

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

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# Motivation

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- 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. The two risk premia are **deeply connected**  
[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, fixed income desk of broker-dealer) 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 2022...]

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

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## 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

# Arbitrageurs and Preferred-Habitat 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  $\beta_{jt}$ , **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  $\gamma_t$ , **downward sloping** in terms of exchange rate (elasticity  $\alpha_e$ )
- **Global rate arbitrageurs**  
(can trade in both currencies, in domestic and foreign bonds:  $W_{Ft}, X_{jt}(\tau)$ )
  - Eg, global hedge funds
  - Mean-variance preferences (risk aversion  $a$ )
  - Engage in **currency carry trade, domestic and foreign bond carry trade**



- **Market clearing:** arbitrageurs take the opposite position of habitat investors

$$Z_{et} + W_{Ft} = 0, \quad Z_{jt}(\tau) + X_{jt}(\tau) = 0$$

- **Equilibrium:** portfolio allocations simultaneously satisfy arbitrageurs' optimality conditions while habitat investors lie on demand curves
  - ⇒ **Market price of risk** will therefore depend on equilibrium holdings
- **Risk factors:** short rates, bond habitat demand, and currency habitat demand

**Key insight:** when arbitrageurs integrate markets, **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:

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

# Risk Neutral Global Arbitrageur

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# 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:

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

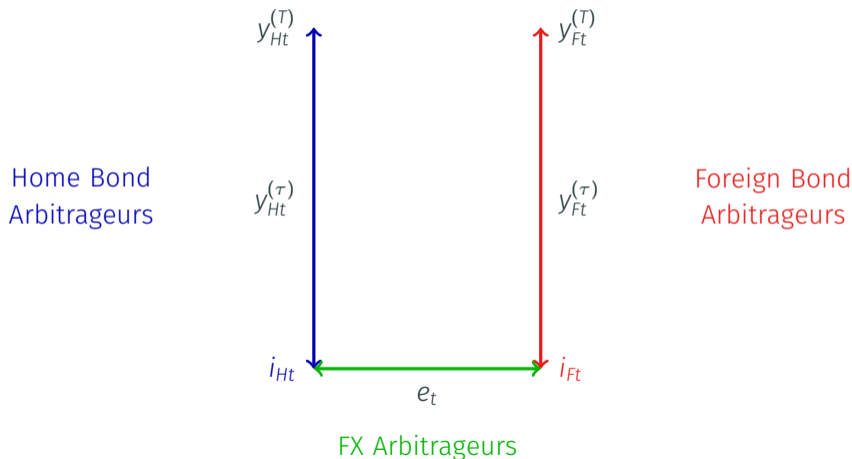
- ‘Mundellian’ insulation: shock to short rates ‘absorbed’ into the exchange rate
- Classical Trilemma: capital flows and floating exchange rates deliver monetary autonomy

# Segmented Arbitrage

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## 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:

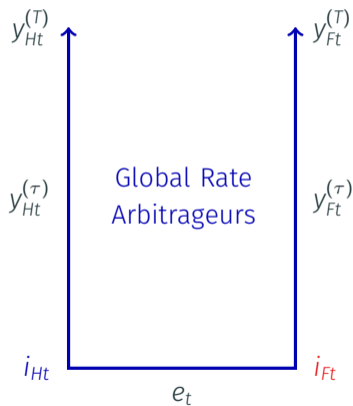
- Changes in Home monetary conditions (conventional or QE) have no effect on the Foreign yield curve. **Full insulation**
- Insulation is even stronger in the case of QE: exchange rate is unchanged
- **Trilemma?** As we will see, this result arises because of markets segmentation (limited capital flows),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

# Global Arbitrage

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### 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:  $A_{ijj'}(\tau) < A_{ijj}(\tau)$

#### 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

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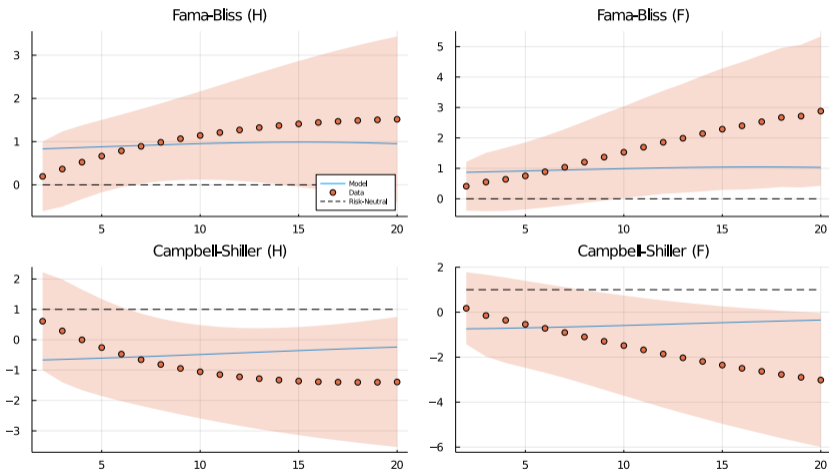
# The Full Model: Adding Demand Shocks

