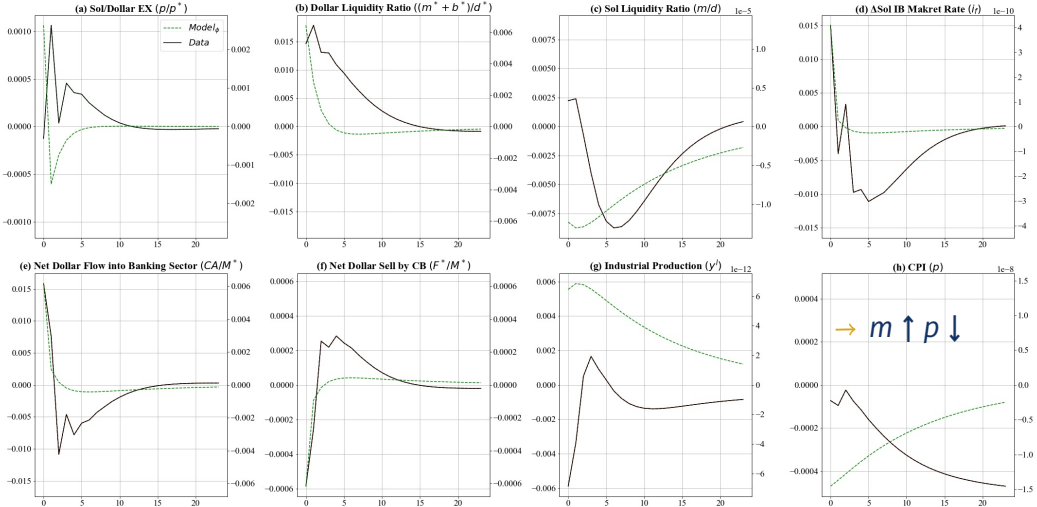

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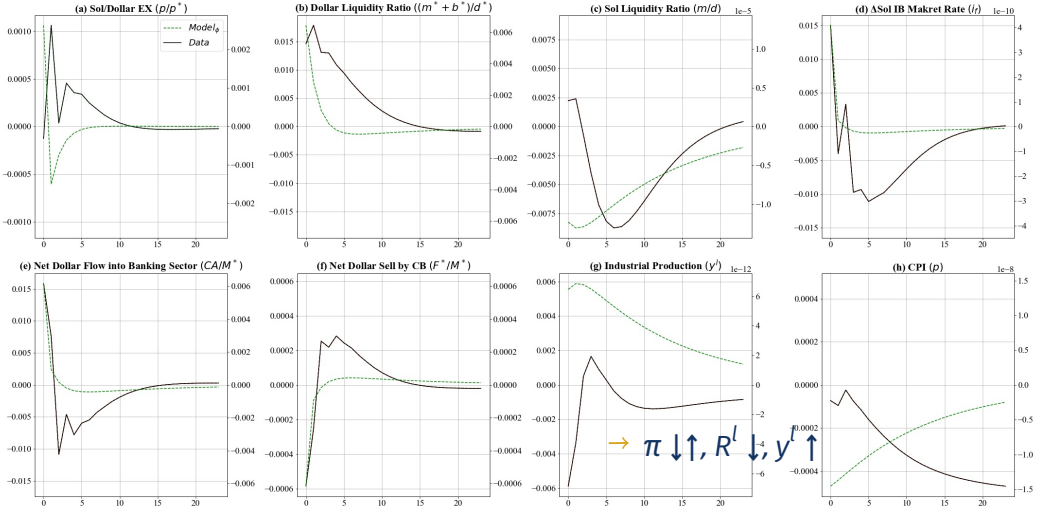

