Foreign Exchange Intervention with UIP and CIP Deviations: The Case of Small Safe Haven Economies

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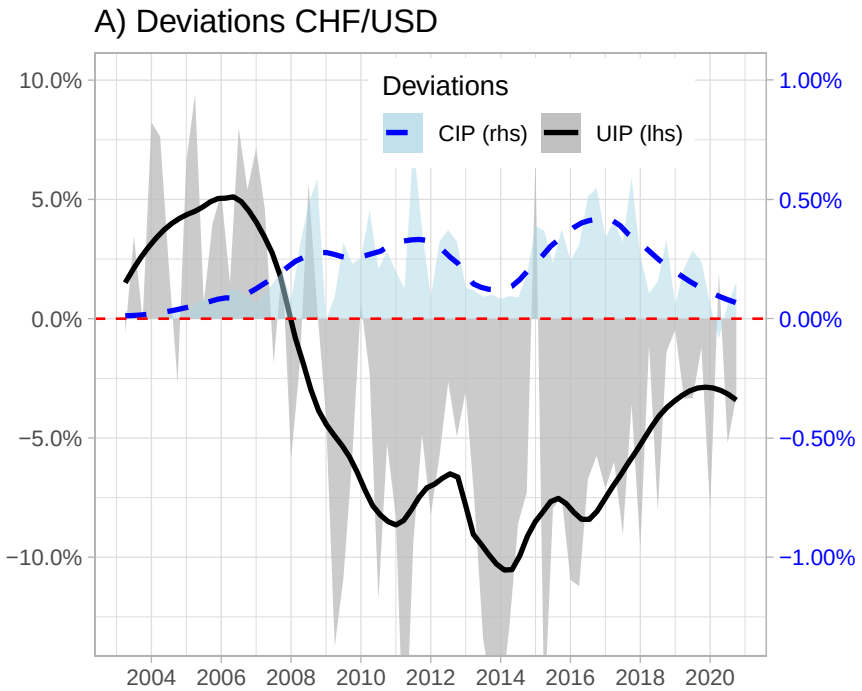
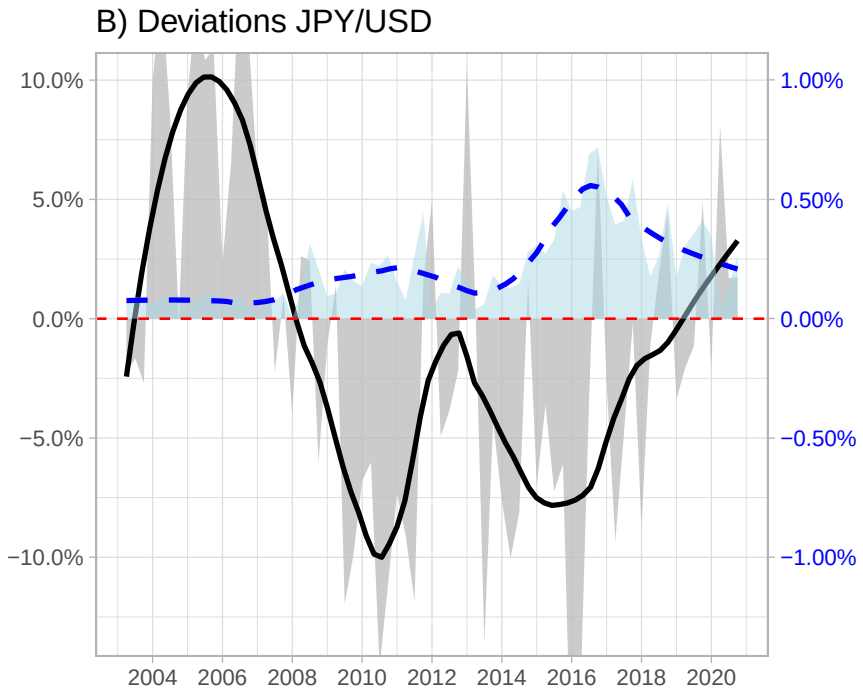
UIP and CIP Deviations





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- Deviation from Covered Interest rate Parity (CIP)?
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- Or deviations from Uncovered Interest Parity (UIP)?

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- Analyze the optimal behavior of the central bank, modeling it as a constrained planner
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- Focus on the **opportunity cost of reserves**.
  - Potential benefits of FX intervention (e.g. stabilizing the real exchange rate or avoiding sudden stops) are **not modeled**

Related Literature

- Systematic deviations from CIP since the Global Financial Crisis
  - e.g., Du and Schreger (2022)

- Large literature on convenience yields in the US
  - Valchev (2020), Kekre and Lenel (2021), Jiang, Krishnamurthy, and Lustig (2021), Bianchi, Bigio, and Engel (2022), Devereux, Engel, and Wu (2022)

- Limited arbitrage by international financial intermediaries
  - Gabaix and Maggiori (2015), Itskhoki and Muhkin (2021)