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

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

- We assume independent processes for all factors, except shocks to short rates may be correlated, and currency demand  $\gamma_t$  may respond to short rates
- **Numerical calibration** details
  - **Data:** Zero coupon data: US Treasuries ( $H$ ) and German Bunds ( $F$ ); exchange rate data: German mark/euro
  - **Targets:** second moments of short/long term rates, exchange rates, and volumes
- **Return predictability** (untargeted)
  - Bond returns and slope of the term structure
  - Currency returns and UIP
  - Cross-country bond and currency returns

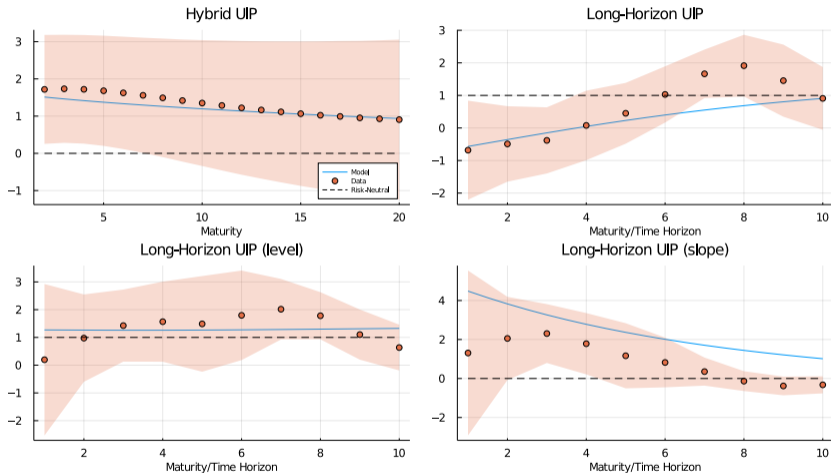
# Regression Coefficients: Term Structure



Implications: Positive slope-premia relationship



# Regression Coefficients: UIP



**Implications:** CCT is profitable, but profitability goes to zero if CCT is done with long-term bonds or over long horizon. Slope differential predicts CCT return

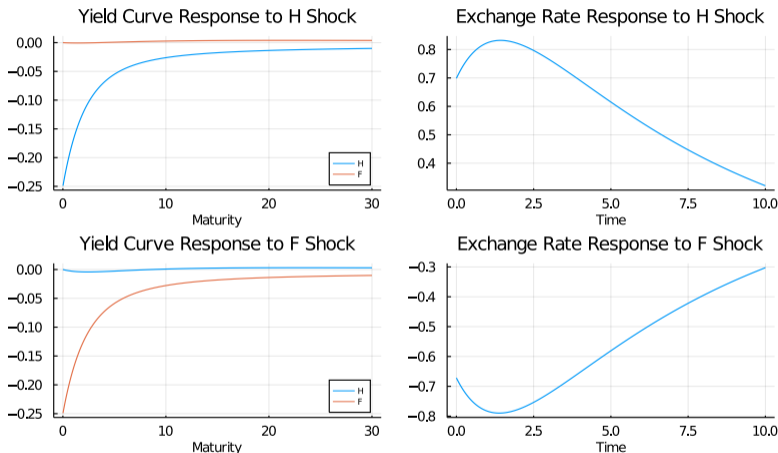
Conduct policy experiments:

- **Monetary policy shock:** unanticipated and idiosyncratic 25bp decrease in policy rate
- **QE shock:** unanticipated and idiosyncratic positive demand shock = 10% of GDP

Examine **spillovers:**

- Across the yield curves (short and long rates; and across countries)
- To the exchange rate

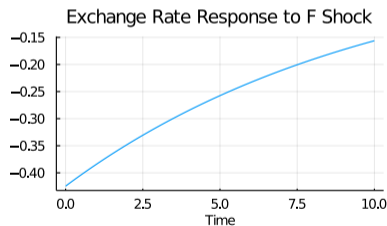
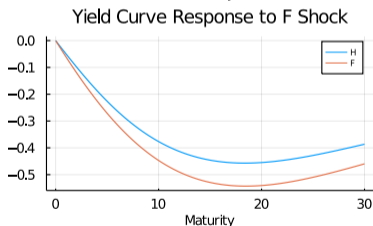
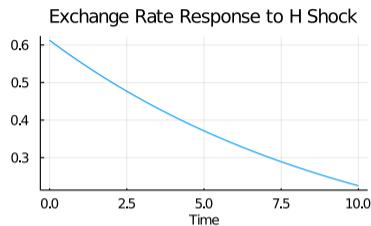
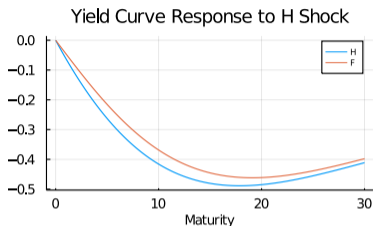
# Monetary Shock Spillovers



