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

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Introduction

- Small safe haven countries face appreciating pressure. May lead to substantial accumulation of FX reserves. Swiss National Bank (SNB): up to 120% of GDP in 2021

- What is the opportunity cost of reserves accumulation ?

- Deviation from Covered Interest rate Parity (CIP)?
  - Amador, Bianchi, Bocola and Perri (ReStud, 2020), Fanelli and Straub (ReStud, 2021)

- Or deviations from Uncovered Interest Parity (UIP)?
  - Adler and Mano (2021)

UIP and CIP Deviations

A) Deviations CHF/USD

B) Deviations JPY/USD
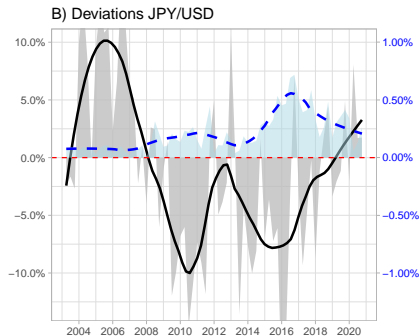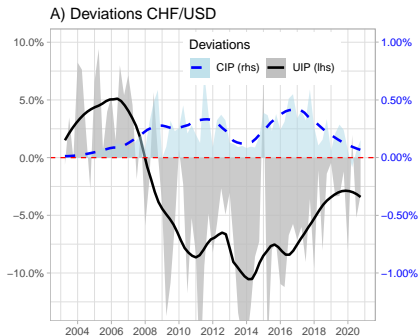
Objectives

- Develop a framework where CIP and UIP deviations can be of different signs

- What is the **welfare-based opportunity cost of reserves**?

- Implications for the optimal behavior of the central bank, modeling it as a constrained planner
  - Introduce other benefits of FX intervention (e.g. stabilizing the real exchange rate or avoiding sudden stops, here: relax households' credit constraints)

The Model

- Two-period small open economy with two currencies (domestic and foreign): financial intermediaries, households, central bank and government
    - Constrained international financial intermediaries (Gabaix-Maggiori)
    - Limited FX position of domestic households (no short-selling of domestic or foreign bonds)
    - Government is passive (fixed supply of gov. bonds)
    - Central Bank performs sterilized (and unsterilized) interventions
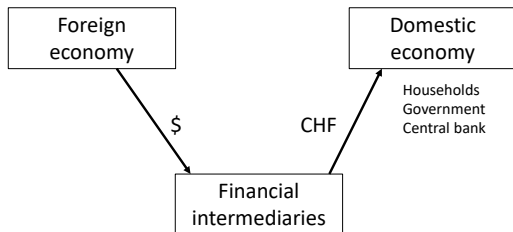
The Model

- Structure is similar to Amador et al. (2020), Fanelli and Straub (2021), Cavallino (2019), Itskhoki and Mukhin (2021), but both **financial intermediaries and households are risk averse** (like Fang and Liu, 2021)

- Home country is a **safe haven**

- Incentive for central banks to buy foreign assets when households are constrained

Model details

Definitions: Excess returns

- 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 $E_t X_{t+1}^* < 0$

The Model: the domestic bond market

- Equilibrium on the domestic bond market:
$$\underbrace{b_t^{H*}}_{\text{Foreign demand}} = \underbrace{b_t^G - b_t^H - b_t^{CB}}_{\text{Domestic supply}}$$

- b_t^G: government debt, b_t^H: households' holdings, b_t^{CB}: central bank holdings

- Foreign exchange interventions (FXI): $\underbrace{b_t^{CBF}}_{\$} = \underbrace{h_t - b_t^{CB}}_{CHF}$

- If $X_{t+1}^* < 0$, FXI can increase the economy's gross position (if households are constrained) and increase resources. But is it optimal?

  Model details

International Financial Intermediaries

- Objective function is (in dollars):

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

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

- Participation constraint:

$$V_t^* \geq \Gamma (b_t^{H*})^2 \tag{1}$$

International Financial Intermediaries

- CIP deviation:

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

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

- UIP deviation:

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

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

The marginal utility cost of reserves

- **Definition:**

$$UCFX_t = \frac{E_t(m_{t+1} X_{t+1}^*)}{E_t(m_{t+1})} \tag{3}$$

- m_{t+1} is the sdf of households

The marginal utility cost of reserves

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- We find:

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

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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
- If $cov_t(m_{t+1}, X^*_{t+1}) = 0$, then UIP matters

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- If CIP matters, there is a cost for the central bank. If it is UIP, there may be a gain ($UCFX_t < 0$).