- Large literature on FX intervention. Different benefits from intervention, but always an opportunity cost of holding reserves
  - Jeanne and Rancière (2011), Bianchi and Lorenzoni (2022)

The Model

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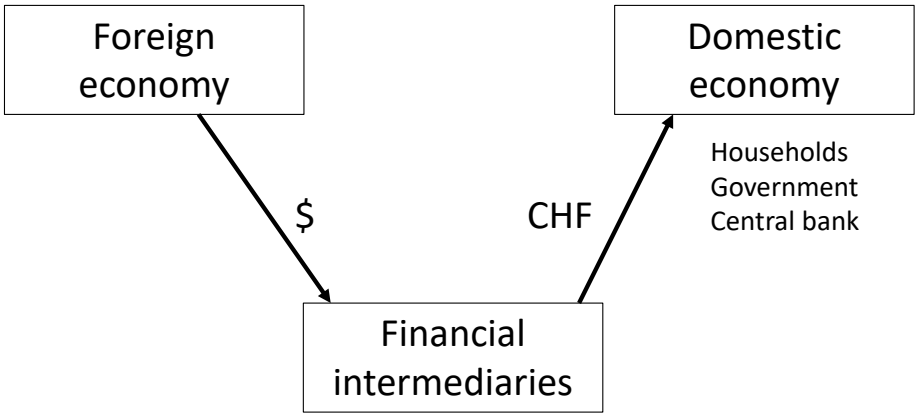
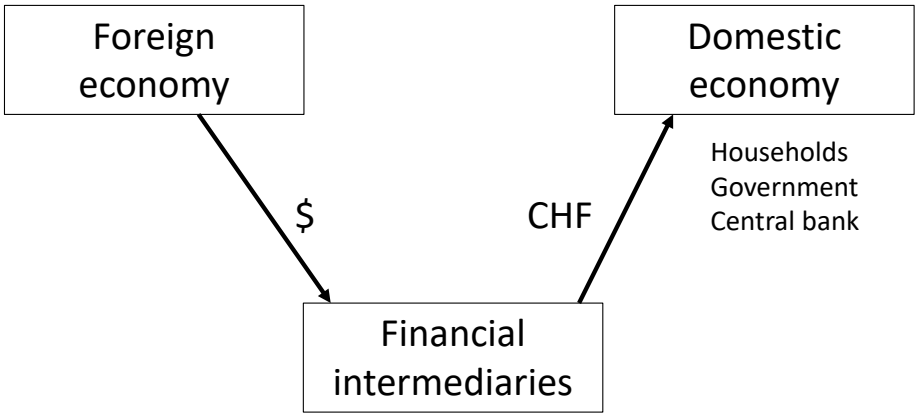
- Home country is a **safe haven**

The Model


Foreign economy
Domestic economy
Households
Government
Central bank
$
CHF
Financial intermediaries

The Model



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$$\underbrace{a_t^{H*}}_{\text{Foreign demand}} = \underbrace{b_t^G - b_t^H - b_t^{CB}}_{\text{Domestic supply}}$$

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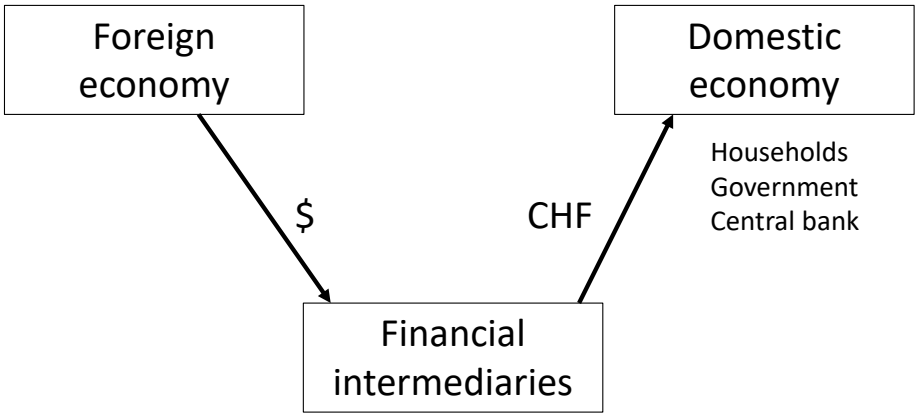

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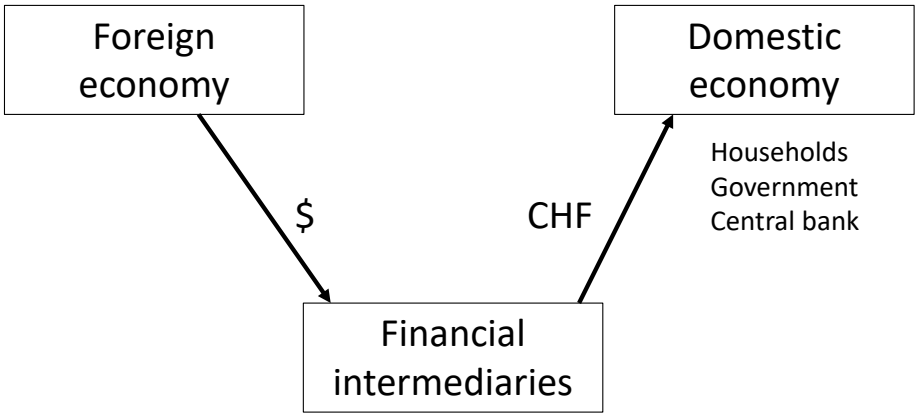

