

A PREFERRED-HABITAT MODEL OF TERM PREMIA, EXCHANGE RATES, AND MONETARY POLICY SPILLOVERS

PIERRE-OLIVIER GOURINCHAS
IMF, UC BERKELEY, NBER, CEPR
pog@berkeley.edu

WALKER RAY
LSE, CEPR
w.d.ray@lse.ac.uk

DIMITRI VAYANOS
LSE, CEPR, NBER
d.vayanos@lse.ac.uk

Bank Of Mexico, July 2024

Motivation

Motivation

- Textbook international macro:
 - Uncovered Interest Parity (UIP) holds
 - The Expectation Hypothesis (EH) holds
- Empirically:
 1. Strong patterns in FX: currency carry trade is profitable \implies deviations from UIP
[Fama 1984...]
 2. Strong patterns in FI: bond carry trade is profitable \implies deviations from the EH
[Fama & Bliss 1987, Campbell & Shiller 1991...]
 3. Exchange rates disconnected from fundamentals; but important comovement in term premia and currency risk premia across countries
[Obstfeld & Rogoff 2001, Itskhoki & Mukhin 2021, Lustig et al 2019, Lloyd & Marin 2019, Chernov & Creal 2020...]
 4. Quantitative easing not only reduced domestic yields, but also had strong effects on exchange rates and foreign yields
[Bhattarai & Neely 2018...]

Motivation

- Making sense of these facts is important:
 - To understand what determines exchange rates (volatility, disconnect...)
 - To understand [monetary policy transmission](#), both domestically (along the yield curve)...
 - ...but also [via international spillovers](#), to exchange rates and foreign yields
- [This paper](#): introduce risk averse ‘[global rate arbitrageur](#)’ absorbing supply and demand shocks in bond and currency markets
 - FX and bond markets populated by different investor clienteles (pension funds, importers/exporters)
 - Arbitrageurs (hedge funds, dealer fixed income desk) partly overcome segmentation
- Formally: Two-country version of Vayanos & Vila’s (2021) [preferred-habitat model](#)
 - More generally, we build on a literature emphasizing the optimization of financial intermediaries and the constraints they face
[Gabaix & Maggiori 2015, Itskhoki & Mukhin 2019, Koijen & Yogo 2020, Greenwood et al 2023...]
 - Revives an older literature on portfolio-balance
[Kouri 1982, Jeanne & Rose 2002...]

Findings

1. Can reproduce **qualitative** and **quantitative** facts about the joint behavior of bond and currency risk premia
2. Rich transmission of monetary policy shocks via exchange rate and term premia, contrasting with standard models
3. **Key mechanisms:**
 - Shifts in arbitrageurs' risk exposure lead to changes in required risk compensation
 - Hedging behavior of **global** arbitrageurs \implies tight linkage between bond term premia and currency risk premia
 - In the presence of market segmentation, policy shocks (particularly **unconventional**) lead to large shifts in risk exposure
4. General message: **floating exchange rates provide limited insulation.**
Failure of Friedman-Obtsfeld-Taylor's Trilemma

Set-Up

Set-Up: Two-Country Vayanos & Vila (2021)

- Continuous time $t \in (0, \infty)$, 2 countries $j = H, F$
- Nominal exchange rate e_t : H price of F (increase \equiv depreciation of H 's currency)
- In each country j , continuum of zero coupon bonds in zero net supply with maturity $0 \leq \tau \leq T$, and $T \leq \infty$
- Bond price (in local currency) $P_{jt}^{(\tau)}$, with yield to maturity $y_{jt}^{(\tau)} = -\log P_{jt}^{(\tau)} / \tau$
- Nominal short rate ("monetary policy") $i_{jt} = \lim_{\tau \rightarrow 0} y_{jt}^{(\tau)}$ follows (exogenous, stochastic) mean-reverting process

Investors

- Home and foreign preferred-habitat **bond investors**
(hold bonds in a specific currency and maturity: $Z_{jt}^{(\tau)}$)
 - Eg, pension funds, money market mutual funds
 - Time-varying demand β_{jt} , **downward sloping** in terms of bond price (elasticity $\alpha_j(\tau)$)
- Preferred-habitat **currency traders**
(hold foreign currency: Z_{et})
 - Eg, importers/exporters
 - Time-varying demand γ_t , **downward sloping** in terms of exchange rate (elasticity α_e)
- **Global rate arbitrageurs**
(can trade in both currencies, in domestic and foreign bonds: $W_{Ft}, X_{Ht}^{(\tau)}, X_{Ft}^{(\tau)}$)
 - Eg, global hedge funds
 - Mean-variance preferences (risk aversion a)
 - Engage in **currency carry trade, domestic and foreign bond carry trade**

Global Rate Arbitrageur: Details

- Mean-variance optimization (limit of OLG model)

$$\begin{aligned} & \max \mathbb{E}_t(dW_t) - \frac{a}{2} \text{Var}_t(dW_t) \\ \text{s.t. } dW_t = & W_t i_{Ht} dt + W_{Ft} \left(\frac{de_t}{e_t} + (i_{Ft} - i_{Ht}) dt \right) \\ & + \int_0^T \chi_{Ht}^{(\tau)} \left(\frac{dP_{Ht}^{(\tau)}}{P_{Ht}^{(\tau)}} - i_{Ht} dt \right) d\tau + \int_0^T \chi_{Ft}^{(\tau)} \left(\frac{d(P_{Ft}^{(\tau)} e_t)}{P_{Ft}^{(\tau)} e_t} - \frac{de_t}{e_t} - i_{Ft} dt \right) d\tau \end{aligned}$$