$\rightarrow \pi \downarrow\uparrow, R^l \downarrow, y^l \uparrow$

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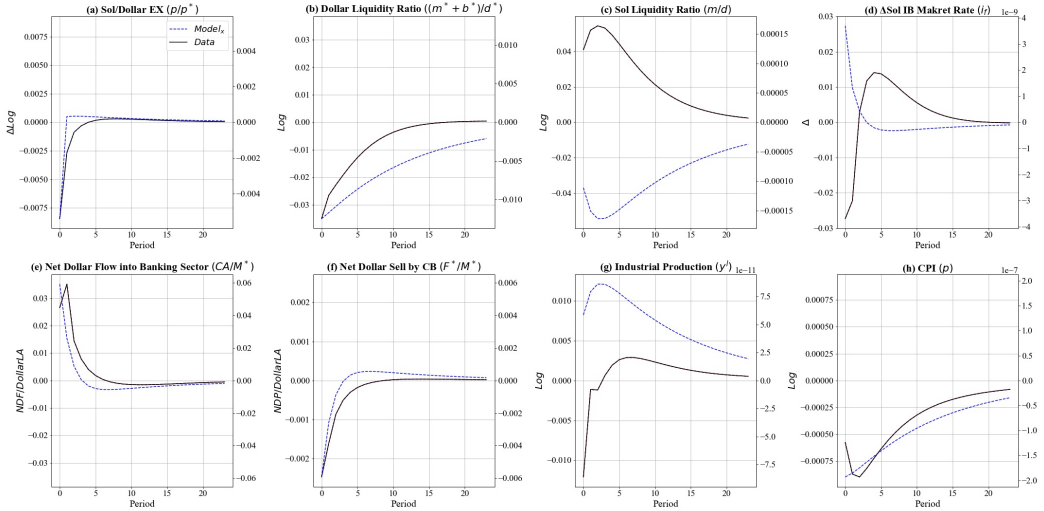

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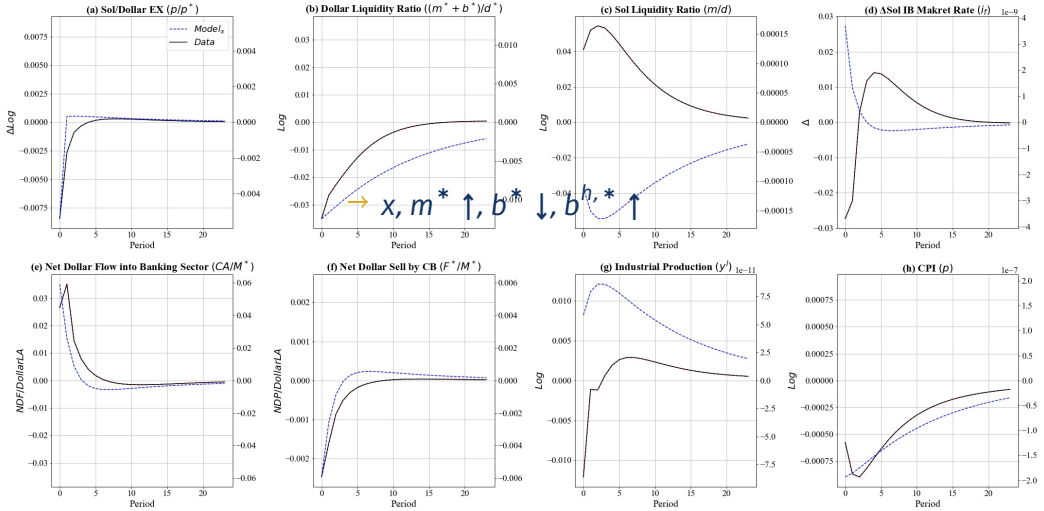

→ $x, m^* \uparrow, b^* \downarrow, b^{h,*} \uparrow$

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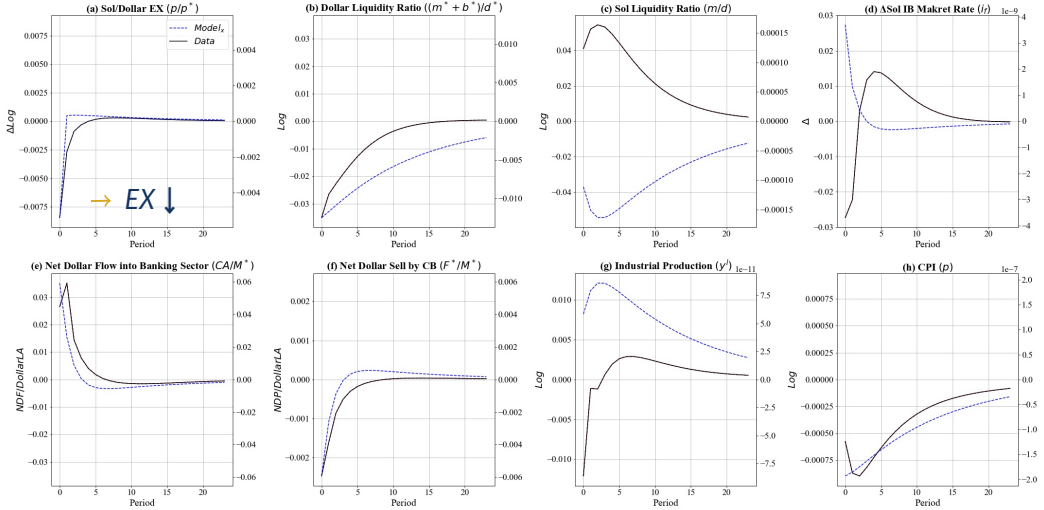