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- b_t^G: government debt
- b_t^H: households' holdings
- b_t^{CB}: central bank holdings, through foreign exchange interventions (FXI):

$$\underbrace{b_t^{CBF}}_{\$} = \underbrace{H_t - b_t^{CB}}_{CHF}$$

Interest Rate Arbitrage

- UIP deviation: excess return in domestic currency, expressed in foreign currency X^*_{t+1}

$$X^*_{t+1} \equiv (1 + i_t)\frac{S_t}{S_{t+1}} - (1 + i^*_t)$$

- CIP deviation: excess return hedged by forward rate Z^*_{t+1}

$$Z^*_{t+1} \equiv (1 + i_t)\frac{S_t}{F_t} - (1 + i^*_t)$$

- For Switzerland and Japan we have $Z^*_{t+1} > 0$ and $E_t X^*_{t+1} < 0$

UIP deviation: a free lunch?

- FXI affect the gross foreign position gfl_t, not the net foreign position $nfl_t = \underbrace{b_t^G - b_t^H - b_t^{CB}}_{gfl_t} - (b_t^{CBF} + b_t^F)$.

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- Intertemporal resource constraint:

$$(1 + r_t) C_t + C_{t+1} = (1 + r_t) Y_t + Y_{t+1} - X_{t+1}^* (\underbrace{b_t^G - b_t^H - b_t^{CB}}_{gfl_t})$$

- If $X_{t+1}^* < 0$, central bank reserve interventions (b_t^{CB}) can increase resources.

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- If $X^*_{t+1} < 0$, central bank reserve interventions (b_t^{CB}) can increase resources.
- Is it optimal?

Model details

International Financial Intermediaries

- Objective function is (in dollars):

$$V_t^* = E_t \left\{ m_{t+1}^* \left[a_t^{H*} \left((1+i_t) \frac{S_t}{S_{t+1}} - (1+i_t^*) \right) - f_t^* \left(\frac{1}{S_{t+1}} - \frac{1}{F_t} \right) \right] \right\} - \chi a_t^{H*}$$

- They can divert a fraction Γa_t^{H*} of the invested funds
  - As in Gabaix and Maggiori
  - After investment decisions are taken, but before shocks are realized

- Participation constraint:

$$E_t \left\{ m_{t+1}^* a_t^{H*} X_{t+1}^* \right\} - \chi a_t^{H*} \geq \Gamma (a_t^{H*})^2 \tag{1}$$

International Financial Intermediaries

- CIP deviation:

  If (1) is binding and take FOC w/ f_t^*, we find

$$Z_{t+1}^* = \frac{\overbrace{\Gamma a_t^{H*}}^{\text{Limited arbitrage}} + \overbrace{\chi}^{\text{Convenience yield}}}{E_t m_{t+1}^*}$$

- UIP deviation:

$$E_t X_{t+1}^* = Z_{t+1}^* - \frac{\overbrace{cov\left(m_t^*, X_{t+1}^*\right)}^{-\text{Risk premium}}}{E_t m_{t+1}^*} \tag{2}$$

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- Safe haven: $cov(m_t^*, X_{t+1}^*) > 0$

Optimal FX Intervention

- Central bank as a constrained planner Constrained planner
- For sterilized intervention (or unsterilized at the ZLB), we find:

$$-E_t X^*_{t+1} - \frac{cov_t(m_{t+1}, X^*_{t+1})}{E_t m_{t+1}} + \frac{\alpha_0}{\eta_t E_t m_{t+1}} \Gamma = 0$$

- m_{t+1} is the sdf of households
- Marginal benefit of buying FX reserves:
  1. Excess return on foreign bonds
  2. Minus the risk premium associated with foreign bonds
  3. Market power of the central bank (influencing i_t and hence $E(X^*_{t+1})$) / Dynamic terms-of-trade externality Bond market equilibrium

Is it CIP or UIP?