- Wealth W_t :
 - W_{Ft} invested in country F short rate (CCT)
 - $\chi_{jt}^{(\tau)}$ invested in bond of country j and maturity τ (BCT _{j})
 - Remainder in country H short rate

Key Insight: Risk averse arbitrageurs' holdings increase with expected return

Preferred-Habitat Bond and FX Investors: Details

- Demand for bonds in currency j , of maturity τ :

$$Z_{jt}^{(\tau)} = -\alpha_j(\tau) \log P_{jt}^{(\tau)} - \theta_j(\tau) \beta_{jt}$$

- $\alpha_j(\tau)$: demand elasticity for τ investor in country j
- $\theta_j(\tau)$: how variations in factor β_{jt} affect demand for τ investor in country j
- Demand for foreign currency (spot):

$$Z_{et} = -\alpha_e \log e_t - \theta_e \gamma_t$$

- Can accommodate forward demand. Under CIP, equivalent to spot + H and F bond trades
- Exogenous bond and FX demand risk factors follow (exogenous, stochastic) mean-reverting processes

Key Insight: elastic habitat traders. Price movements require portfolio rebalancing

- Risk factors: short rates (dB_{ijt}), bond demands ($dB_{\beta jt}$) and currency demand ($dB_{\gamma t}$)
- State variables collected into vector $\mathbf{q}_t = \begin{bmatrix} i_{Ht} & i_{Ft} & \beta_{Ht} & \beta_{Ft} & \gamma_t \end{bmatrix}^\top$
- Dynamics:

$$d\mathbf{q}_t = -\boldsymbol{\Gamma}(\mathbf{q}_t - \bar{\mathbf{q}})dt + \boldsymbol{\sigma}d\mathbf{B}_t$$

- Affine solution:

$$-\log p_{jt}^{(\tau)} = \mathbf{A}_j(\tau)^\top \mathbf{q}_t + C_j(\tau), \quad -\log e_t = \mathbf{A}_e^\top \mathbf{q}_t + C_e$$

- Arbitrageurs' optimality conditions imply expected excess returns are given by:

$$\mathbb{E}_t dP_{jt}^{(\tau)} / P_{jt}^{(\tau)} - i_{jt} = \mathbf{A}_j(\tau)^\top \boldsymbol{\Lambda}_t, \quad \mathbb{E}_t de_t / e_t + i_{Ft} - i_{Ht} = \mathbf{A}_e^\top \boldsymbol{\Lambda}_t$$

$$\text{where } \boldsymbol{\Lambda}_t = a\boldsymbol{\Sigma} \left(W_{Ft}\mathbf{A}_e + \sum_{j=H,F} \int_0^T \chi_{jt}^{(\tau)} \mathbf{A}_j(\tau) d\tau \right)$$

- Endogenous coefficients $\mathbf{A}_j(\tau), \mathbf{A}_e$ govern sensitivity to market price of risk $\boldsymbol{\Lambda}_t$
- Model is closed through market clearing: $\chi_{jt}^{(\tau)} + Z_{jt}^{(\tau)} = 0$, $W_{Ft} + Z_{et} = 0$

Key Insight: market price of risk $\boldsymbol{\Lambda}_t$ depends on equilibrium holdings. Bond and currency premia jointly determined

Data Generating Process: Assumptions

- In order to derive analytical results, we assume **independent** short-rate processes, and non-stochastic demand factors:

$$di_{Ht} = \kappa_{iH}(\bar{i}_H - i_{Ht}) dt + \sigma_{iH} dB_{iHt}, \quad di_{Ft} = \kappa_{iF}(\bar{i}_F - i_{Ft}) dt + \sigma_{iF} dB_{iFt}$$

- For quantitative results, we can allow for **rich demand structure** embodied in dynamics of risk factors. DGP:

$$\mathbf{q}_t = \begin{bmatrix} i_{Ht} & i_{Ft} & \beta_{Ht} & \beta_{Ft} & \gamma_t \end{bmatrix}^\top$$
$$d\mathbf{q}_t = -\mathbf{\Gamma}(\mathbf{q}_t - \bar{\mathbf{q}}) dt + \mathbf{\sigma} d\mathbf{B}_t$$

Risk Neutral Global Arbitrageur

1. Benchmark: Risk Neutral Global Rate Arbitrageur (“Standard Model”)

Consider the benchmark case of a risk neutral global rate arbitrageur: $a = 0$

- Expectation Hypothesis holds:

$$\mathbb{E}_t dP_{Ht}^{(\tau)} / P_{Ht}^{(\tau)} = i_{Ht}, \quad \mathbb{E}_t dP_{Ft}^{(\tau)} / P_{Ft}^{(\tau)} = i_{Ft}$$

- No effect of QE on yield curve, at Home or Foreign
- Yield curve independent from foreign short rate shocks

- Uncovered Interest Parity holds:

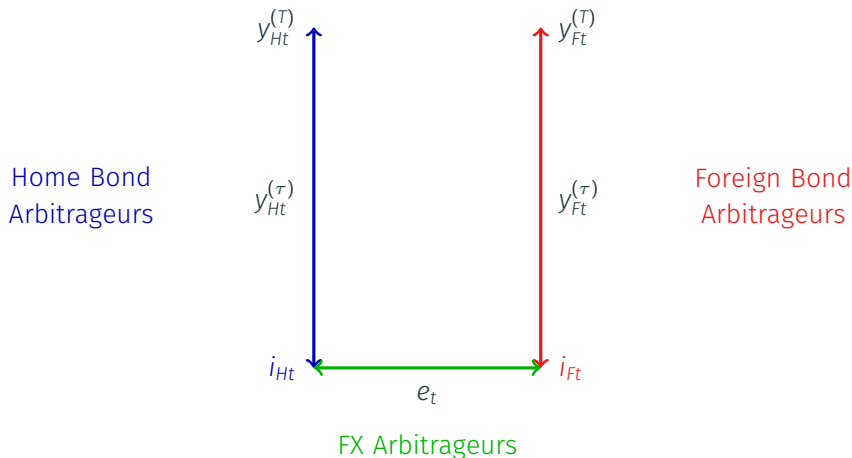
$$\mathbb{E}_t de_t / e_t = i_{Ht} - i_{Ft}$$

- ‘Mundellian’ insulation: shock to short rates ‘absorbed’ into the exchange rate
- Classical Trilemma: capital flows and floating exchange rates deliver monetary autonomy

Segmented Arbitrage

2. Intermediate Step: Segmented Arbitrage and No Demand Shocks

Assume foreign currency and bonds traded by **three disjoint sets of arbitrageurs**



2. Intermediate Step: Segmented Arbitrage and No Demand Shocks

Postulate: $\log P_{jt}^{(\tau)} = -A_{ij}(\tau)i_{jt} - C_j(\tau)$; $\log e_t = A_{iFe}i_{Ft} - A_{iHe}i_{Ht} - C_e$

Proposition (Segmented Arbitrage, Currency Carry Trade CCT and UIP Deviations)

When arbitrage is segmented, risk aversion $a > 0$ and FX price elasticity $\alpha_e > 0$

- Attenuation: $0 < A_{ije} < 1/\kappa_{ij}$
- CCT expected return $\mathbb{E}_t de_t / e_t + i_{Ft} - i_{Ht}$ decreases in i_{Ht} and increases in i_{Ft} (UIP deviation)

Intuition: Similar to Kouri (1982), Gabaix and Maggiori (2015)

- When $i_{Ht} \downarrow$ or $i_{Ft} \uparrow$, FX arbitrageurs want to invest more in the CCT
- Foreign currency appreciates ($e_t \uparrow$)
- As $e_t \uparrow$, price elastic FX traders ($\alpha_e > 0$) reduce holdings: $Z_{et} \downarrow$
- FX arbitrageurs increase their holdings $W_{Ft} \uparrow$, which requires a higher CCT return

2. Intermediate Step: Segmented Arbitrage and No Demand Shocks

Proposition (Segmented Arbitrage and Bond Carry Trade BCT)

When arbitrage is segmented, $a > 0$ and $\alpha(\tau) > 0$ in a positive-measure subset of $(0, T)$:

- Attenuation: $A_{ij}(\tau) < (1 - e^{-\kappa_{ij}\tau})/\kappa_{ij}$
- Bond prices in country j only respond to country j short rates (no spillover)
- BCT_j expected return $\mathbb{E}_t dP_{jt}^{(\tau)} / P_{jt}^{(\tau)} - i_{jt}$ decreases in i_{jt}

Intuition: Similar to Vayanos & Vila (2021)

- When $i_{jt} \downarrow$, bond arbitrageurs want to invest more in the BCT
- Bond prices increase ($P_{jt}^{(\tau)} \uparrow$)
- As $P_{jt}^{(\tau)} \uparrow$, price-elastic habitat bond investors ($\alpha_j(\tau) > 0$) reduce their holdings: $Z_{jt}^{(\tau)} \downarrow$
- Bond arbitrageurs increase their holdings $X_{jt}^{(\tau)} \uparrow$, which requires a larger BCT return

Macro Implications of the Segmented Model

Assume $a > 0$, $\theta_j(\tau) > 0$ and $\theta_e > 0$:

- Unexpected **increase in bond demand** in country j (QE_j) reduces yields in country j
- No effect on bond yields in the other country or on the exchange rate
 - QE purchases: $Z_{jt}^{(\tau)} \uparrow$
 - Bond arbitrageurs reduce holdings $X_{jt}^{(\tau)} \downarrow$, reducing risk exposure and pushing down yields
 - Arbitrageurs in other markets are unaffected

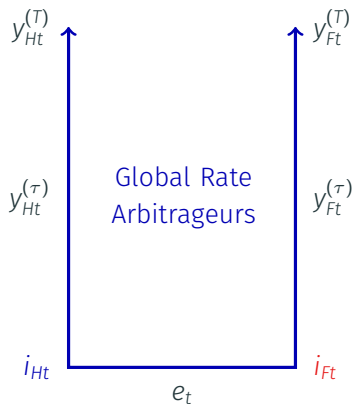
Open Economy Macro Implications:

- Changes in Home monetary conditions (conventional or QE) have no effect on the Foreign yield curve. **Full insulation**
- Insulation is even stronger in the case of QE: exchange rate is unchanged
- **Trilemma?** As we will see, this result arises because of markets segmentation (limited capital flows), not because of floating exchange rates