**Implications:** small cross-country yield response; exchange rate “delayed overshooting”

- **Intuition:** correlated short rates, currency demand response

# QE Shock Spillovers



Implications: large spillovers of QE, both to foreign yields and exchange rate

- Intuition: correlated short rates, elastic currency traders

## 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
- **Rich transmission of monetary policy** domestically and abroad via FX and term premia
- Extensions:
  - (a) Endogenize policy rates as in Ray (2019), Droste, Gorodnichenko, & Ray (2022)
  - (b) Consider deviations from LOP as in Hebert, Du & Wang (2019)
  - (c) Consider additional unconventional monetary policy and official interventions

Thank You!

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# Global Rate Arbitrageur

- Mean-variance optimization (limit of OLG model)

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

- Wealth  $W_t$ :
  - $W_{Ft}$  invested in country  $F$  short rate (CCT)
  - $X_{jt}^{(\tau)}$  invested in bond of country  $j$  and maturity  $\tau$  (BCT <sub>$j$</sub> )
  - Remainder in country  $H$  short rate

Key Insight: Risk averse arbitrageurs' holdings increase with expected return [back](#)

# Preferred-Habitat Bond and FX Investors

- Demand for bonds in currency  $j$ , of maturity  $\tau$ :

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

- $\alpha_j(\tau)$ : demand elasticity for  $\tau$  investor in country  $j$
  - $\theta_j(\tau)$ : how variations in factor  $\beta_{jt}$  affect demand for  $\tau$  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:

$$d\beta_{jt} = -\kappa_{\beta j} \beta_{jt} dt + \sigma_{\beta j} dB_{\beta jt}, \quad d\gamma_t = -\kappa_{\gamma} \gamma_t dt + \sigma_{\gamma} dB_{\gamma t}$$

Key Insight: elastic habitat traders. Price movements require portfolio rebalancing [back](#)



# Equilibrium

- Risk factors: short rates ( $dB_{ijt}$ ), bond demands ( $dB_{\beta jt}$ ) and currency demand ( $dB_{\gamma t}$ )
- Arbitrageurs' optimality conditions imply expected excess returns are given by:

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

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

- 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:  $X_{jt}^{(\tau)} + Z_{jt}^{(\tau)} = 0$ ,  $W_{Ft} + Z_{et} = 0$

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

# Numerical Calibration

- **Data:** Zero coupon data: US Treasuries ( $H$ ) and German Bunds ( $F$ ); exchange rate data: German mark/euro
- **Targets:** second moments of short/long term rates, exchange rates, and volumes

Parameter	Value	Parameter	Value	Parameter	Value
$\kappa_{iH}$	0.126	$\kappa_\gamma$	0.134	$a\sigma_\beta\theta_0$	90.6
$\kappa_{iF}$	0.0896	$\kappa_{\gamma,iH}$	-0.267	$a\alpha_e$	73.4
$\sigma_{iH}$	1.43	$\kappa_{\gamma,iF}$	0.252	$a\alpha_0$	4.74
$\sigma_{iF}$	0.751	$a\sigma_\gamma\theta_e$	763.0	$\alpha_1$	0.144
$\sigma_{iH,iF}$	1.05	$\kappa_\beta$	0.0501	$\theta_1$	0.374

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

# Model Fit: Short Rates and Exchange Rates

Moment	Data	Model	Moment	Data	Model
$\sigma \left( y_{Ht}^{(1)} \right)$	2.622	2.614	$\rho \left( \Delta \log e_t, (y_{Ht}^{(1)} - y_{Ft}^{(1)}) \right)$	-0.105	-0.096
$\sigma \left( \Delta y_{Ht}^{(1)} \right)$	1.273	1.254	$\rho \left( \Delta \log e_t, \Delta y_{Ht}^{(1)} \right)$	-0.095	-0.214
$\sigma \left( y_{Ft}^{(1)} \right)$	2.822	2.853	$\rho \left( \Delta \log e_t, \Delta y_{Ft}^{(1)} \right)$	0.048	0.071
$\sigma \left( \Delta y_{Ft}^{(1)} \right)$	1.09	1.174	$\rho \left( \Delta^{(5)} \log e_t, (y_{Ht}^{(5)} - y_{Ft}^{(5)}) \right)$	0.12	0.06
$\sigma \left( (y_{Ht}^{(1)} - y_{Ft}^{(1)}) \right)$	1.816	1.717	$\tilde{V}_H(0 \leq \tau \leq 3)$	0.361	0.378
$\sigma \left( \Delta \log e_t \right)$	10.186	10.183	$\tilde{V}_H(11 \leq \tau \leq 30)$	0.08	0.116

# Model Fit: Long Rates