- Substitute $E_t X^*_{t+1}$, from arbitrage equation:

$$\underbrace{\overbrace{-\frac{\Gamma a_t^{H*} + \chi}{E_t m^*_{t+1}}}^{-devCIP} + \frac{cov_t(m^*_{t+1}, X^*_{t+1})}{E_t m^*_{t+1}}}_{-devUIP} - \frac{cov_t(m_{t+1}, X^*_{t+1})}{E_t m_{t+1}} + \frac{\alpha_0}{\eta_t E_t m_{t+1}}\Gamma = 0$$

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- If $\frac{cov_t(m^*_{t+1}, X^*_{t+1})}{E_t m^*_{t+1}} = \frac{cov_t(m_{t+1}, X^*_{t+1})}{E_t m^{CB}_{t+1}}$, then CIP matters

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- If $cov_t(m_{t+1}, X^*_{t+1}) = 0$, then UIP matters
- If CIP matters, there is a cost for the central bank. If it is UIP, there may be a gain.

Proposition

Is it CIP or UIP?

$$\overbrace{-\frac{\Gamma a_t^{H*} + \chi}{E_t m_{t+1}^*}}^{-devCIP} + \overbrace{\frac{cov_t(m_{t+1}^*, X_{t+1}^*)}{E_t m_{t+1}^*} - \frac{cov_t(m_{t+1}, X_{t+1}^*)}{E_t m_{t+1}}}^{\Delta Cov} + \frac{\alpha_0}{\eta_t E_t m_{t+1}} \Gamma = 0$$

- Depends on ΔCov
- If $\Delta Cov > 0$, international intermediaries value more the safe haven properties than domestic households

A Quadratic-Linear Version of a Safe Haven Economy

- Assume the SDF of international financial intermediaries is proportional to a global variable Y_t^*. Assume log utility
- Y_{t+1}^* is log-normal with $log(Y_{t+1}^*) \sim N(\sigma_y^2/2, \sigma_y^2)$
- The SDF of domestic households is proportional to domestic output Y_t and

$$\log(Y_{t+1}) = \alpha \log(Y_{t+1}^*)$$

$\Rightarrow$ $0 < \alpha < 1$: low exposure to global risk

- With the appropriate assumptions on money supply in $t+1$, we can assume

$$S_{t+1} = He^{\rho \log(Y_{t+1}^*)}$$

$\Rightarrow$ $\rho > 0$: currency appreciates when global variable is low

A Quadratic-Linear Version of a Safe Haven Economy

- If σ_y and ρ large and α small (safe haven):
  - ΔCov is be positive
  - FXI are optimal

$$\widehat{b}_t^{CBF} = \frac{\rho\sigma_y^2[1-\alpha b_t^G]-\chi}{2\Gamma+\rho(\alpha+\rho)\sigma_y^2} - (b_t^G - 1)$$

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- Domestic households less exposed to global risk $\Rightarrow$ optimal to go short on domestic bonds and long on foreign bonds

Social and private optimum

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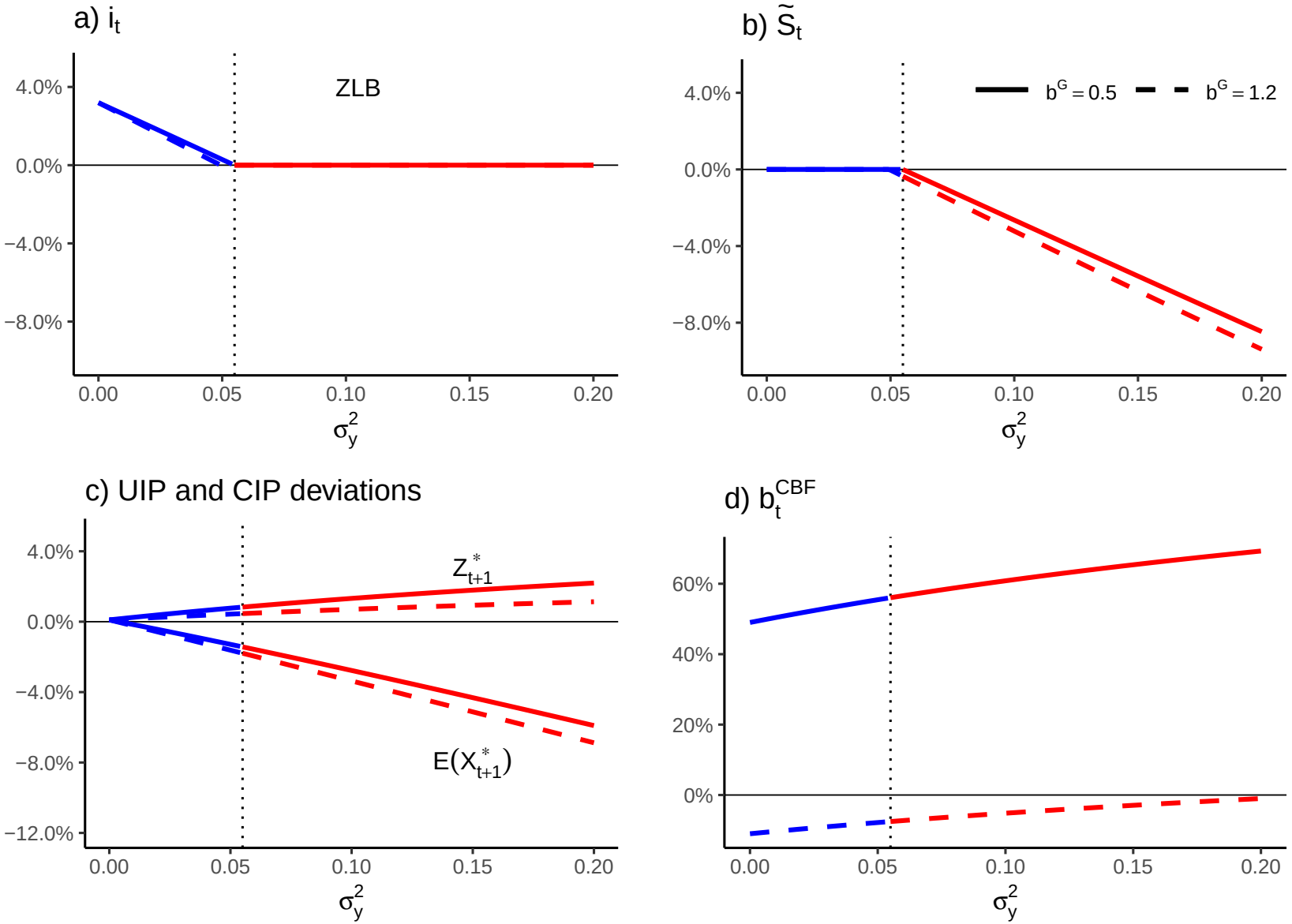
Social and private optimum