Global Arbitrage

3. Global Rate Arbitrageur and No Demand Shocks

Assume now [global rate arbitrageur](#) can invest in bonds (H and F) and FX




3. Global Rate Arbitrageur and No Demand Shocks

Postulate $\log P_{jt}^{(\tau)} = -A_{ijj}(\tau)i_{jt} - A_{ijj'}(\tau)i_{j't} - C_H(\tau)$; $\log e_t = A_{iFe}i_{Ft} - A_{iHe}i_{Ht} - C_e$

Proposition (Global Arbitrage and Carry Trades CCT, BCT)

When arbitrage is global, risk aversion $a > 0$ and price elasticities $\alpha_e, \alpha_j(\tau) > 0$:


- The results of the previous propositions obtain: both CCT and BCT_H return decrease with i_{Ht} , and attenuation is stronger than with segmented markets
-  In addition, BCT_F increases with i_{Ht}
- The effect of i_{jt} on bond yields is smaller in the other country: $A_{jj'}(\tau) < A_{jj}(\tau)$

Intuition: Bond and FX Premia Cross-Linkages

- When $i_{Ht} \downarrow$ global arbitrageurs want to invest more in CCT and BCT_H
- e_t and $W_{Ft} \uparrow$: increased FX exposure (risk of $i_{Ft} \downarrow$)
- Hedge by investing more in BCT_F since price of foreign bonds increases when i_{Ft} drops: foreign yields decline and BCT_F decreases

Macro Implications of Global Rate Arbitrageur Model

Assume $a > 0$ and $\alpha_e, \alpha_j(\tau) > 0$:

- Unexpected QE_H reduces yields in country H
-  Also reduces yields in country F , and depreciates the Home currency
 - Arbitrageurs decrease H bond exposure (less exposed to risk of $i_{Ht} \uparrow$)
 - More willing to hold assets exposed to this risk: increase holdings of F bonds and currency, pushing down F yields and depreciating the H currency

Open Economy Macro Implications:

- Changes in Home monetary conditions (conventional or QE) affect both yield curves and the exchange rate: potential spillovers from monetary policy. Imperfect insulation even with floating rates
- QE or FX interventions in one country affect monetary conditions in both countries and depreciate the currency
- Failure of the Classical Trilemma

The Full Model

The Full Model: Adding Demand Shocks

- Now we allow for **richer demand structure** of risk factors:

$$dq_t = -\mathbf{\Gamma}(q_t - \bar{q})dt + \mathbf{\sigma}dB_t$$

- We assume independent processes for all factors, except shocks to short rates may be correlated, and currency demand γ_t may respond to short rates

$$\mathbf{\Gamma} = \begin{bmatrix} \kappa_{iH} & 0 & 0 & 0 & 0 \\ 0 & \kappa_{iF} & 0 & 0 & 0 \\ 0 & 0 & \kappa_{\beta} & 0 & 0 \\ 0 & 0 & 0 & \kappa_{\beta} & 0 \\ \kappa_{\gamma,iH} & \kappa_{\gamma,iF} & 0 & 0 & \kappa_{\gamma} \end{bmatrix}, \quad \mathbf{\sigma} = \begin{bmatrix} \sigma_{iH} & 0 & 0 & 0 & 0 \\ \sigma_{iH,iF} & \sigma_{iF} & 0 & 0 & 0 \\ 0 & 0 & \sigma_{\beta} & 0 & 0 \\ 0 & 0 & 0 & \sigma_{\beta} & 0 \\ 0 & 0 & 0 & 0 & \sigma_{\gamma} \end{bmatrix}$$

- Numerical estimation**
 - Data:** Zero coupon data: US Treasuries (H) and German Bunds (F); exchange rate data: German mark/euro
 - Time period:** 1986-2021 (due to availability of long-term yields)
 - Main estimation strategy:** Maximum likelihood (MLE)
 - Alternative:** moment-matching (MM) via classical minimum distance targeting second moments of short/long term rates, exchange rates, and volumes

Maximum Likelihood

- Discretized **structural** model for time step Δt :

$$\begin{aligned}dq_t &= -\mathbf{\Gamma} (q_t - \bar{q}) dt + \boldsymbol{\sigma} dB_t \\ \implies q_{t+\Delta t} - \bar{q} &= e^{-\mathbf{\Gamma}\Delta t} (q_t - \bar{q}) + \boldsymbol{\varepsilon}_{t,t+\Delta t}\end{aligned}$$

- Gaussian structural shocks $\boldsymbol{\varepsilon}_{t,t+\Delta t}$: mean zero and variance-covariance matrix solves

$$\mathbf{\Gamma}\boldsymbol{\Sigma}_{\Delta t} + \boldsymbol{\Sigma}_{\Delta t}\mathbf{\Gamma}^\top = \boldsymbol{\Sigma} - e^{-\mathbf{\Gamma}\Delta t}\boldsymbol{\Sigma}e^{-\mathbf{\Gamma}^\top\Delta t}$$

- However, we only have **observation data**: $\mathbf{p}_t = \mathbf{A}q_t$
 - Endogenous matrix \mathbf{A} maps structural factors to observation data (yields, exchange rates)
- When \mathbf{A} is full column rank we have

$$\begin{aligned}\mathbf{B} &\equiv \mathbf{A}e^{-\mathbf{\Gamma}\Delta t}\mathbf{A}^+ \\ \implies \mathbf{p}_{t+\Delta t} &= \mathbf{B}\mathbf{p}_t + \mathbf{A}\boldsymbol{\varepsilon}_{t,t+\Delta t}\end{aligned}$$