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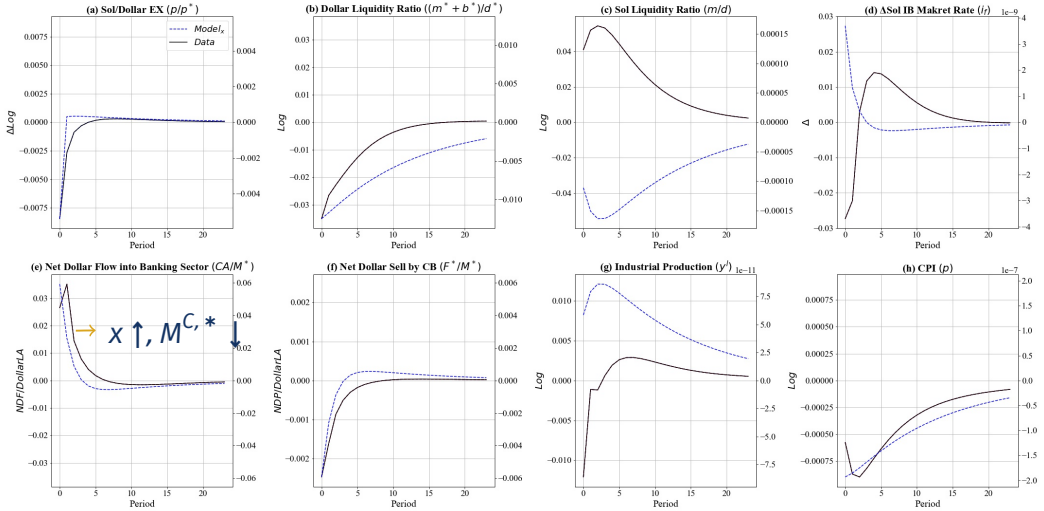

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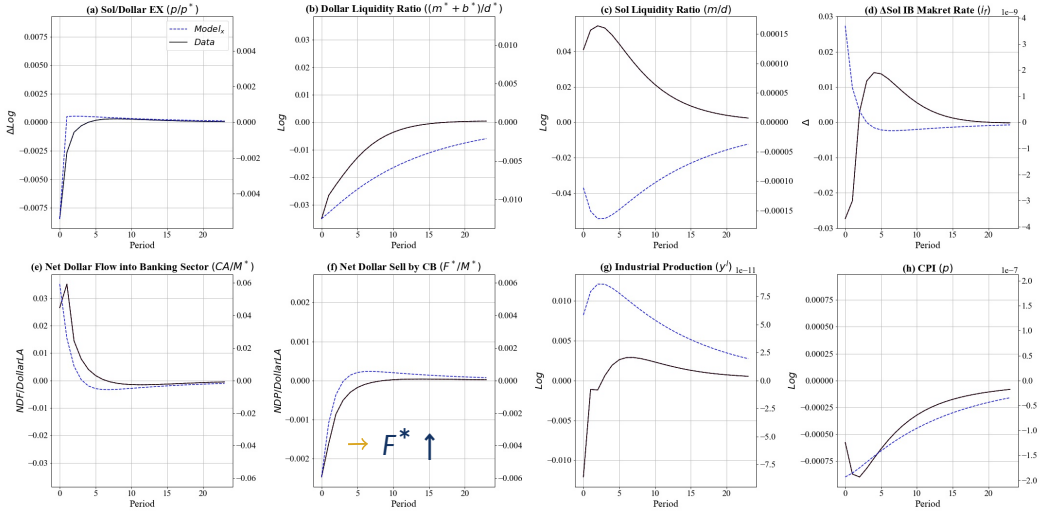