- The supply of public debt matters

Numerical Illustration: Impact of σ_y^2



Estimating Covariances

- Compute covariances between x^*_{t+1} (X^*_{t+1} in logs) at 3 months and m^*_{t+1} or m_{t+1}, quarterly data for 1999-2021, CHF and JPY vs USD

- Assume:

$$m^*_{t+1} = \beta \left(\frac{NW^*_{t+1}}{NW^*_t} \right)^{-\gamma}$$

  - NW^*_t: net worth of financial intermediaries (recent literature on intermediary asset pricing), measured as equity capital ratios of US financial intermediaries (He, Kelly, and Manela 2017, Adrian, Etula, and Muir 2014)

- For the SDF of Swiss and Japanese households, use real total consumption

- $\beta = 0.99$, $\gamma = 5$

Estimating Covariances

Table: $Cov(x^*_{t+1}, m^*_{t+1})$ and $Cov(x^*_{t+1}, m_{t+1})$ in %

	$\beta\left(\frac{NW_{t+1}}{NW_t}\right)^{-\gamma}$		$\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}$
	NW^{HKM}_{t+1}	NW^{AEM}_{t+1}	
CHF			
1999-2021	-1.83	3.84	-0.01
2010-2021	1.59	0.88	-0.03
JPY			
1999-2021	18.08	1.91	0.15
2010-2021	4.71	1.76	0.20

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- Japan and CH: $\Delta Cov > 0$
- CH: $cov_t(m_{t+1}, X^*_{t+1})$ close to zero $\Rightarrow$ Only UIP matters!

$\Rightarrow$ Benefit of holding reserves Risk

Conclusion

- We provide a simple framework where UIP and CIP deviations can be of different signs for a safe haven economy
- We examine the opportunity cost of FX reserves in this context
- UIP should matter if domestic households give less value to the safe haven than international investors
- For Switzerland, the SNB has an opportunity gain of holding reserves
- For Japan, not optimal given high public debt

Domestic Households

- Hold money, H_t^H, domestic bonds B_t^H (both expressed in domestic currency), and foreign bonds b_t^F (expressed in foreign currency)

- Their utility function is:

$$U(C_t) + \beta E_t U(C_{t+1})$$

- Budget constraints:

$$C_t = Y_t - \frac{H_t^H}{P_t} - \frac{B_t^H}{P_t} - \frac{S_t b_t^F}{P_t} + \frac{T_t}{P_t}$$

$$C_{t+1} = Y_{t+1} + \frac{H_t^H - H_{t+1}^H}{P_{t+1}} + (1 + i_t)\frac{B_t^H}{P_{t+1}} + (1 + i_t^*)\frac{S_{t+1} b_t^F}{P_{t+1}} + \frac{T_{t+1}}{P_{t+1}}$$

- Short-selling constraints: $b_t^H \geq 0,\ b_t^F \geq 0$
- Cash-in-advance constraints: $h_t^H \geq Y_t,\ h_{t+1}^H \geq Y_{t+1}$

Back

The Central Bank

- In t, issues money H_t, buys domestic and foreign bonds B_t^{CB} and b_t^{CBF}

$$S_t b_t^{CBF} + B_t^{CB} = H_t$$

- Two ways to change b_t^{CBF}:
  1. Sterilized intervention, changing B_t^{CB}
  2. Unsterilized intervention, changing total money supply H_t
- No transfers! (no "fiscal" intervention)

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- In $t+1$, issues new money $H_{t+1} - H_t$ and distributes its profits Π_{t+1}^{CB} to the government

$$\Pi_{t+1}^{CB} = (1 + i_t^*) S_{t+1} b_t^{CBF} + (1 + i_t) B_t^{CB} + H_{t+1} - H_t$$

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The Government

- Issues debt B_t^G and transfers the funds to households:

$$B_t^G = T_t^G$$

- At $t+1$, receives the central bank profits, Π_{t+1}^{CB} and repays its debt :

$$T_{t+1}^G = -(1+i_t)B_t^G + \Pi_{t+1}^{CB}$$

- We assume that the government is passive and that the level of real debt $b_t^G = B_t^G / P_t$ is exogenous.