Maximum Likelihood: Baseline

- Finally, need **functional form** for habitat demand and elasticity functions:

$$\alpha(\tau) = \alpha_0 e^{-\alpha_1 \tau}, \quad \theta(\tau) = \theta_0 \theta_1^2 \tau e^{-\theta_1 \tau}$$

- Estimate by maximizing likelihood. Baseline MLE choices:
 - Data \mathbf{p}_t : 1-year H and F rates, 10-year H and F rates, and exchange rate (so $\mathbf{A}^+ \equiv \mathbf{A}^{-1}$)
 - Quarterly data with $\Delta t = 1$ quarter
 - Technical issue: **volume moments** do not fit into the MLE framework
 - Thus, we fix shape parameters $\alpha_1 = 0.15, \theta_1 = 0.3$ based on Vayanos-Vila
- Results are robust to:
 - Alternative or additional inclusion of maturities
 - Alternative time frequencies
 - Alternative habitat shape parameters α_1, θ_1
 - Ad-hoc inclusion of volume targets and direct estimation of α_1, θ_1
 - Finally, MM gives highly similar results

MLE Baseline Estimate

Parameter	Value	Std. Err.
σ_{iH}	1.163	0.076
σ_{iF}	0.873	0.058
$\sigma_{iH,iF}$	0.338	0.081
κ_{iH}	0.145	0.058
κ_{iF}	0.140	0.046
κ_{β}	0.068	0.055
κ_{γ}	0.155	0.100
$\theta_e \kappa_{\gamma,iH}$	-0.148	0.117
$\theta_e \kappa_{\gamma,iF}$	0.184	0.131
$a\theta_0\sigma_{\beta}$	884.8	173.9
$a\theta_e\sigma_{\gamma}$	941.6	464.8
$a\alpha_0$	5.379	3.096
$a\alpha_e$	76.89	37.52

- For policy experiments: CRRA $\gamma = 2$ and arbitrageur wealth $\frac{W}{GDP_H} \approx 5\% \implies a = 40$
- Moment matching estimates: MM

Return Predictability Regressions

- Compare **return predictability regressions** in the model vs. data
 - **Bond** predictability: Fama-Bliss and Campbell-Shiller:

$$\frac{1}{\Delta\tau} \log \left(\frac{p_{j,t+\Delta\tau}^{(\tau-\Delta\tau)}}{p_{jt}^{(\tau)}} \right) - y_{jt}^{(\Delta\tau)} = \alpha_{FB} + \beta_{FB} \left(f_{jt}^{(\tau-\Delta\tau,\tau)} - y_{jt}^{(\Delta\tau)} \right) + e_{t+\Delta\tau}$$
$$y_{j,t+\Delta\tau}^{(\tau-\Delta\tau)} - y_{jt}^{(\tau)} = \alpha_{CS} + \beta_{CS} \frac{\Delta\tau}{\tau - \Delta\tau} \left(y_{jt}^{(\tau)} - y_{jt}^{(\Delta\tau)} \right) + e_{t+\Delta\tau}$$

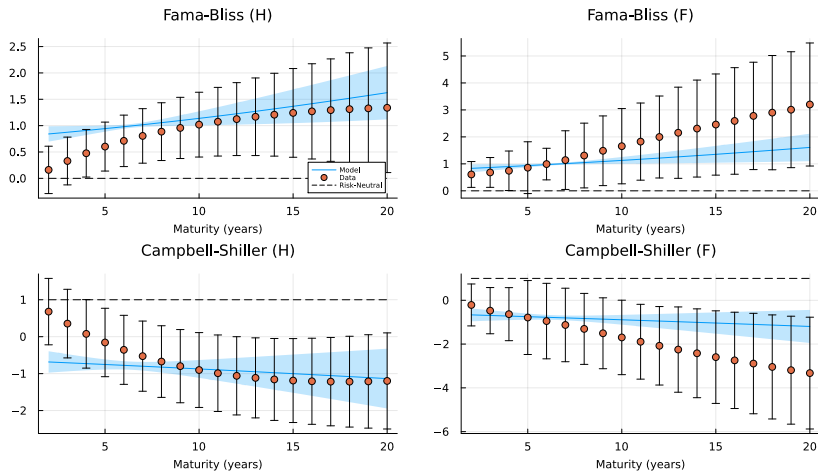
- **FX** predictability: Fama and Chinn-Meredith:

$$\frac{1}{\Delta\tau} \log \left(\frac{e_t}{e_{t+\Delta\tau}} \right) = \alpha_{UIP} + \beta_{UIP} \left(y_{Ft}^{(\Delta\tau)} - y_{Ht}^{(\Delta\tau)} \right) + e_{t+\Delta\tau}$$

