Collateral Advantage: Exchange Rates, Capital Flows, and Global Cycles

Michael B. Devereux
UBC

Charles Engel
U Wisconsin

Steve Pak Yeung Wu
UCSD

6 Oct 2023

4th Joint Workshop

Bank of England – Banque de France – IMF – OECD – Banca d'Italia

Motivation

- Macro finance literature has focused on the liquidity yield or "**convenience yield"** of short-term U.S. govt bonds (Krishnamurthy, Vissing Jorgensen 2012)

- Internationally, US govt bonds play a central role and serve particular function in the international finance architect

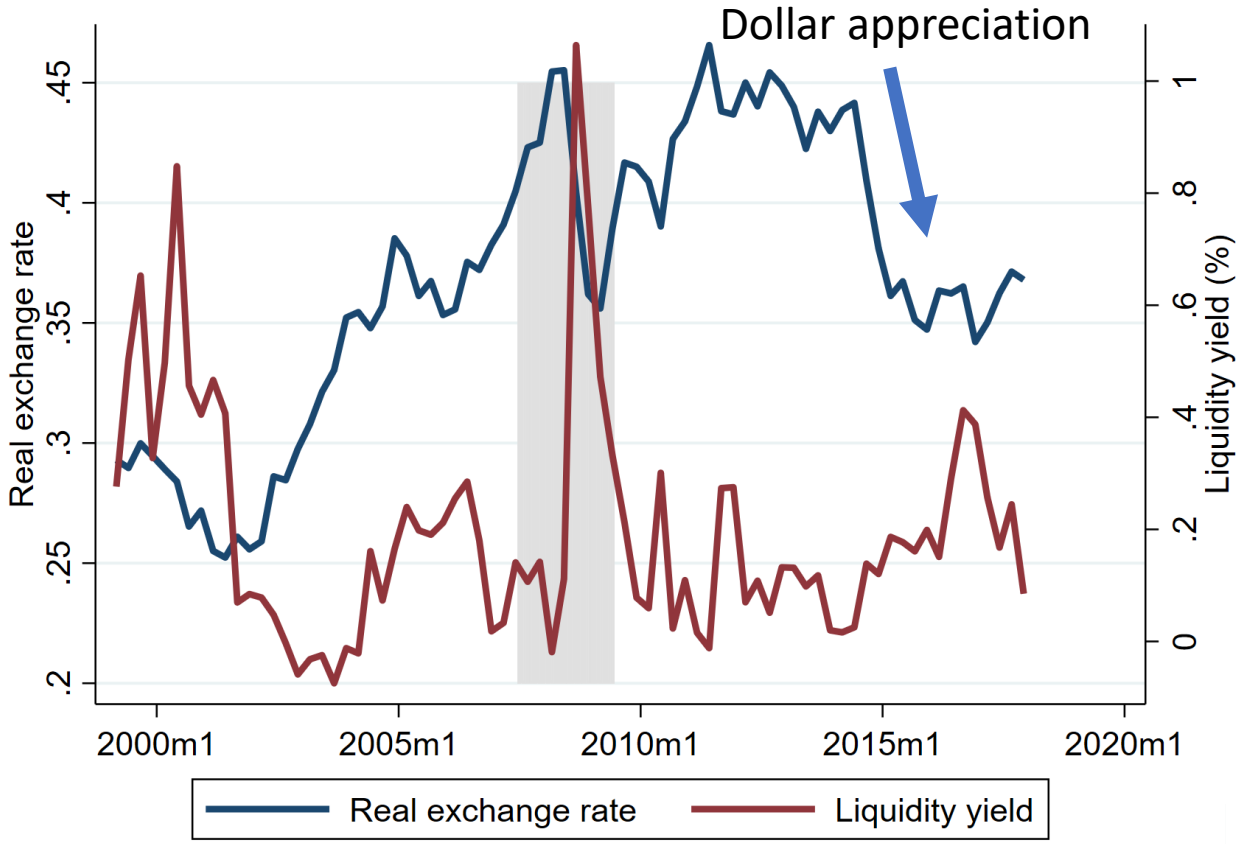
- Recent empirical evidence support a relationship of "**convenience yield"** of government bonds and exchange rate movements

Engel and Wu (REStud Forthcoming), Jiang, Lustig, Krishnamurthy (JF 2021)

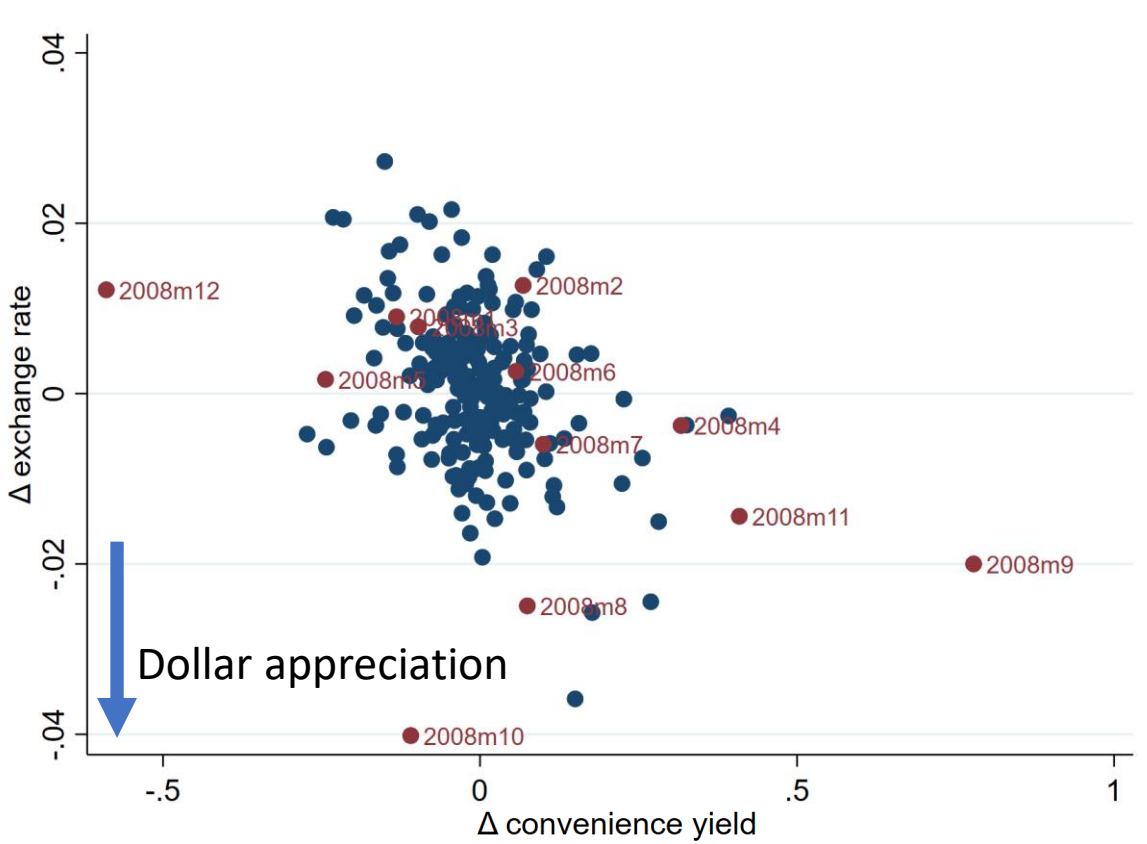
Exchange rate and convenience yield

US vs rest of G10 real exchange rate and convenience yield

LHS: levels



RHS: monthly changes



Data: Engel and Wu 2023

Goal

- Many existing models features exogenous convenience yield

  (e.g., bonds in the utility function, UIP wedges)

Goal

- Many existing models features exogenous convenience yield

  (e.g., bonds in the utility function, UIP wedges)