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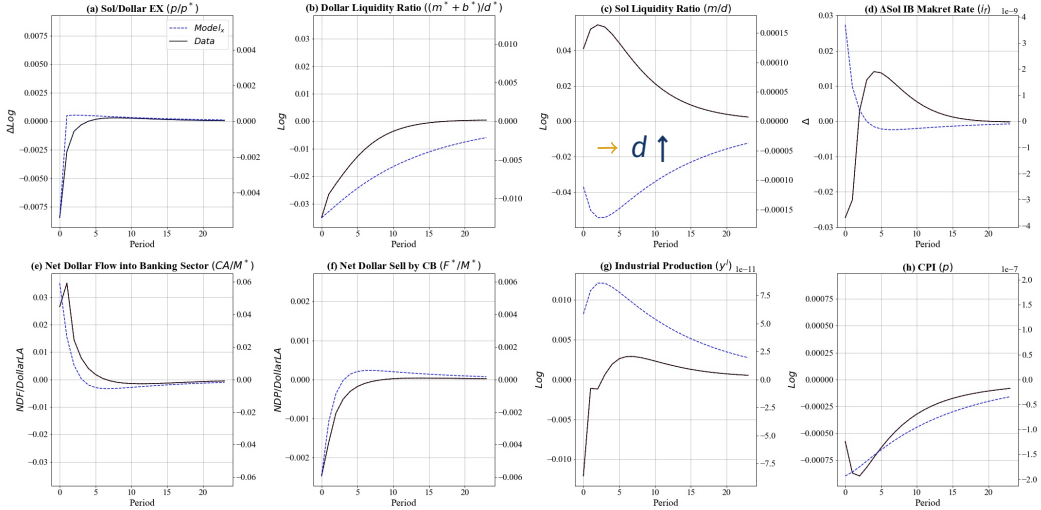

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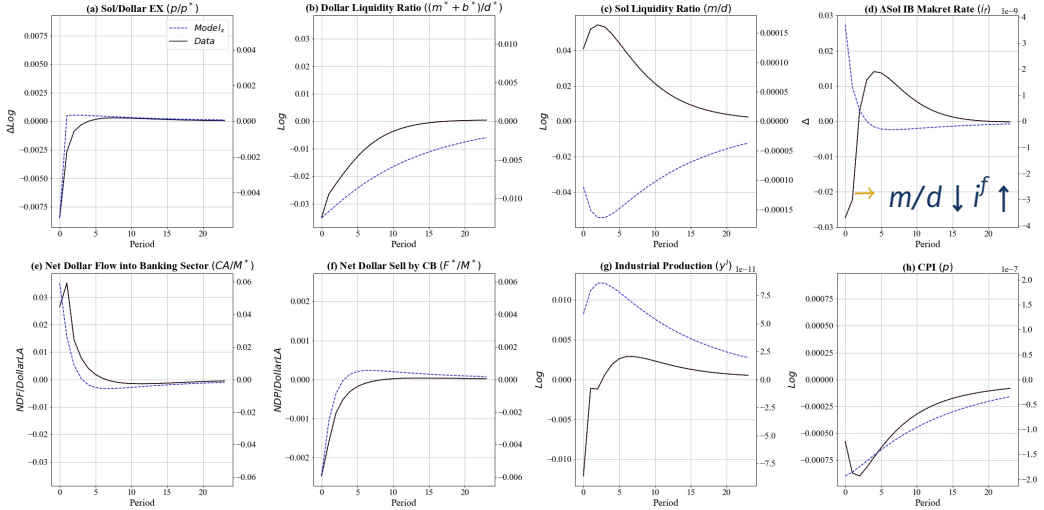