- **FX-Bond** predictability: Lustig-Stathopoulos-Verdelhan, Chernov-Creal, Lloyd-Marin

$$\frac{1}{\Delta\tau} \log \left(\frac{p_{F,t+\Delta\tau}^{(\tau-\Delta\tau)} e_{t+\Delta\tau}}{p_{Ft}^{(\tau)} e_t} \right) - \frac{1}{\Delta\tau} \log \left(\frac{p_{H,t+\Delta\tau}^{(\tau-\Delta\tau)}}{p_{Ht}^{(\tau)}} \right) = \alpha_{LSV} + \beta_{LSV} \left(y_{Ft}^{(\Delta\tau)} - y_{Ht}^{(\Delta\tau)} \right) + e_{t+\Delta\tau}$$
$$\frac{1}{\Delta\tau} \log \left(\frac{e_t}{e_{t+\Delta\tau}} \right) = \alpha_{UIP-LS} + \beta_L \left(y_{Ft}^{(\Delta\tau)} - y_{Ht}^{(\Delta\tau)} \right) + \beta_S \left[\left(y_{Ft}^{(\tau_2)} - y_{Ft}^{(\tau_1)} \right) - \left(y_{Ht}^{(\tau_2)} - y_{Ht}^{(\tau_1)} \right) \right] + e_{t+\Delta\tau}$$

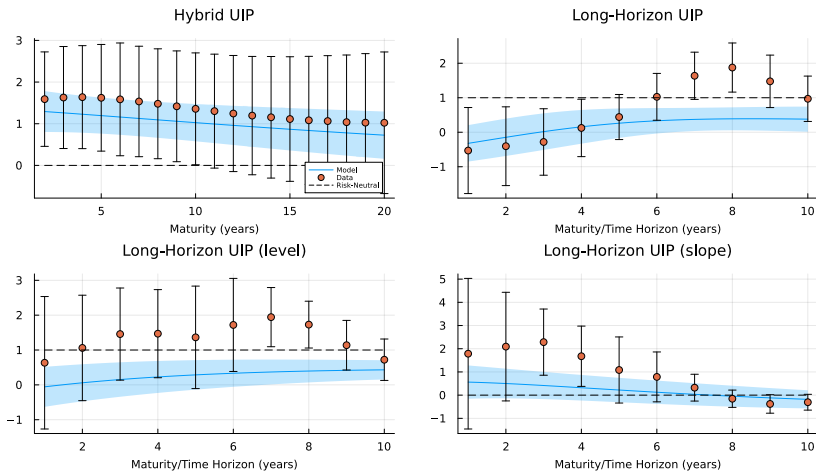
MLE Regression Coefficients: Term Structure



Moment-matching results: MM

- **Implications:** Positive slope-premia relationship
- **Intuition:** positive slope predicts higher bond returns for two main reasons:
 - Due to **elastic bond habitat traders**, an increase in the short rate implies long-term yields **under-react** and arbitrageurs require **less risk compensation**
 - When **habitat demand is low**, long-term yields are **high** and arbitrageurs require **more risk compensation**

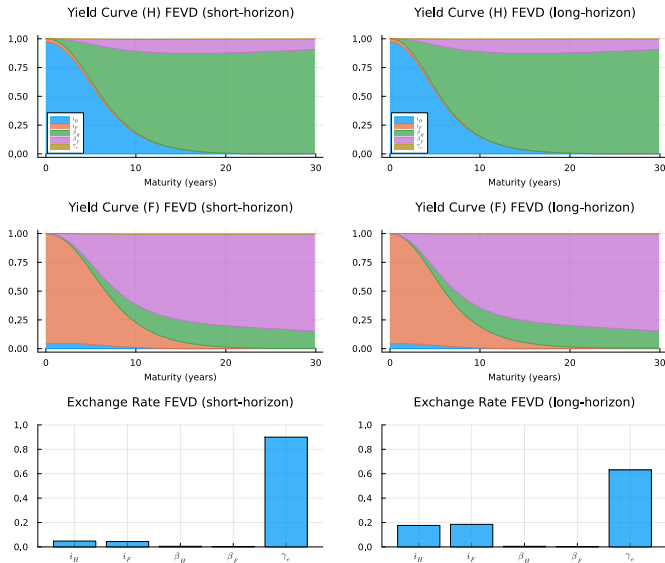
MLE Regression Coefficients: UIP



Moment-matching results: MM

- **Implications:** CCT is profitable, but profitability goes to zero if CCT is done with long-term bonds
- **Intuition:** Due to **elastic currency traders**, an increase in the foreign short rate implies foreign currency appreciates and arbitrageurs require **more risk compensation**
- However, long-maturity bond returns **underperform** in high short-rate countries, hence the CCT is most profitable when conducted with short-term bonds
- **Implications:** High slope differential predicts lower CCT return
- **Intuition:** when **habitat demand is low** for foreign bonds, long-term foreign yields are **high**; foreign yield curve is **steeper** than home yield curve
- Additionally, the low demand causes appreciation of foreign currency today and an **expected depreciation**, implying **low expected returns** for the CCT

Variance Decomposition

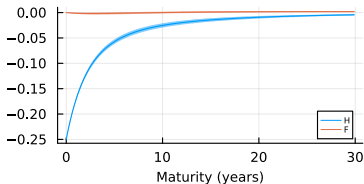


Policy Spillovers

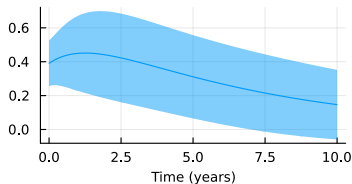
- **Monetary policy shock:** unanticipated and idiosyncratic 25bp decrease in policy rate
 - Zero-probability shock
 - Half-life \approx 1 year
- **QE shock:** unanticipated and idiosyncratic positive demand shock = 10% of GDP
 - Zero-probability shock
 - Half-life \approx 7 years
- **FXI shock:** unanticipated and idiosyncratic foreign exchange intervention shock = 10% of GDP
 - Zero-probability shock
 - Half-life \approx 1 year
- Use the model to examine **spillovers:**
 - Across the yield curves (short and long rates; and across countries)
 - To the exchange rate