- A model with endogenous convenience yield that can help explain exchange rate and external position of the US

Goal

- Many existing models features exogenous convenience yield

  (e.g., bonds in the utility function, UIP wedges)

- A model with endogenous convenience yield that can help explain exchange rate and external position of the US

1. Exchange rate and convenience yield in **normal times**

2. **Long term** external position of the US (exorbitant privilege)

3. During **global crisis** (GFC, COVID19), dollar appreciates and large wealth transfer (exorbitant duty)

What we do in this paper

- A NK DSGE model with banks to generate endogenous convenience yield
- Financial intermediaries as in Gertler Karadi 2011, Gertler Kiyotaki 2010 who face collateral constraint on their asset holding
- Symmetric 2-country model (US and foreign) with one asymmetry

US bond is assumed to be better collateral

- Demand for an asset not just for interest rate, but as collateral

What we find

- Because the US bond is better collateral
- In steady state, the US

1. generates “excess return” on its foreign investment
2. has negative NFA and positive net foreign income (exorbitant privilege)

- Upon a uniform global financial shock

1. Banks have tight balance sheet constraints→ run to least constrained assets (US bonds)
2. Demand for US bond appreciates the currency
3. Wealth transfer from the US to RoW (exorbitant duty and Maggiori 2017 paradox)
4. Capital flow retrenchment for both countries

- Exchange rates

1. Endogenous convenience yield and UIP deviation
2. Reasonably match many untargeted moments

Road map

1. **Quantitative model**
2. IRFs to mimic GFC
3. Exchange rate moments

A two-country New Keynesian model with Treasury convenience

- Goods market

- Home (US) and foreign (Eurozone) goods

- Nominal price stickiness with pricing to market (i.e., local currency pricing – LCP)

- Banking sector

- Gertler Karadi / Gertler Kiyotaki type of Home and Foreign banks

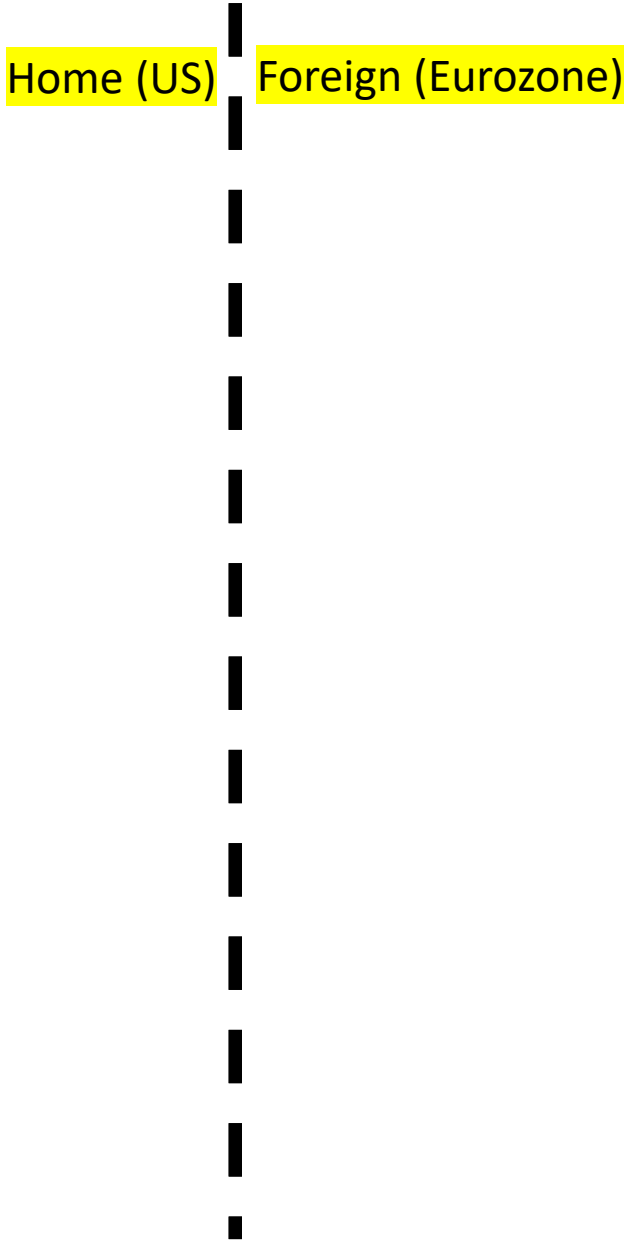
- Moral hazard problem → Incentive constraint on asset holding

- Assets market

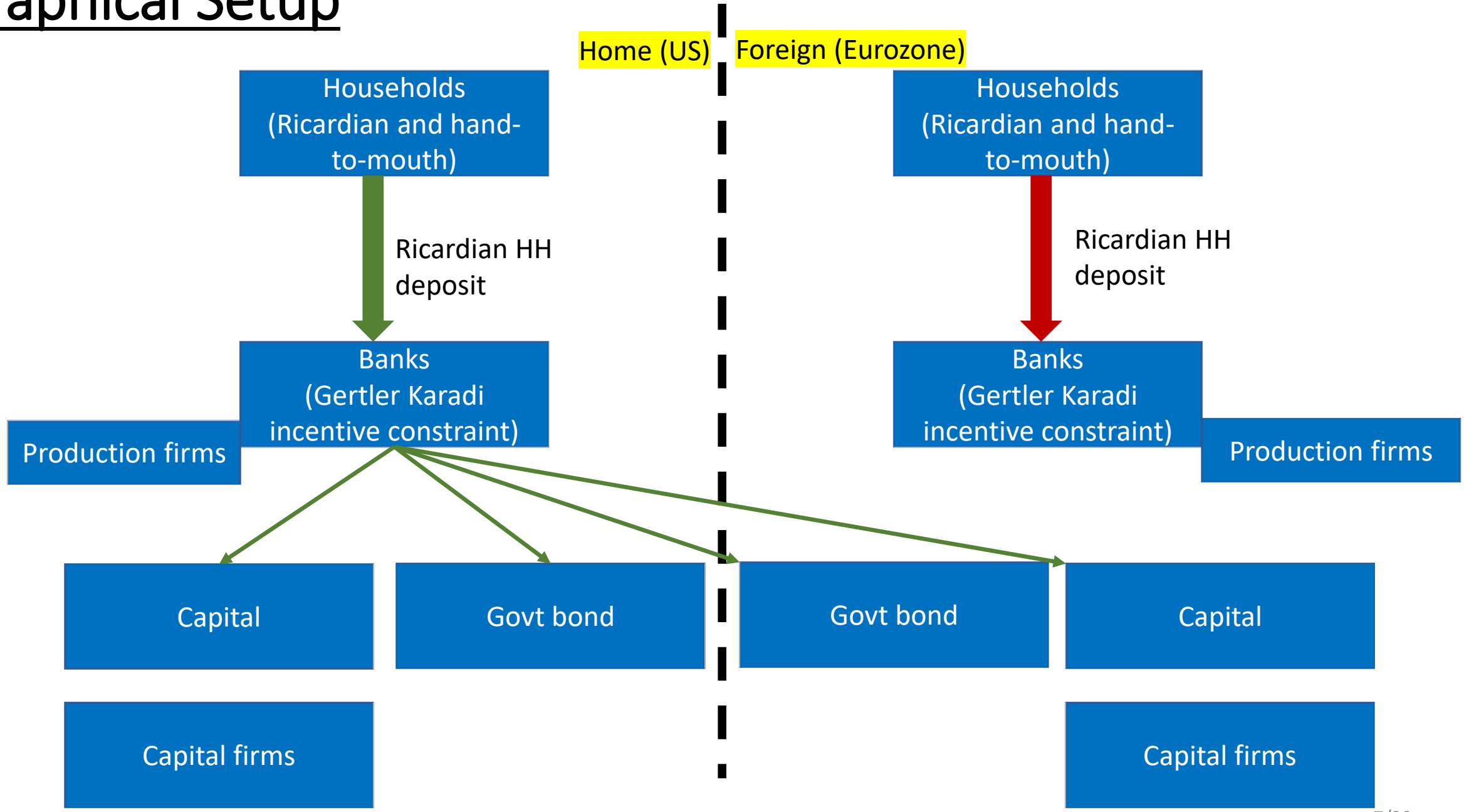
- Home bond, foreign bond, home capital, foreign capital