Proposition

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 $\times$ wealth of 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 $Cov(x^*_{t+1}, m_{t+1})$

A) CHF domestic currency, USD foreign currency				
	Fin. Intermediaries			HH
$NW_{t+1} =$	$\eta^{HKM}_{t+1} \times W^{MSCI}_{t+1}$	$\eta^{AEM}_{t+1} \times W^{MSCI}_{t+1}$	$\eta^{HKM}_{t+1} \times W^{GDP}_{t+1}$	$\eta^{AEM}_{t+1} \times W^{GDP}_{t+1}$	C^{CH}_{t+1}
1999-2010	1.61	1.74	0.2	-1.17	0.25***
2010-2020	2.82**	1.32	5.1*	2.13**	0.01

B) JPY domestic currency, USD foreign currency				
$NW_{t+1} =$	$\eta^{HKM}_{t+1} \times W^{MSCI}_{t+1}$	$\eta^{AEM}_{t+1} \times W^{MSCI}_{t+1}$	$\eta^{HKM}_{t+1} \times W^{GDP}_{t+1}$	$\eta^{AEM}_{t+1} \times W^{GDP}_{t+1}$	C^{JP}_{t+1}
1999-2010	1.85	-2.9	-3.57	-2.56**	0.7***
2010-2020	6.39***	3.31**	7.93***	2.63**	0.33

- Japan and CH 2010-2020: $\Delta Cov > 0$
- CH: $cov_t(m_{t+1}, X^*_{t+1})$ close to zero $\Rightarrow$ Only UIP matters!
- $\Rightarrow$ Benefit of holding reserves (Risk)

Optimal FX Intervention

- Implications for FX interventions?

- Central bank as a constrained planner `Constrained planner`

- For sterilized intervention (or unsterilized at the ZLB), we find:

$$\underbrace{\overbrace{-E_t X_{t+1}^* - \frac{cov(m_{t+1}, X_{t+1}^*)}{E_t m_{t+1}}}^{-UCFX_t} + \overbrace{\frac{\alpha_0}{\eta_t E_t m_{t+1}} \Gamma}^{<0}}_{MBFX_t} = 0$$

- Central bank buys fewer foreign assets than households would like

A Linear-Quadratic Version of a Safe Haven Economy

- The SDF of international financial intermediaries is inversely proportional to a global factor Y_t^*

- Y_{t+1}^* is log-normal with $log(Y_{t+1}^*) \sim N(\sigma_y^2/2, \sigma_y^2)$. σ_y^2 measures global risk

- Safe haven assumption:
  1. Currency appreciates when global factor is low
  2. Domestic output only partially correlated with global factor

Numerical Illustration: Impact of σ_y^2 Constraints
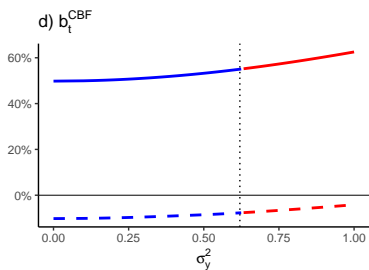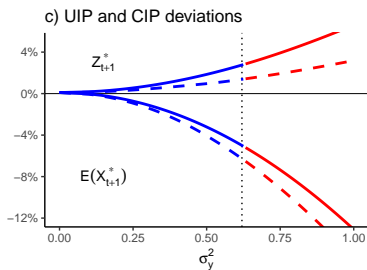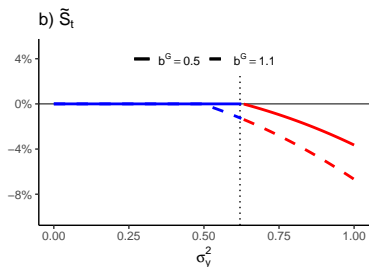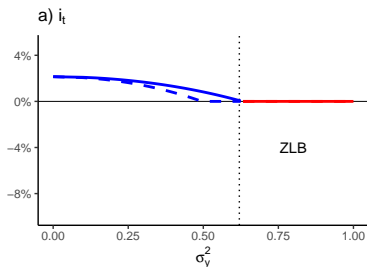
Notes: Baseline parameters : $\beta = 0.98$, $\chi = 0.002$ $\Gamma = 0.5$, $\alpha = 0.6$, $\rho = 0.2$. We assume that $\bar{b}^H = \bar{b}^F = 0$.