Monetary Shock Spillovers

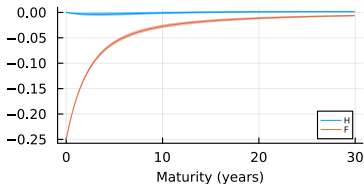
Yield Curve Response to H Shock



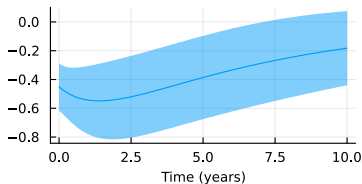
Exchange Rate Response to H Shock



Yield Curve Response to F Shock



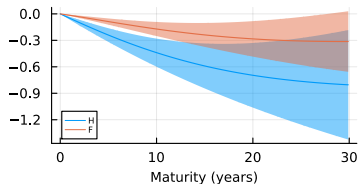
Exchange Rate Response to F Shock



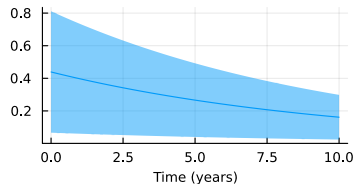
Implications: Small cross-country yield spillovers of conventional policy; exchange rate “delayed overshooting” MM

QE Shock Spillovers

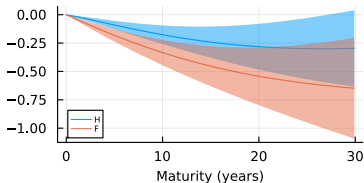
Yield Curve Response to H Shock



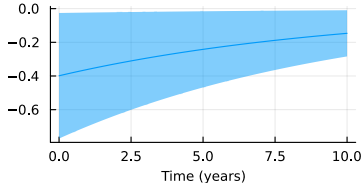
Exchange Rate Response to H Shock



Yield Curve Response to F Shock

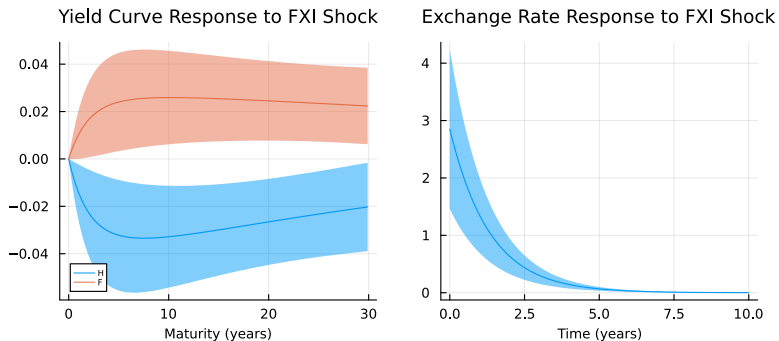


Exchange Rate Response to F Shock



Implications: Large yield spillovers of QE; modest exchange rate depreciation MM

FXI Shock Spillovers



Implications: Large exchange rate response to FXI; but small yield curve spillovers

MM

Policy Spillovers

- **Puzzle?** Long-maturity yields **connected** despite **disconnect** with exchange rate
 - With short rate shocks only: bond demand spillovers are via arbitrageur FX hedging
 - Bond demand risk **strengthens** H and F long-maturity yield comovement (as bond demand shocks move H and F yields in the same direction)
 - However, comovement between yields and exchange rate is **unaffected** (as bond demand shocks move the exchange rate in opposite directions)
 - Currency demand risk **weakens** exchange rate and yield comovements (as currency demand shocks move H and F yields in opposite directions)
- Model generates simultaneously: positive comovement in bond yields across countries, transmission of bond demand shocks through the currency market, and exchange-rate disconnect

Concluding Remarks

- Present an **integrated framework** to understand term premia and currency risk
- Resulting model ties together
 - Deviations from Uncovered Interest Parity
 - Deviations from Expectation Hypothesis
 - Joint behavior of currency/bond return predictability
- **Rich transmission of monetary policy** domestically and abroad via FX and term premia
- Extensions:
 - Embed into a standard open-economy NK model
 - \implies endogenizing policy rates as in Ray, Droste, & Gorodnichenko (2023), Ray (2019)
 - Allow for deviations from LOP as in Hebert, Du & Wang (2019)
 - \implies introducing holding costs into the preferred habitat framework

Thank You!

Equilibrium Details: Solution Characterization

- Substitute market clearing into arbitrageur optimality conditions, collect \mathbf{q}_t terms:

$$\mathbf{A}'_j(\tau) + \mathbf{M}\mathbf{A}_j(\tau) - \mathbf{e}_j = \mathbf{0}, \quad \mathbf{M}\mathbf{A}_e - (\mathbf{e}_H - \mathbf{e}_F) = \mathbf{0} \quad (\text{where } \mathbf{e}_j^\top \mathbf{q}_t = i_{jt})$$