- Key is that home bond is better collateral

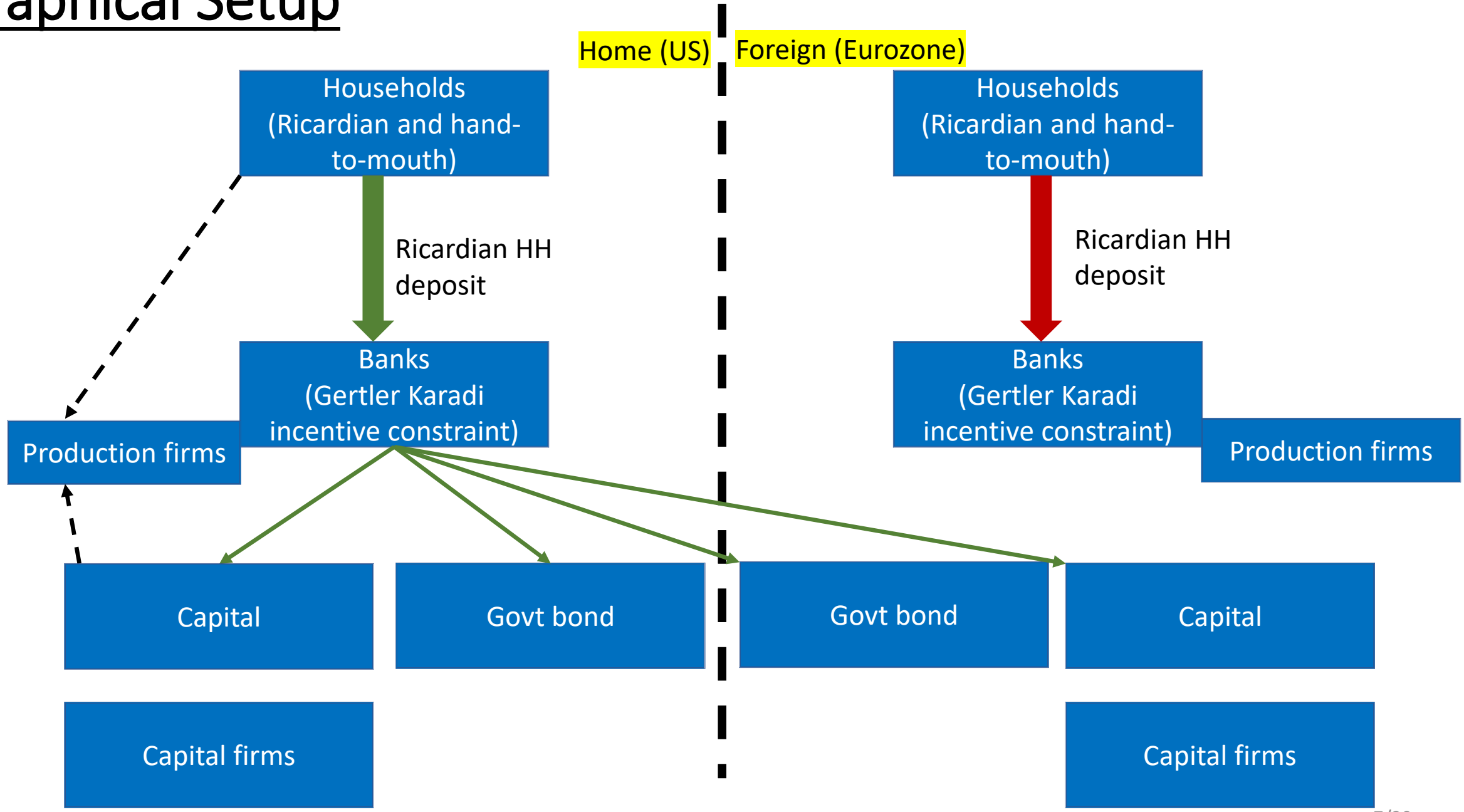
Graphical Setup



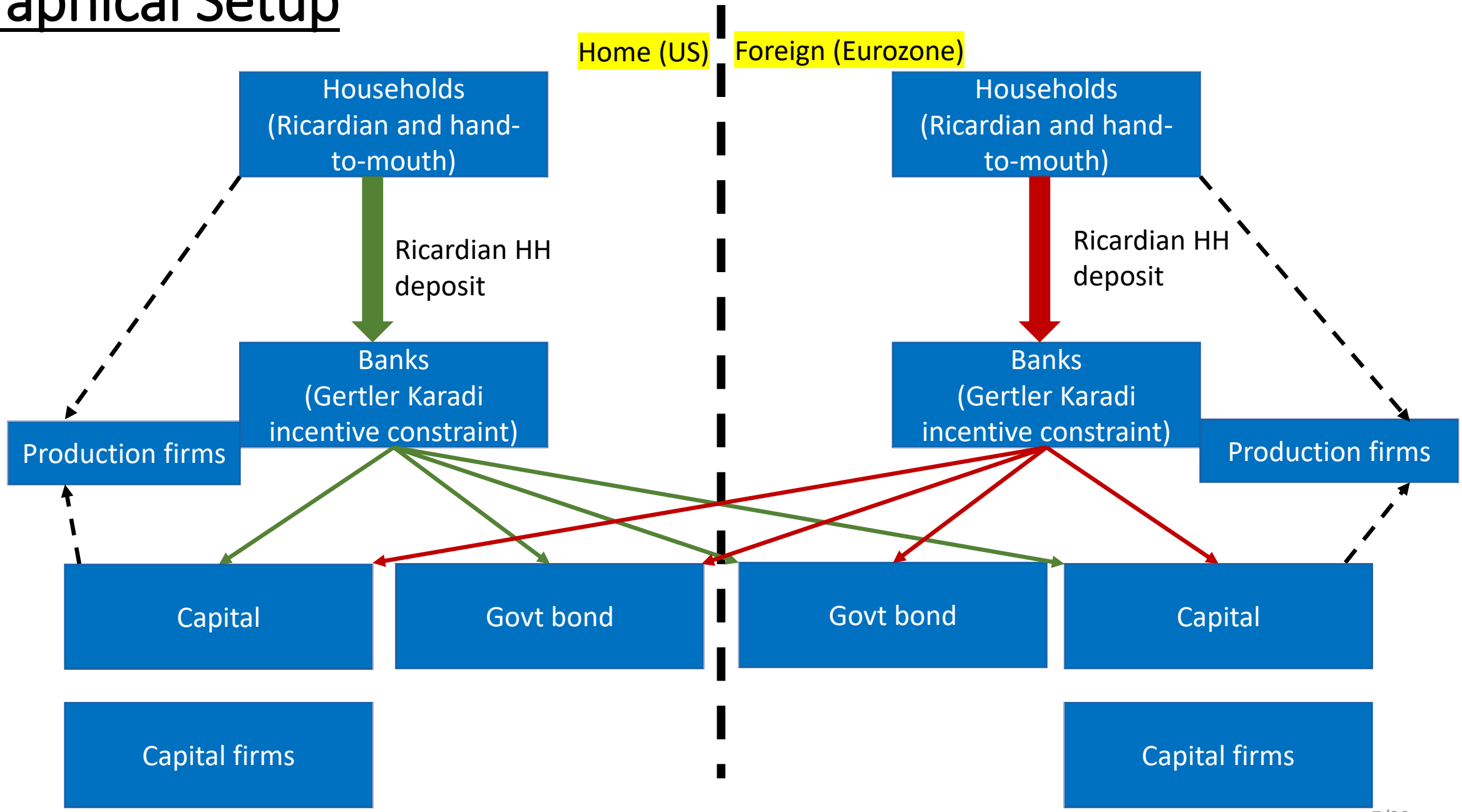
Graphical Setup



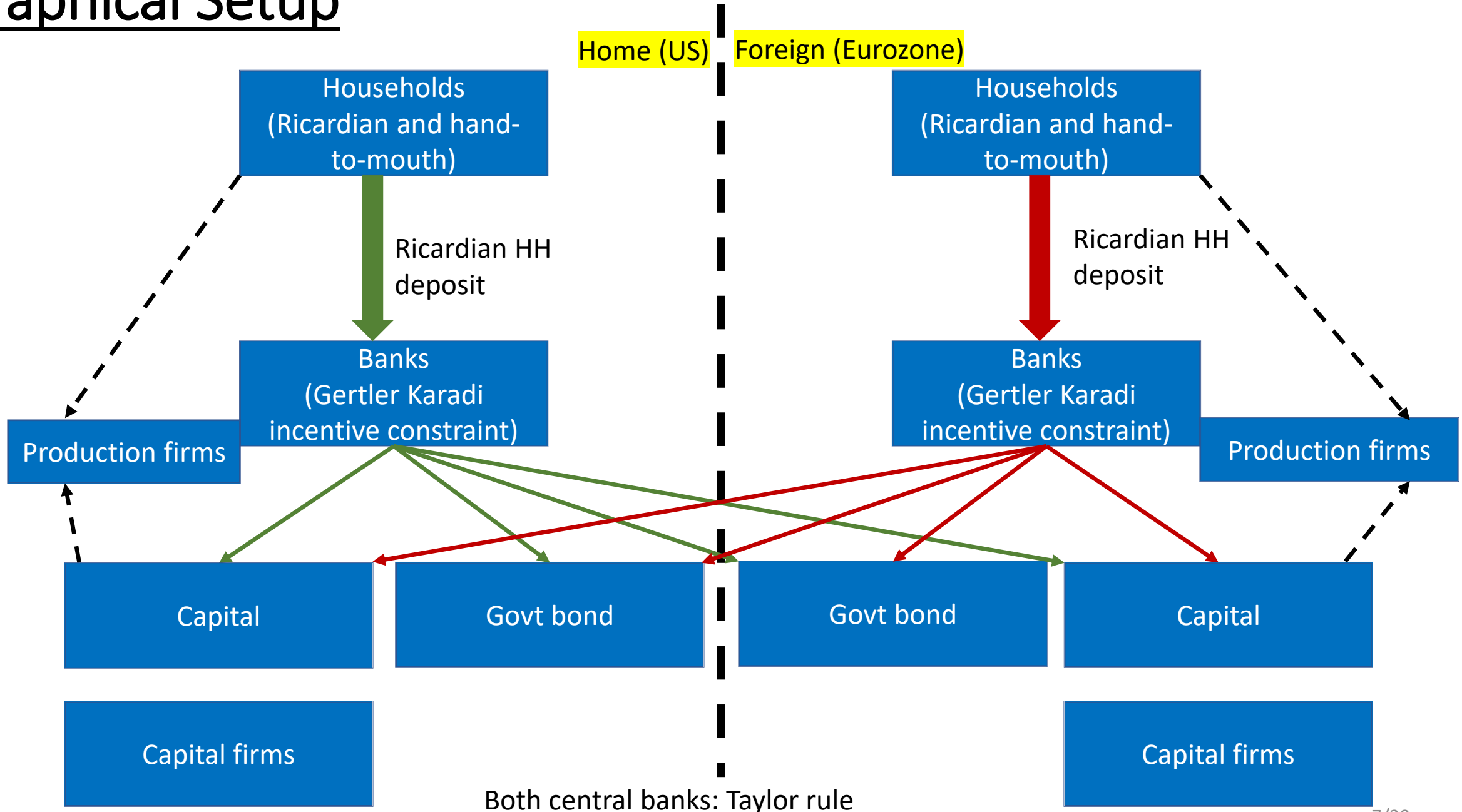
Graphical Setup



Graphical Setup



Graphical Setup



Both central banks: Taylor rule

Both govts: Issue constant bond every period

Banks

- Follows the Gertler and Karadi framework

- A fraction $1-\theta$ of each household becomes a banker each period, and continues with probability θ, and reverts to being a consumer with probability $1-\theta$
- Balance sheet of bank (omitted *i* subscript):

$$N_t + B_t = \left[Q_t K_{h,t+1} + D_{h,t}\right] + S_t\left[Q_t^* K_{f,t+1} + D_{f,t}\right]$$

Net worth + deposit = [investment in Home asset] + [investment in Foreign asset]

where Q_t is the home capital price, S_t is the home price of a foreign currency
K_h is the home bank holding of home capital
K_f is the home bank holding of foreign capital
D_h is the home bank holding of home bond
D_f is the home bank holding of foreign bond

Banks' problem

- Banks' value function is

$$V_t = E_t \Omega_{t+1}[(1-\theta)N_{t+1} + \theta V_{t+1}]$$

- Maximize value function by choosing the four assets (K_h, K_f, D_h, D_f)
- Subject to Gertler-Kiyotaki, Gertler-Karadi type of incentive constraint
- Banker can abscond κ amount of the assets so

$$\text{value of the bank} \geq \kappa(\text{value of the assets})$$