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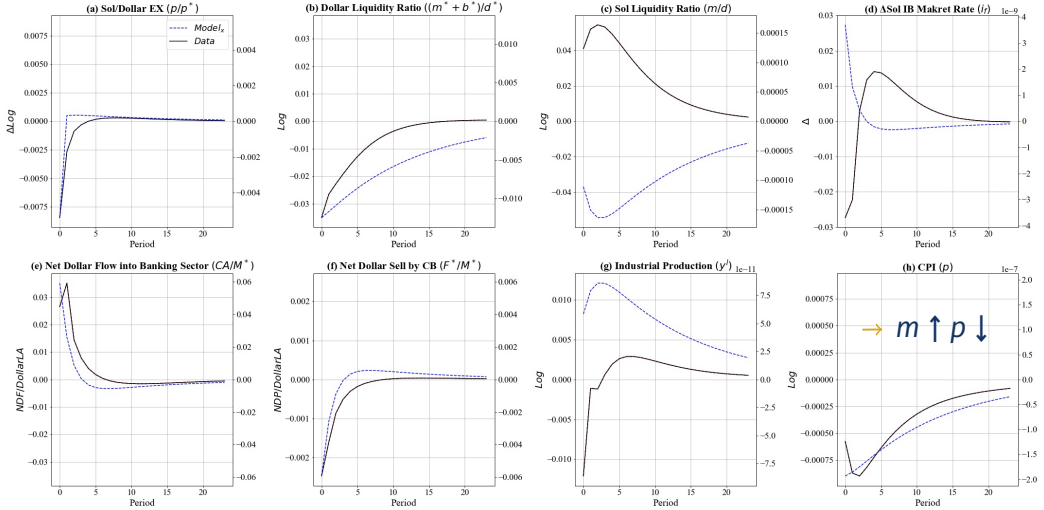

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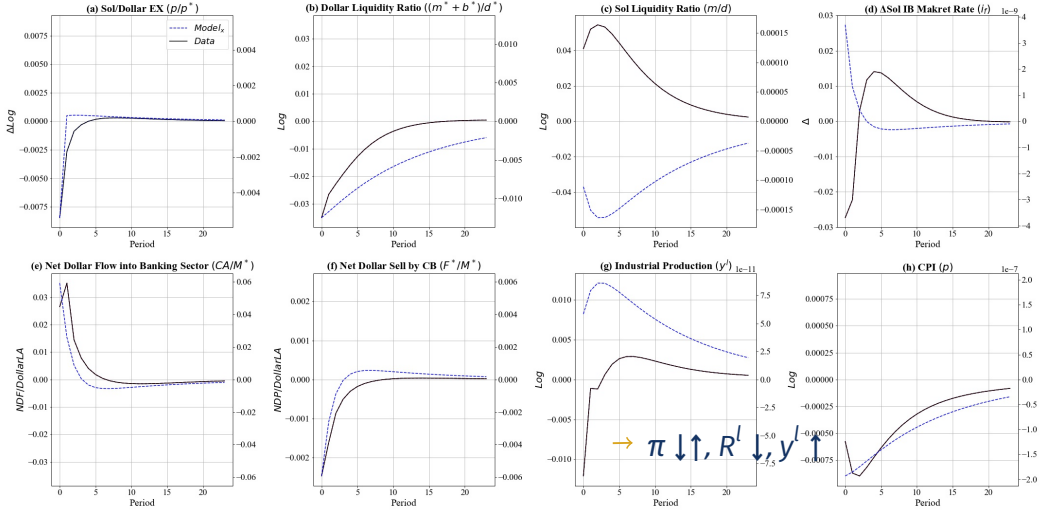

Conclusion

- **SOE Domestic Banks' Liquidity Management ∼ Exchange Rate**
- **Given the banks' liquidity needs, dollar inflows can generates either**
  - Depreciation (Supply Shocks) / Appreciation (Demand Shocks)
- **Novel domestic spillover effect of dollar inflow**
- **Future Plans**
  - Domestic Bonds → Improve the model performance
  - More on Domestic Spill-over Effects (Lending Behaviors)
  - More Empirical Works for Other Countries
  - Policy Analysis (e.g. sterilized FXI.)

Thank You

VAR Specification (Y) - 12 Variables

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** **Variable Specification**

1. IB rates/$MGRR$ in level difference
2. NDF_{dt}, NDS_{dt} are normalized by level of $DollarLA$
3. Other variables in Logs Return