- The matrix \mathbf{M} is defined as

$$\begin{aligned} \mathbf{M} = \boldsymbol{\Gamma}^\top - a \bigg\{ & \int_0^T [-\alpha_H(\tau)\mathbf{A}_H(\tau) + \boldsymbol{\Theta}_H(\tau)] \mathbf{A}_H(\tau)^\top d\tau \\ & + \int_0^T [-\alpha_F(\tau)\mathbf{A}_F(\tau) + \boldsymbol{\Theta}_F(\tau)] \mathbf{A}_F(\tau)^\top d\tau \\ & + [-\alpha_e\mathbf{A}_e + \boldsymbol{\Theta}_e] \mathbf{A}_e^\top \bigg\} \boldsymbol{\Sigma} \end{aligned} \quad (1)$$

- Initial conditions $\mathbf{A}_j(0) = \mathbf{0}$. Hence

$$\mathbf{A}_j(\tau) = [\mathbf{I} - e^{-\mathbf{M}\tau}] \mathbf{M}^{-1} \mathbf{e}_j \quad (2)$$

$$\mathbf{A}_e = \mathbf{M}^{-1}(\mathbf{e}_H - \mathbf{e}_F) \quad (3)$$

Equilibrium Details: Existence and Uniqueness

- Note: \mathbf{M} appears on both sides of equation (1), through the solution of the affine coefficients (2), (3)
 - Interpretation: risk-adjusted dynamics of the risk factors
- In general: system of J^2 nonlinear equations in J^2 unknowns, where $J = \dim \mathbf{q}_t$
- Under risk neutrality ($a = 0$), the solution is simple: $\mathbf{M} = \mathbf{\Gamma}^\top$
- When $a > 0$, the solution may not exist, or there may be multiple equilibria
- Can show (using IFT) that in a neighborhood of $a = 0$, the solution exists and is (locally) unique. Beyond that, very difficult to prove anything analytically in the fully general version of the model
- Numerically: solve via continuation as $\uparrow a$ (more stable, and serves as equilibrium selection device)

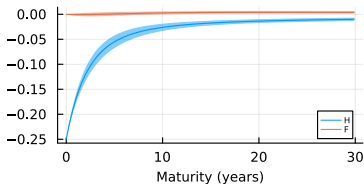
Moment-Matching Results

Parameter	Value	Std. Err.
σ_{iH}	1.429	0.148
σ_{iF}	0.751	0.140
$\sigma_{iH,iF}$	1.054	0.083
κ_{iH}	0.126	0.030
κ_{iF}	0.090	0.020
κ_{β}	0.050	0.009
κ_{γ}	0.134	0.102
$\theta_e \kappa_{\gamma,iH}$	-0.267	0.550
$\theta_e \kappa_{\gamma,iF}$	0.252	0.528
$a\theta_0\sigma_{\beta}$	648.9	80.27
$a\theta_e\sigma_{\gamma}$	762.7	1067.0
$a\alpha_0$	4.740	3.302
$a\alpha_e$	73.38	106.3
α_1	0.144	0.031
θ_1	0.374	0.014

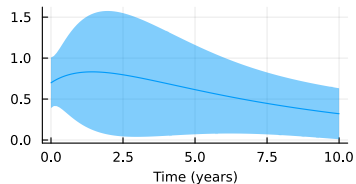
- MM point estimates very similar to MLE point estimates (but wider SEs) [back](#)

Moment-Matching Monetary Shock Spillovers

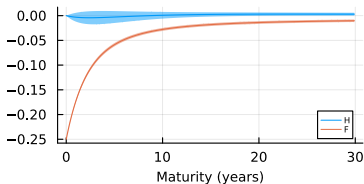
Yield Curve Response to H Shock



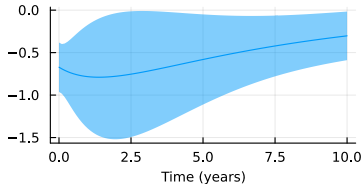
Exchange Rate Response to H Shock



Yield Curve Response to F Shock

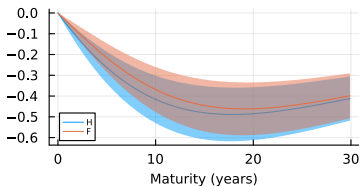


Exchange Rate Response to F Shock

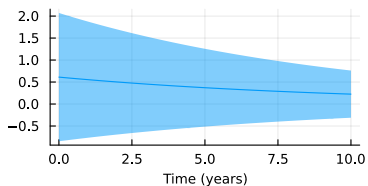


Moment-Matching QE Shock Spillovers

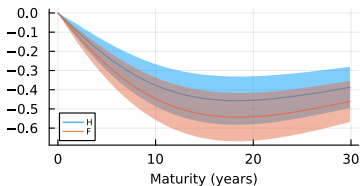
Yield Curve Response to H Shock



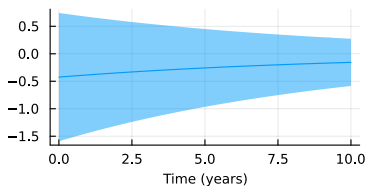
Exchange Rate Response to H Shock



Yield Curve Response to F Shock

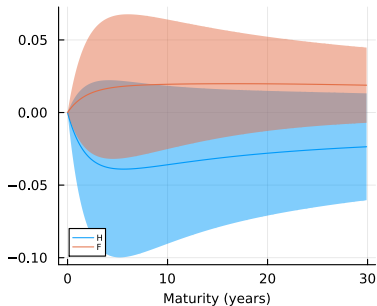


Exchange Rate Response to F Shock



Moment-Matching FXI Shock Spillovers

Yield Curve Response to FXI Shock



Exchange Rate Response to FXI Shock