value if running the business

value if running away

Steve Pak Yeung Wu – UCSD

Banks' problem

- Banks' value function is

$$V_t = E_t \Omega_{t+1}[(1-\theta)N_{t+1} + \theta V_{t+1}]$$

- Maximize value function by choosing the four assets (K_h, K_f, D_h, D_f)
- Subject to Gertler-Kiyotaki, Gertler-Karadi type of incentive constraint
- Banker can abscond κ amount of the assets so

$$V_t \geq \vartheta_t\left[\left(\kappa_{K,h} Q_t K_{h,t+1} + \boldsymbol{\kappa_h} D_{h,t}\right) + \left(\kappa_{K,f} S_t Q_t^* K_{f,t+1} + \kappa_f S_t D_{f,t}\right)\right]$$

- The lower the parameter κ, the more it is pledgeable
- **Key assumption:**

Home bond is the best collateral $\boldsymbol{\kappa_h} < \kappa_f \leq \kappa_{K,h} \leq \kappa_{K,f}$

The same for the foreign banks $\boldsymbol{\kappa_h^*} < \kappa_f^* \leq \kappa_{K,f}^* \leq \kappa_{K,h}^*$

First-order conditions

Bank SDF:

$$\Lambda_{t+1} = \Omega_{t+1}((1-\theta) + \theta\nu_{t+1})$$

These are zeros in frictionless models

$$FOC[D_h]: \quad E_t\Lambda_{t+1}\left(R_{h,t+1} - R_{t+1}\right) = \eta_t\vartheta_t(\kappa_{h,t})$$

$$FOC[D_f]: \quad E_t\Lambda_{t+1}\left(\frac{S_{t+1}}{S_t}R_{f,t+1} - R_{t+1}\right) = \eta_t\vartheta_t(\kappa_{f,t})$$

$\eta_t = shadow\ value\ of\ constraint$
$\vartheta_t = 1 = country\ wide\ constaint$
$\kappa_{h,t} = asset\ specific\ pledgeability$