Back

Decentralized Equilibrium

- Equilibrium in the domestic money market: $H_t / P_t = h_t^H$
- Law of one price: $S_t = P_t$

- Equilibrium in the domestic bonds market is given by:

$$B_t^G = S_t b_t^{H*} + B_t^H + B_t^{CB}$$

- Arbitrage Equation (2) implies:

$$\Gamma\left(b_t^G - b_t^H - \frac{B_t^{CB}}{S_t}\right) = (1 + i_t) S_t E_t \frac{1}{S_{t+1}} - (1 + i_t^*) + \frac{cov_t(m_t^*, X_{t+1}^*)}{E_t m_{t+1}^*} - \chi$$

- Determines i_t

Back Optimal FXI

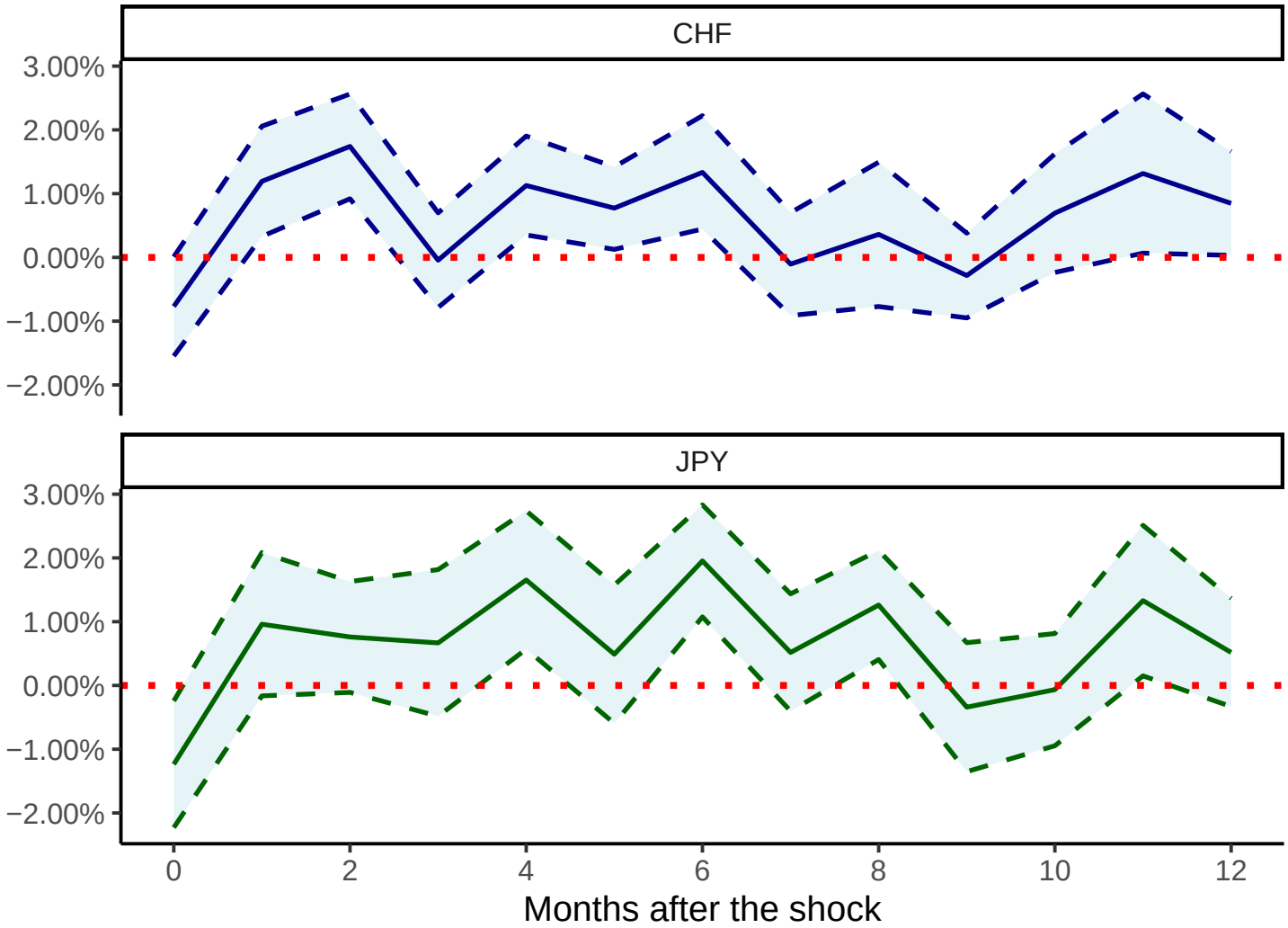
Correlation between UIP deviations and selected (global) risk variables