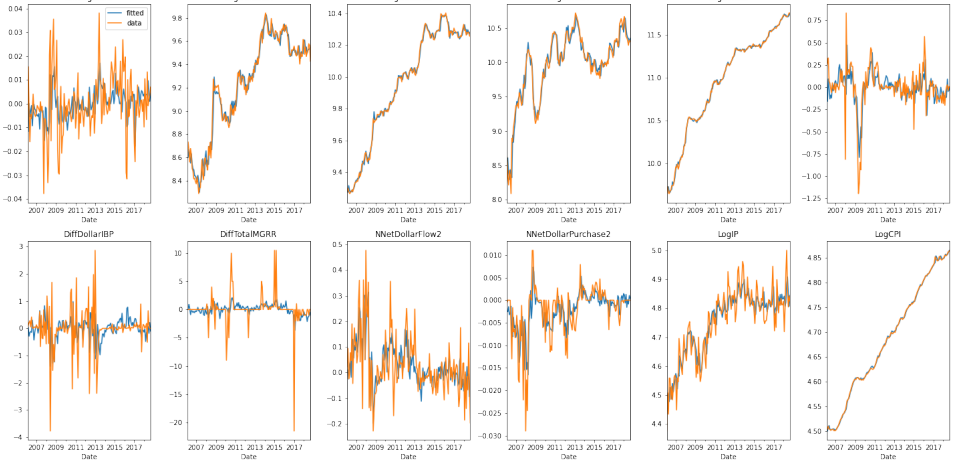
VAR Specification - Lag Selection

VAR Order Selection (* highlights the minimums)

	AIC	BIC	FPE	HQIC
0	-55.11	-54.87	1.162e-24	-55.01
1	-72.12	-68.93*	4.794e-32	-70.83*
2	-72.28*	-66.15	4.240e-32*	-69.79
3	-72.04	-62.97	5.899e-32	-68.36
4	-71.83	-59.82	8.784e-32	-66.95
5	-71.87	-56.91	1.176e-31	-65.79
6	-71.94	-54.03	1.873e-31	-64.66

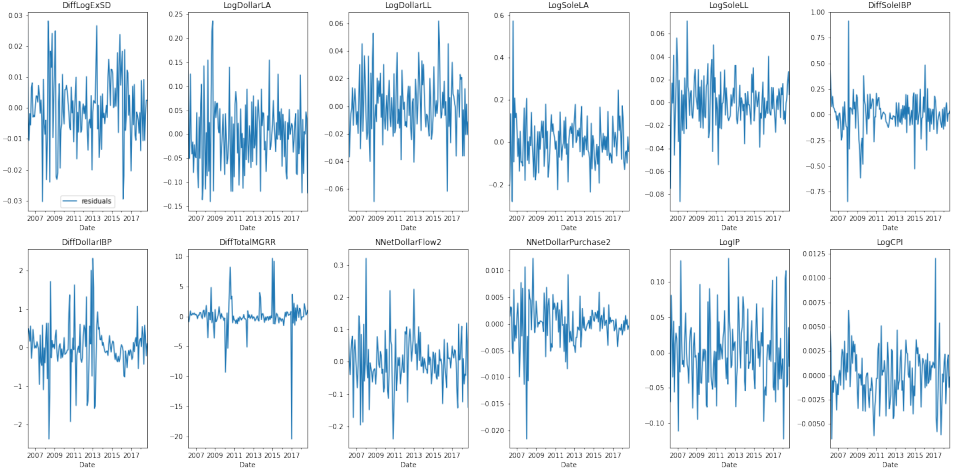
We choose lag 1 as the best case among other specifications. Return

VAR fitted values vs VAR data



Return

VAR residuals



Return

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- **US IB Spread**
- Std_a: Std of FFM (Average)
- $FF_1^{99}a$: **99q-1q of FFM (A)**
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- *COPPERP*: **Global Copper Price**

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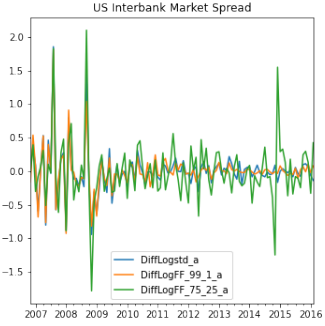
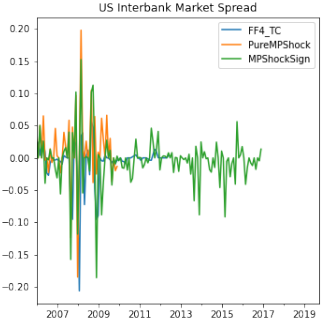
** **Variable Specification**