First-order conditions

Bank SDF:

$$\Lambda_{t+1} = \Omega_{t+1}((1-\theta) + \theta\nu_{t+1})$$

These are zeros in frictionless models

$$FOC[D_h]: \quad E_t\Lambda_{t+1}\left(R_{h,t+1} - R_{t+1}\right) = \eta_t\vartheta_t(\kappa_{h,t})$$

$$FOC[D_f]: \quad E_t\Lambda_{t+1}\left(\frac{S_{t+1}}{S_t}R_{f,t+1} - R_{t+1}\right) = \eta_t\vartheta_t(\kappa_{f,t})$$

- Combining $FOC[D_h]$ and $FOC[D_f]$ gives

UIP wedge

$$E_t\Lambda_{t+1}\left(\frac{S_{t+1}}{S_t}R_{f,t+1} - R_{h,t+1}\right) = \eta_t\vartheta_t(\kappa_{f,t} - \kappa_{h,t})$$

- As the constraint tightens, η_t rises

First-order conditions

Bank SDF:

$$\Lambda_{t+1} = \Omega_{t+1}((1-\theta) + \theta\nu_{t+1})$$

These are zeros in frictionless models

$$FOC[D_h]: \quad E_t\Lambda_{t+1}\left(R_{h,t+1} - R_{t+1}\right) = \eta_t\vartheta_t(\kappa_{h,t})$$

$$FOC[D_f]: \quad E_t\Lambda_{t+1}\left(\frac{S_{t+1}}{S_t}R_{f,t+1} - R_{t+1}\right) = \eta_t\vartheta_t(\kappa_{f,t})$$

- Combining $FOC[D_h]$ and $FOC[D_f]$ gives

UIP wedge

$$E_t\Lambda_{t+1}\left(\frac{S_{t+1}}{S_t}R_{f,t+1} - R_{h,t+1}\right) = \eta_t\vartheta_t(\kappa_{f,t} - \kappa_{h,t})$$

- As the constraint tightens, η_t rises
- Forward iterating gives

$$S_t = -E_t\left\{\sum_{t=1}^{\infty}\left(R_{h,t} - R_{f,t}\right) + \sum_{t=1}^{\infty}(\tilde{\eta}_t)\right\} + \lim_{k\to\infty} E_t s_{t+k} - k\bar{s}$$

Calibration table

- Log-linearize around non-stochastic steady state

Symbol	Meaning	Value	Target
$\overline{D_h} = \overline{D_f}$	Total govt debt	2.7	Debt to GDP of 83%
θ	Bank survival prob.	0.95	Leverage of 3
$\boldsymbol{\kappa_h}$	**Home constraint cost of holding home bond**	**0.025**	**Convenience yield = 1%**
$\boldsymbol{\kappa_h^*}$	**Foreign constraint cost of holding home bond**	**0.05**	**Foreign holding of US Treasury of 45%**
$\boldsymbol{\kappa_f}$	**Home constraint cost of holding foreign bond**	**0.40**	**-ve NFA 18.5%**
$\boldsymbol{\kappa_f^*}$	**Foreign constraint cost of holding foreign bond**	**0.32**	**Net foreign income / GDP = 0.0013**
$\kappa_{Kh}^* = \kappa_{Kf}$	Constraint cost of holding external capital	0.49	Equity premium of 6%
$\kappa_{Kh} = \kappa_{Kf}^*$	Constraint cost of holding own capital	0.41	Home bias of equity of 70%

Steady state

Symbol	Steady state
NFA/GDP	-18.50%
$r_f - r_h$	4.4 - 3.4% = 1%
Net income from abroad / GDP	0.13%

Exorbitant privilege:
+ve Net income from abroad because of convenience yield despite the –ve NFA

Steady state

Symbol	Steady state
NFA/GDP	-18.50%
$r_f - r_h$	4.4 - 3.4% = 1%
Net income from abroad / GDP	0.13%

Exorbitant privilege:
+ve Net income from abroad because of convenience yield despite the –ve NFA

Symbol	Steady state
C, C*	0.6113 > 0.6107
L, L*	0.3314 < 0.3325
Y, Y*	0.8059 < 0.8082
Equity share of foreign claims	61% > 53%

Living off the privilege, US has a high consumption, despite less L and Y

Road map

1. Quantitative Model
2. **IRFs to mimic 2008 GFC**
3. Exchange rate moments

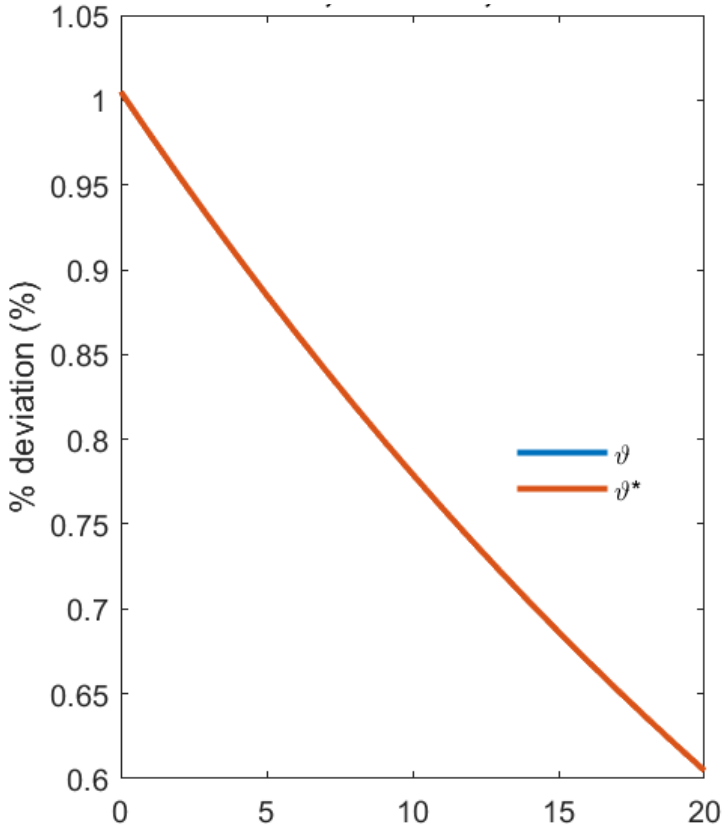
Key takeaways

- Dollar appreciates in crisis due to convenience demand
- Dollar appreciates despite a wealth transfer to the rest of the world (reconcile reserves currency paradox Maggiori 2017)
- Capital flow retrenchment

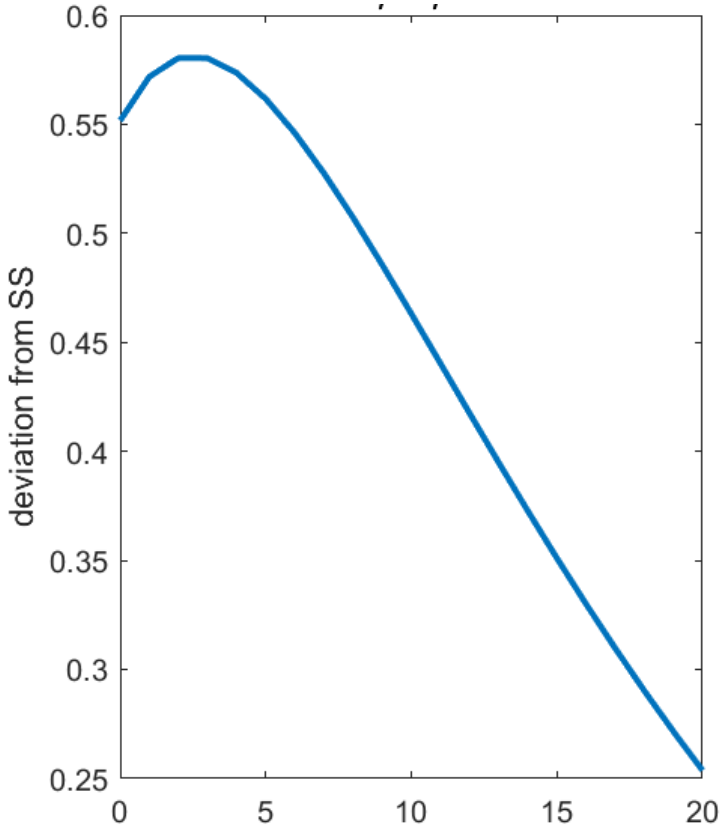
Experiment

- A 1% shock to ϑ and ϑ^* (1% tightening to all assets on incentive constraint)
- The shock is AR1, with persistence of 0.98