$Corr(RiskVariables, E(x^*_{t+1}))$						
	A) CHF/USD			B) JPY/USD		
Sample	USEPU	GEPU	WUI	USEPU	GEPU	WUI
1999-2021	-0.23	-0.29	-0.30	-0.11	-0.03	0.06
2010-2021	0.14	0.26	0.41	0.14	0.32	0.43

Back

Local Projections to a Global EPU shock

Back



Optimal Policy

- Define gross and net financial liabilities:

$$gfl_t = \left(b_t^G - \frac{B_t^{CB}}{S_t} - b_t^H \right) + \left(\frac{H_t}{S_t} - h_t^H \right)$$

  First term: foreign holdings of domestic bonds. Second term: foreign holdings of domestic money. In equilibrium, $gfl_t = a_t^{H*}$.

- Net foreign liabilities are given by

$$nfl_t = gfl_t - (b_t^F + b_t^{CBF}) = b_t^G - b_t^H - b_t^F - h_t^H$$

  where $b_t^F + b_t^{CBF}$ are the domestic holding of foreign assets.

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Central Bank's Program

$$
\begin{aligned}
&\max E\Big\{ U(C_t) + \beta U(C_{t+1}) \\
&+\eta_t \left(Y_t - C_t + nfl_t\right) \\
&+\eta_{t+1}\left[Y_{t+1} - C_{t+1} - (1+i_t^*)nfl_t + \left[(1+i_t^*) - (1+i_t)\frac{S_t}{S_{t+1}}\right] gfl_t + i_t \frac{S_t}{S_{t+1}}\left(\frac{H_t}{S_t} - h_t^H\right)\right] \\
&+\xi i_t \\
&+\Delta_t^H \left(h_t^H - Y_t\right) \\
&+\Delta_t^F \left(\frac{H_t}{S_t} - h_t^H\right) \\
&+\Lambda \left(gfl_t - b_t^{CBF} - nfl_t\right) \\
&+\tilde{\Lambda} \left(b_t^G + b_t^{CBF} - h_t^H - gfl_t\right) \\
&+\alpha_0 \left(E_t\left(m_{t+1}^* \left[(1+i_t^*) - (1+i_t)\frac{S_t}{S_{t+1}}\right]\right) + \Gamma gfl_t + \chi\right) \Big\}
\end{aligned}
$$

S_{t+1} is exogenous variable since $S_{t+1} = He^h / Y_{t+1}$.

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First Order Conditions

$$
\begin{aligned}
/\, nfl_t: \quad & \eta_t - E_t\left(\eta_{t+1}(1+i_t^*)\right) && -\Lambda && = 0 \\
/\, gfl_t: \quad & E_t\left(\eta_{t+1}\left[(1+i_t^*) - (1+i_t)\frac{S_t}{S_{t+1}}\right]\right) && +\Lambda - \tilde{\Lambda} + \alpha_0\Gamma && = 0 \\
/\, H_t: \quad & E_t\left(\eta_{t+1}\left[i_t\frac{S_t}{S_{t+1}}\right]\right) && +\Delta_t^F && = 0 \\
/\, b_t^{CBF}: \quad & && -\Lambda + \tilde{\Lambda} && = 0
\end{aligned}
$$

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Proposition 1

Consider the SDF of domestic households, m_t, and of international financial intermediaries m_t^* and the excess return in foreign currency, X_{t+1}^*. The benefit (or cost) of foreign exchange intervention $MBFX_t$ depends on

(i) CIP deviations when $cov(m_{t+1}, X_{t+1}^*) = cov(m_{t+1}^*, X_{t+1}^*)$.

(ii) UIP deviations when $cov(m_{t+1}, X_{t+1}^*) = 0$.

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Proposition 2

Consider a safe haven economy. Suppose that $\widehat{gfl}_t \geq 0$ and $\widehat{nfl}_t = b^G - 1$. Then optimal foreign exchange interventions, $\widehat{b}_t^{CBF}$:

(i) are increasing in risk measures σ_y and ρ;

(ii) are decreasing in intermediaries financial frictions Γ and χ;

(iii) are decreasing in the domestic output exposure to global risk α, as long as $b_t^G > 0$;

(iv) are decreasing in the supply of government bonds b_t^G;

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Proposition 3

Suppose Suppose that $\widehat{gfl}_t \geq 0$ and $\widehat{nfl}_t = b^G - 1$. Then:

(i) Z^*_{t+1} is increasing in σ_y (it becomes more positive);