Numerical Illustration: With a "domestic motive" for FXI
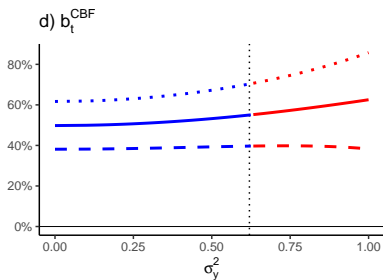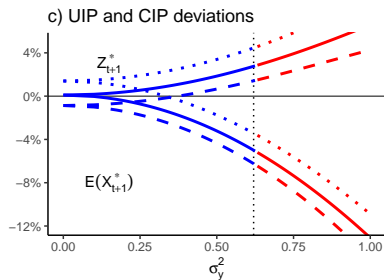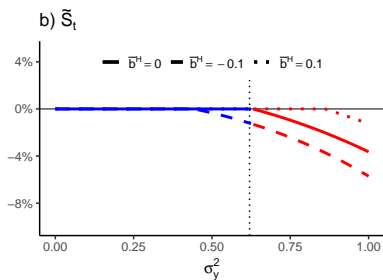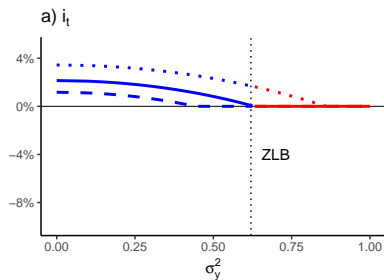
Conclusion

- 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

The Model: Domestic Households

- Foreign price normalized to one: $P_t^* = 1$, Law of one price: $S_t = P_t$.

- Hold money, h_t^H, domestic-currency bonds b_t^H, and foreign-currency bonds b_t^F (all expressed in real terms)

- Their utility function is:

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

- Budget constraints:

$$C_t = Y_t - h_t - b_t^H - b_t^F + t_t$$

$$C_{t+1} = Y_{t+1} + \frac{S_t}{S_{t+1}} h_t^H - h_{t+1}^H + (1 + i_t)\frac{S_t}{S_{t+1}} b_t^H + (1 + i_t^*) b_t^F + t_{t+1}$$

- Short-selling constraints:
$E_t \left[(1 + i_t)\frac{S_t}{S_{t+1}} b_t^H \right] \geq \bar{b}^H, \ E_t(1 + i_t^*) b_t^F \geq \bar{b}^F$

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

The Model: The Central Bank

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

$$b_t^{CBF} + t_t^{CB} = h_t$$

- 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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  2. Unsterilized intervention, changing total money supply h_t
- No transfers! (no "fiscal" intervention)

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

$$\Pi_{t+1}^{CB} = (1 + i_t^*) b_t^{CBF} + (1 + i_t) \frac{S_t}{S_{t+1}} b_t^{CB} + h_{t+1} - \frac{S_t}{S_{t+1}} h_t$$

Back to summary

The Model: 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 :

$$t_{t+1}^G = -(1+i_t)\frac{S_t}{S_{t+1}}b_t^G + \Pi_{t+1}^{CB}$$

- We assume that the government is passive and that the level of real debt b_t^G is exogenous.

Decentralized Equilibrium

- Equilibrium in the domestic money market: $H_t / S_t = h_t^H$

- Equilibrium in the domestic bonds market is given by:

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

- Arbitrage Equation (2) implies:

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

- Determines $(1 + i_t) S_t$

Back to summary   Optimal FXI

UIP deviation: a free lunch?

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

UIP deviation: a free lunch?

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- Intertemporal resource constraint:

$$(1 + r_t)C_t + C_{t+1} = (1 + r_t)Y_t + Y_{t+1} - X_{t+1}^* gfl_t$$

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

Back to domestic bond market

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
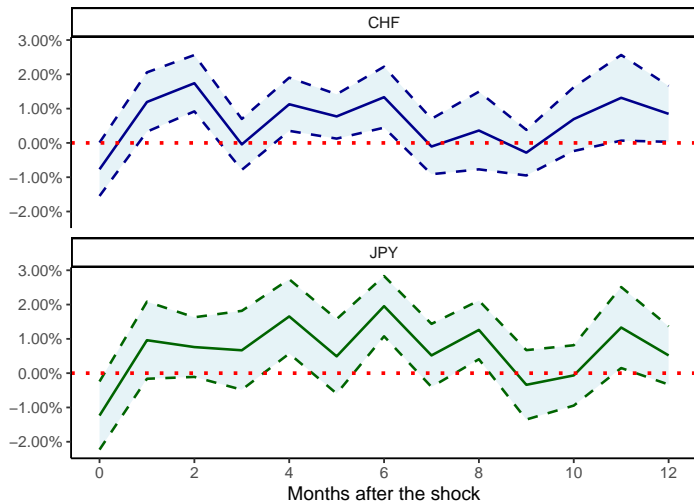
Optimal Policy

- 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.