Home and Foreign financial shock



Home - Foreign Lagrangian multiplier

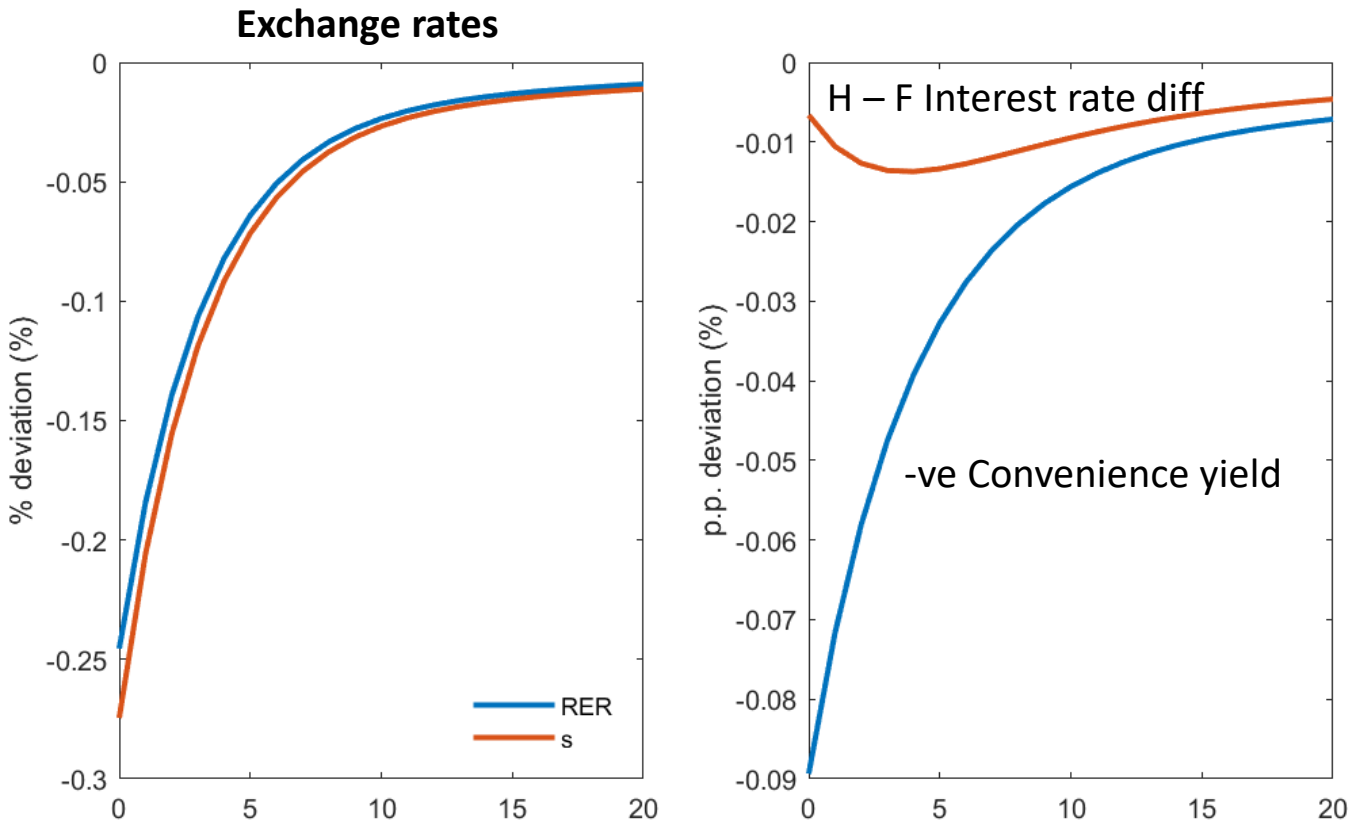


- Symmetric shock but asymmetric effects

IRF of ϑ shock – exchange rate

$$S_t = -E_t\left\{\sum_{t=1}^{\infty}\left(R_{h,t} - R_{f,t}\right) + \sum_{t=1}^{\infty}\left(\tilde{\eta}_t\right)\right\} + \lim_{k\to\infty} E_t s_{t+k} - k\bar{s}$$

Convenience yield: $\tilde{\eta}_t \equiv E_t S_{t+1} - S_t - \left(R_{h,t} - R_{f,t}\right)$