(ii) $E_t X^*_{t+1}$ is decreasing in σ_y (it becomes more negative) if Γ is not too large;

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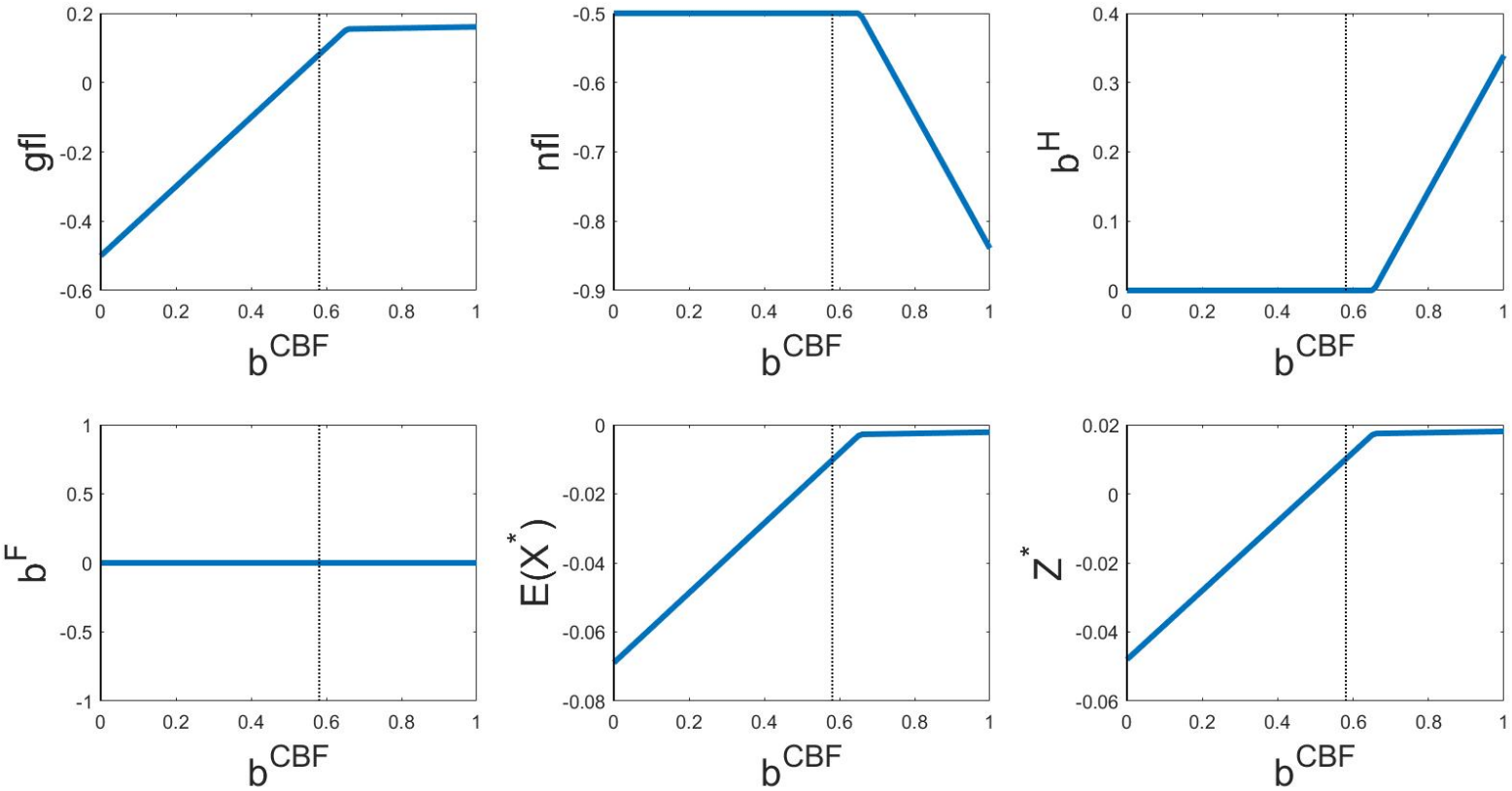
Social and private optimum



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Social and private optimum

- First-order conditions associated with bond portfolio choices for the household:

$$-E_t X^*_{t+1} - \frac{cov_t(m_{t+1}, X^*_{t+1})}{E_t m_{t+1}} + \lambda^F - \lambda^H = 0$$

  λ^H and λ^F: multipliers associated with short-selling constraints

- Planner's optimum: $\underbrace{-\frac{\alpha_0}{\eta_t E_t m_{t+1}}}_{>0}\Gamma = \lambda^H - \lambda_F, \Rightarrow \lambda^H > 0.$

- Households do not internalize the intertemporal terms of trade externality $\Rightarrow$ The private optimum does not coincide with the social optimum

- The social optimum can be implemented if the household is constrained in her capacity to issue domestic bonds $\Rightarrow$ Not too much FXI to crowd out domestic savings

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