Back

Central Bank's Program

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

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

Back

First Order Conditions

$$/nfl_t: \quad \eta_t - E_t\left(\eta_{t+1}(1+i_t^*)\right) \qquad\qquad -\Lambda \qquad = 0$$

$$/gfl_t: \quad E_t\left(\eta_{t+1}\left[(1+i_t^*) - (1+i_t)\frac{S_t}{S_{t+1}}\right]\right) \quad +\Lambda - \tilde{\Lambda} + \alpha_0\Gamma \quad = 0$$

$$/H_t: \quad E_t\left(\eta_{t+1}\left[i_t\frac{S_t}{S_{t+1}}\right]\right) \qquad\qquad +\Delta_t^F \qquad = 0$$

$$/b_t^{CBF}: \qquad\qquad\qquad\qquad\qquad\qquad -\Lambda + \tilde{\Lambda} \qquad = 0$$

Back

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 $UCFX_t$ depends on

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

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

Back

Proposition 2

Consider a safe haven economy. Suppose that $\bar{b}^H = 0$, $\widehat{gfl}_t \geq 0$ 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;

Back

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;

Social and private optimum
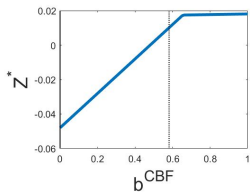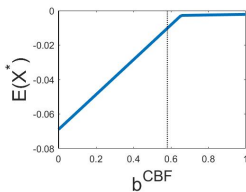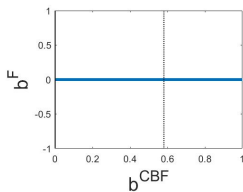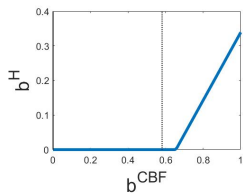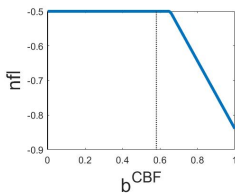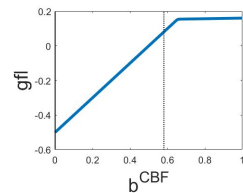
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Social and private optimum

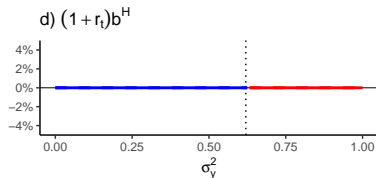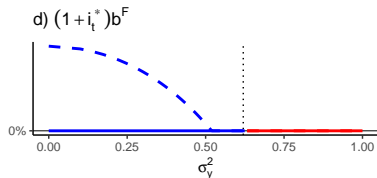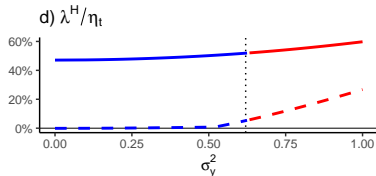- First-order conditions associated with bond portfolio choices for the household:
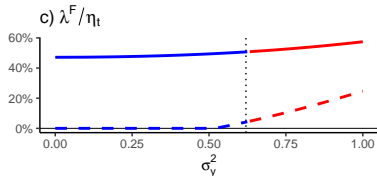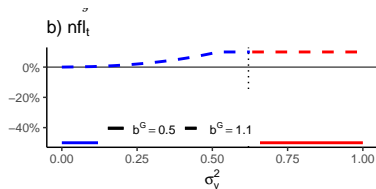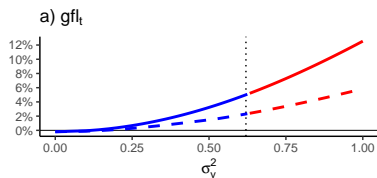
$$-E_t X_{t+1}^* - \frac{cov_t(m_{t+1}, X_{t+1}^*)}{E_t m_{t+1}} + \lambda^F - \lambda^H = 0$$

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

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

- 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

Numerical Illustration: Financial constraints Back

Notes: Baseline parameters : $\beta = 0.98, \chi = 0.002\, \Gamma = 0.5, \alpha = 0.6, \rho = 0.2$. We assume that $\bar{b}^H = \bar{b}^F = 0$.