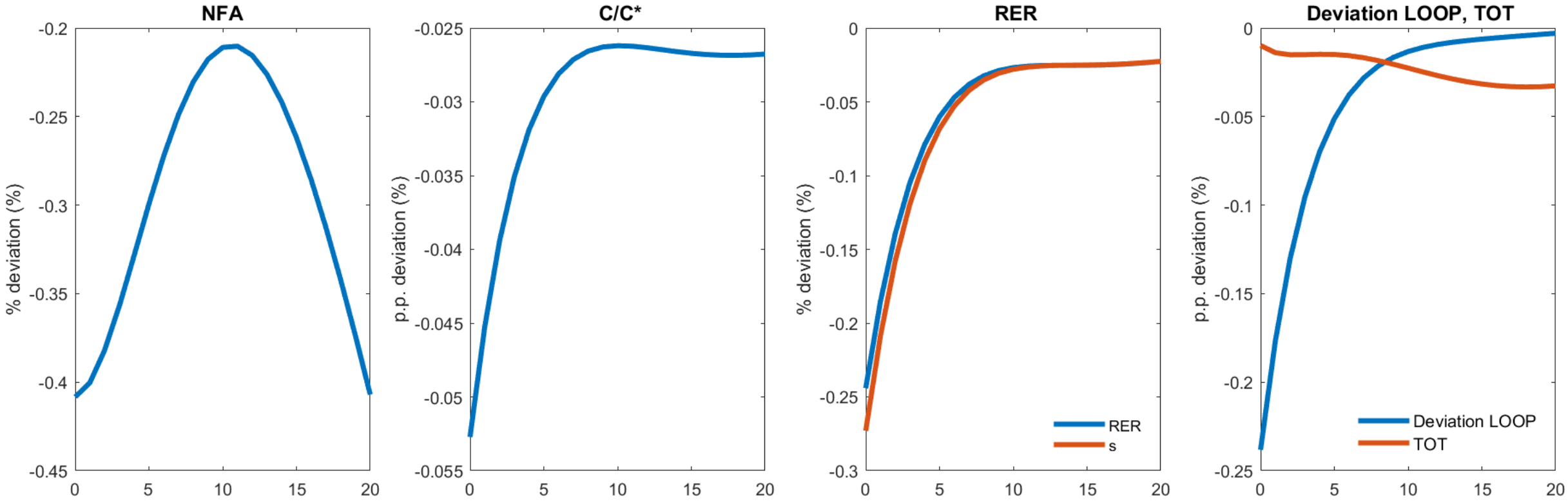


- USD appreciates mostly because of strong convenience yield demand

Steve Pak Yeung Wu – UCSD

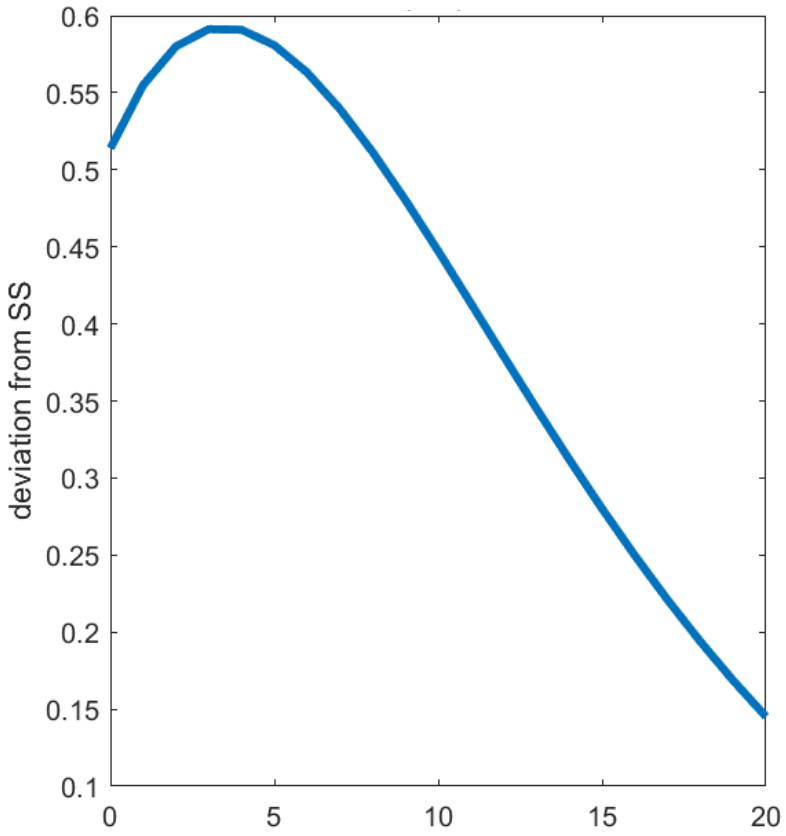
IRF of ϑ shock – reserves currency paradox

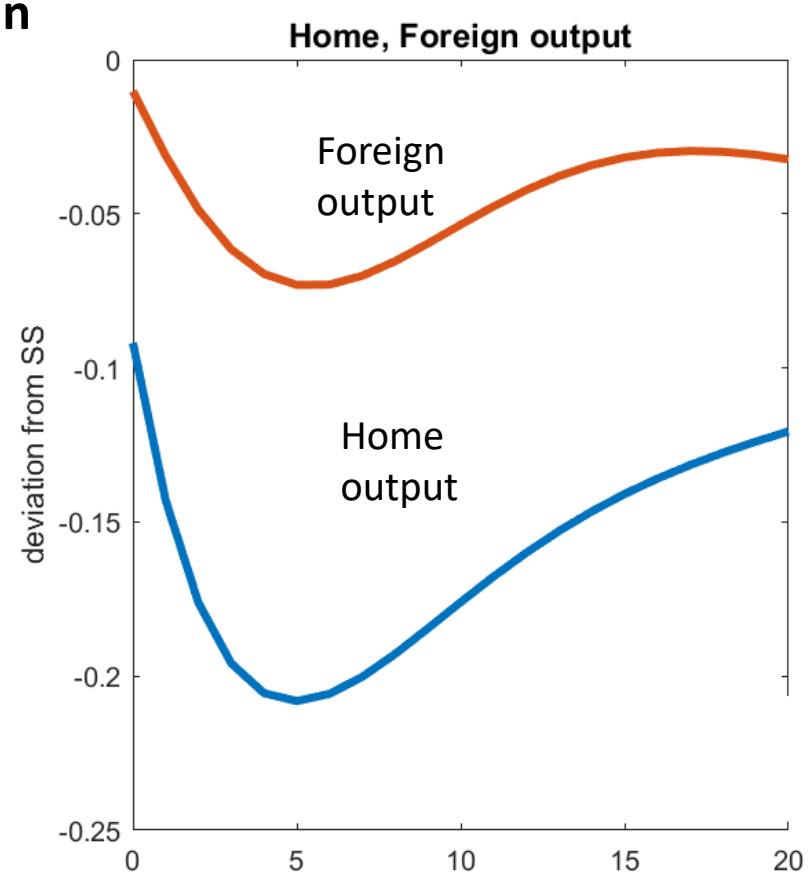
- Recall that $RER_t = TOT_t^{2\omega-1} \times D_t$

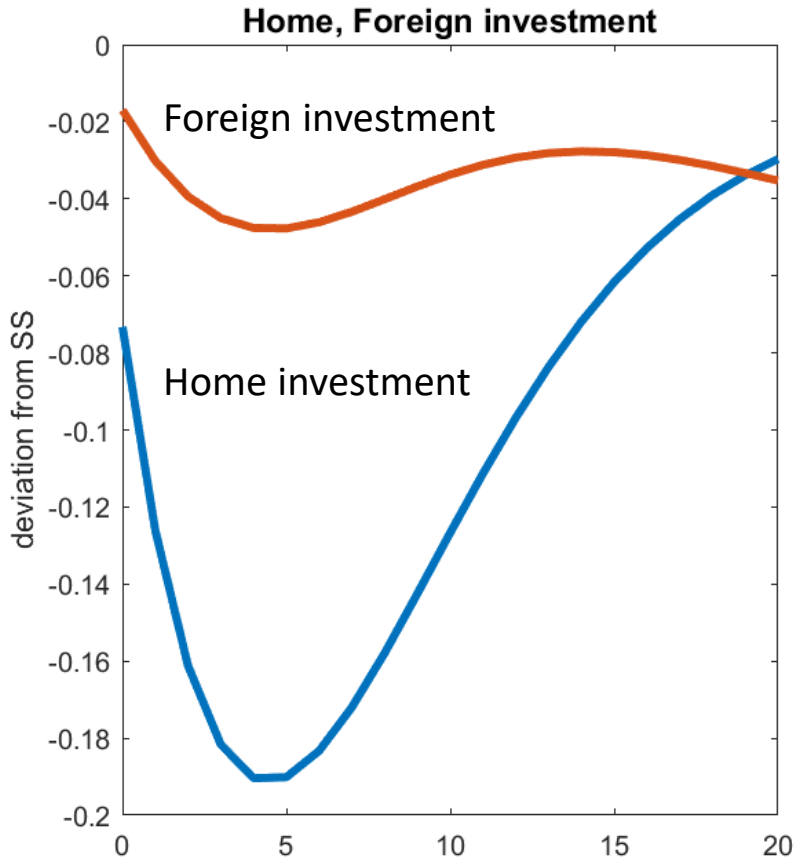


- Despite a wealth transfer to RoW →RER appreciation because of deviation of LOOP