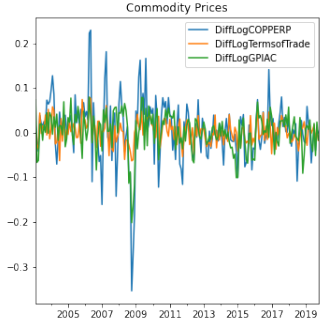
1. HFMP are in level
2. Other shocks are in Log Difference

Return

Proxy Variables Movements







Return

Proxy Variables Correlations

Return

Daily VAR Specification (Y) - 10 Variables

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- **Banking Sector Variables (Sol)**
  - *SolLALL*: Sol LA / Sol STL
  - *SolBLA*: Sol Bond-like Asset / Sol LA
  - *SolCLA*: Sol Cash-like Asset / Sol LA
  - Δ*SolIBRate*: Sol IB Market Rate
- **FX Market Variables**
  - EX_t: EX rate Sol per $
- **Policy Variables**
  - NDS_{dt}: Net Dollar Purchase

Daily VAR Specification (Y) - 10 Variables

- **Banking Sector Variables ($)**
  - *DollarLALL*: $ LA / $ STL
  - *DollarBLA*: $ Bond-like Asset / $ LA
  - *DollarCLA*: $ Cash-like Asset / $ LA
  - Δ*DollarIBRate*: $ IB Market Rate
- **Banking Sector Variables (Sol)**
  - *SolLALL*: Sol LA / Sol STL
  - *SolBLA*: Sol Bond-like Asset / Sol LA
  - *SolCLA*: Sol Cash-like Asset / Sol LA
  - Δ*SolIBRate*: Sol IB Market Rate
- **FX Market Variables**
  - EX_t: EX rate Sol per $
- **Policy Variables**
  - NDS_{dt}: Net Dollar Purchase

** **Variable Specification**

1. IB rates are in level difference
2. NDS_{dt} is normalized by level of *DollarLA*
3. Other variables in Logs

Return

Proxy SVAR (Gertler Karadi 2015)

1. Structural VAR with the **shock of interest** ϵ^p

$$
\begin{aligned}
AY_t &= \sum B_i Y_{t-i} + \epsilon_t, \\
Y_t &= \sum C_i Y_{t-i} + \nu_t, \ \ \nu_t = S\epsilon_t, \ S = A^{-1}, \ C_i = A^{-1}B_i \\
Y_t &= \sum C_i Y_{t-i} + s\epsilon_t^p
\end{aligned}
$$

2. Estimate $(\frac{s^q}{s^p})$ by using Z **(proxies)** on v^p from Y^p

$$
\begin{aligned}
\text{First Stage:} \quad & v_t^p = \alpha + \gamma Z_t + \psi_t \quad \text{where} \quad E[Z_t \epsilon_t^p] = \phi, \ E[Z_t \epsilon_t^{q\prime}] = 0. \\
\text{Second Stage:} \quad & v_t^q = \frac{s^q}{s^p} \hat{v_t}^p + \zeta_t \quad \rightarrow \quad (\frac{\hat{s^q}}{s^p}) \text{ for all } q
\end{aligned}
$$

Proxy SVAR (Gertler Karadi 2015)

3. Estimate s^p from covariance matrix up to sign convention

$$E[\nu_t \nu_t'] = E[(S\epsilon)(S\epsilon)'] = \Sigma$$
$$\hat{s^p}\hat{s^p} = \hat{\Sigma}[p, p]$$

4. With estimated $\hat{s^p}$ and $\frac{\hat{s^q}}{\hat{s^p}}$ for all q, and $\hat{C}_i$ from the reduced form VAR, calculate the impulse response functions

5. Use the Wild bootstrap with 1,000 simulations ⏩ Bootstrap

⏩ ProxySVARShort

Bootstrapping Procedure - Wild Bootstrapping

1. **Generate the hypothetical time series of VAR variables**
   - Calculate the reduced-form residuals from the reduced-form VAR
   - Multiply the randomly generated (1,-1) to those residuals
   - Come up with a new hypothetical time series of VAR variables with point estimates and new residuals
2. **Generate the hypothetical time series of** Z
   - Multiply the Z with the randomly generated (1,-1)
   - Come up with a hypothetical Z series
3. **Execute Proxy VAR with the generated time series**

→ Repeat ($1 \sim 3$) for 1,000 times Return

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