IRF of ϑ shock – real outcomes







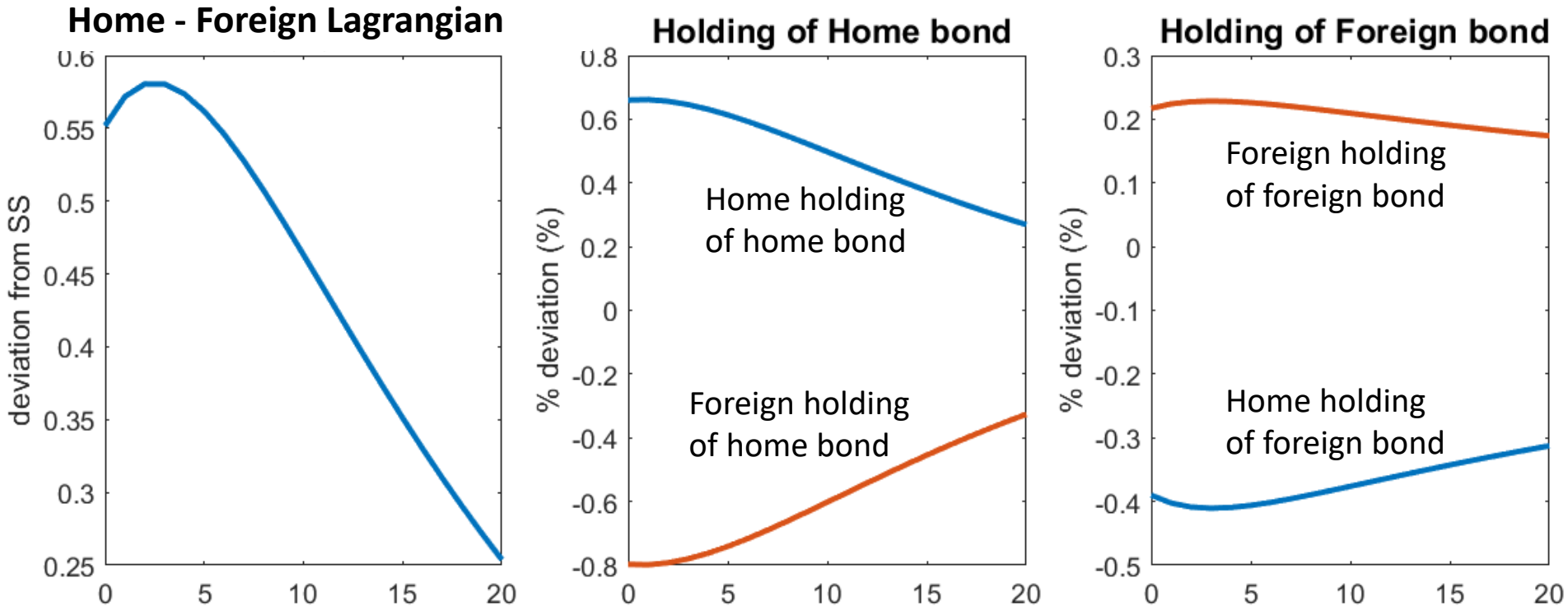
- Intuition:

Home bond is great

→ Home banks shift out from investment more during a crisis

→ Home output drops more

IRF of ϑ shock – capital flows



- Home banks suffer more during the crisis

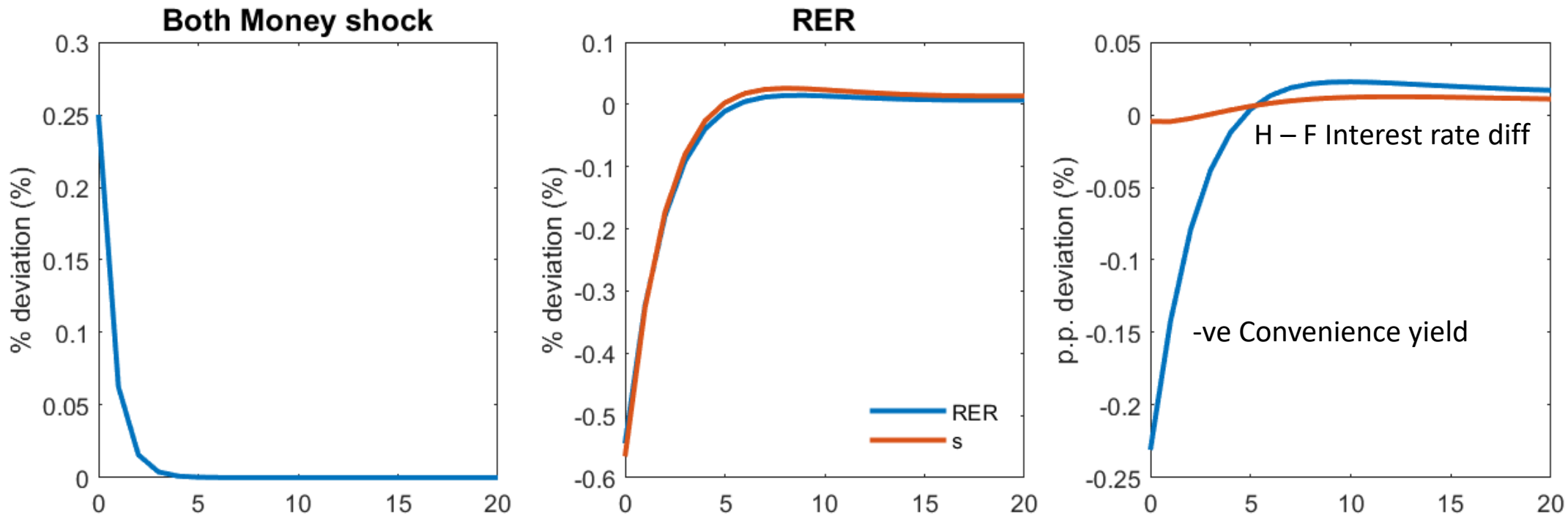
→ Home banks demand more of the least constrained bond

→ Foreign selling home bonds despite they also demand more of the liquid bond

→ Retrenchment of capital flows

Note: direction of capital flows ≠ demand revelation

IRF of symmetric money shocks (2022 global tightening)



- Same size of global tightening results in USD RER appreciation
- Convenience yield demand drives most of the RER appreciation

Road map

1. Quantitative Model
2. IRFs to mimic GFC
3. **Exchange rate moments**

Replicate Engel Wu empirical regression

$$\boldsymbol{\Delta s_{j,t}} = \alpha_j + \beta_0 s_{j,t-1} + \boldsymbol{\beta_1 \Delta \eta_{j,t} + \beta_2 \Delta (i - i^*)_{j,t}} + \beta_3 \eta_{j,t-1} + \beta_4 (i - i^*)_{j,t-1} + u_{j,t}$$

	G10 panel regression	**Model implied**
	Quarterly	Quarterly
$s_{j,t-1}$	-0.06**	-0.02
	(0.02)	
$\boldsymbol{\Delta \eta_{j,t}}$	**-1.65****	**-1.15**
	(0.76)	
$\boldsymbol{\Delta (i - i^*)_{j,t}}$	**-2.61*****	**-2.45**
	(0.97)	
$\eta_{j,t-1}$	-2.08**	-0.04
	(0.87)	
$(i - i^*)_{j,t-1}$	-0.44**	-0.02
	(0.22)	
N	739	14,900

Note: S.E. cluster by time

Exchange rate moments

	Data moment (Eurozone vs US)	Model implied
$\sigma(\Delta NER)/\sigma(\Delta y)$	3.6	2.5
$\sigma(\Delta NER)/\sigma(\Delta c)$	3.3	2.0
$\rho(RER)$	0.93	0.89
$Fama\ \beta$	-0.18	-0.03
Backus Smith correlation	0.05	0.16
Corr$(\Delta GDP, \Delta c)$	0.94	0.78
Corr$(\Delta GDP, \Delta I)$	0.81	0.66
Corr$(\Delta GDP, \Delta GDP^*)$	0.88	0.56

- Can match these untargeted moments reasonably well

Conclusion

- A DSGE model of endogenous convenience yield
- It takes a pretty standard NK model with one important new assumption
- **One single asymmetry – US bond is better collateral**
- Convenience yield links to banking friction – no exogenous yield / noise trader
- Matches US external positions and exchange rate dynamics well

Conclusion

- A DSGE model of endogenous convenience yield
- It takes a pretty standard NK model with one important new assumption
- **One single asymmetry – US bond is better collateral**
- Convenience yield links to banking friction – no exogenous yield / noise trader
- Matches US external positions and exchange rate dynamics well

THANK YOU