London Junior Macro Conference

Walker Ray
LSE
w.d.ray@lse.ac.uk

Research Agenda

Financial Frictions and Monetary Policy

How does monetary policy interact with market segmentation and limits to arbitrage?

- (theory) preferred habitat in GE, international; conventional vs. unconventional policy
  [with Pierre-Olivier Gourinchas, Dimitri Vayanos]
- (empirical) identifying demand shocks in bond markets; testing model predictions
  [with Michael Droste, Yuriy Gorodnichenko]

Deviations from FIRE

How do agents form and act on their beliefs about the economy?

- (empirical) HH expectations, consumption, and political polarization
  [with Rupal Kamdar]
- (theory) information-processing frictions
  [with Rupal Kamdar, Nick Sander, Maxime Sauzet]

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
w.d.ray@lse.ac.uk

Dimitri Vayanos
LSE, CEPR, NBER
d.vayanos@lse.ac.uk

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Motivation

- Four broad empirical facts
  1. Strong patterns in currency returns: deviations from Uncovered Interest Parity (UIP) (Fama 1984...)
  2. Strong patterns in the term structure: deviations from the Expectation Hypothesis (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 (which affects term premia) seems to have strong effect on exchange rates even with policy rates unchanged at the ZLB...

- Making sense of these facts is important
  - To understand what determines exchange rates (volatility, disconnect...)
  - To understand how monetary policy transmits domestically (along the yield curve)...
  - ...but also internationally, via exchange rates and the foreign yield curve (spillovers)

Motivation

- On the theory side:
  - Standard representative agent no-arbitrage models have a hard time
  - Recent literature emphasizes the optimization of financial intermediaries and the constraints they face (Gabaix & Maggiori 2015, Itskhoki & Mukhin 2019, Koijen & Yogo 2020)
  - Revives an old literature on portfolio-balance (Kouri 1982, Jeanne & Rose 2002)
- 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
  - Contemporaneous paper by Greenwood et al (2022) in discrete time with two bonds

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 $\Longrightarrow$ 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: 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") $i_{jt} = \lim_{\tau \to 0} y_{jt}^{(\tau)}$ 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 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: $W_{Ft}, X_{jt}(\tau)$)
  - Eg, global hedge funds
  - Mean-variance preferences (risk aversion a)
  - Engage in currency carry trade, domestic and foreign bond carry trade

details

Equilibrium

- 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

  $\Longrightarrow$ 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

details

Standard Model: Risk Neutral Global Rate Arbitrageur

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

- Expectation Hypothesis holds:

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

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

- Uncovered Interest Parity holds:

$$\mathbb{E}_t \, \mathrm{d}e_t / e_t = i_{Ht} - i_{Ft}$$

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

Imperfect Arbitrage: Deviations from UIP

Deviations from UIP: when arbitrageurs have imperfect risk-bearing capacity, CCT earns excess expected returns

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

Imperfect Arbitrage: Deviations from EH

Deviations from EH: when arbitrageurs have imperfect risk-bearing capacity, BCT earns excess expected returns

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

Imperfect Arbitrage: Term and FX Premia Spillovers

Bond and FX Premia Spillovers: when *global* arbitrageurs have imperfect risk-bearing capacity, FX premia and H/F term premia are linked

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

Imperfect Arbitrage: Macro Implications

- 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

Quantitative Model: Adding Demand Shocks

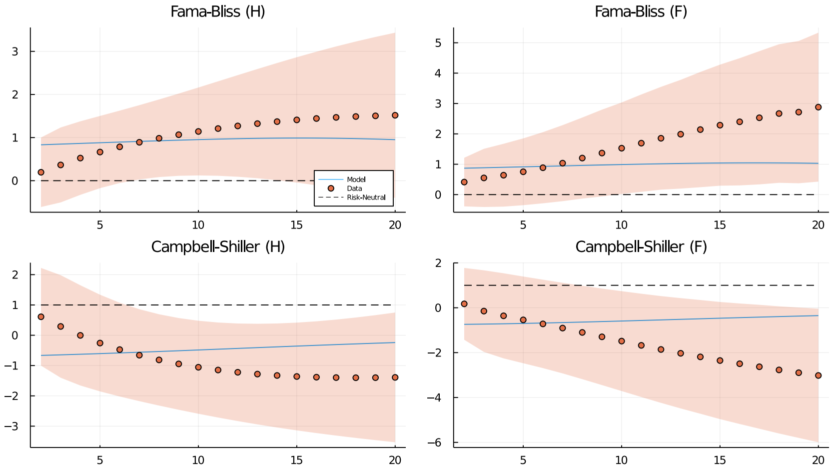
- Can allow for rich demand structure embodied in dynamics of risk factors. DGP:

$$\mathbf{q}_t = \begin{bmatrix} i_{Ht} & i_{Ft} & \beta_{Ht} & \beta_{Ft} & \gamma_t \end{bmatrix}^\top$$

$$\mathrm{d}\mathbf{q}_t = -\boldsymbol{\Gamma}\left(\mathbf{q}_t - \overline{\mathbf{q}}\right)\mathrm{d}t + \boldsymbol{\sigma}\,\mathrm{d}\mathbf{B}_t$$

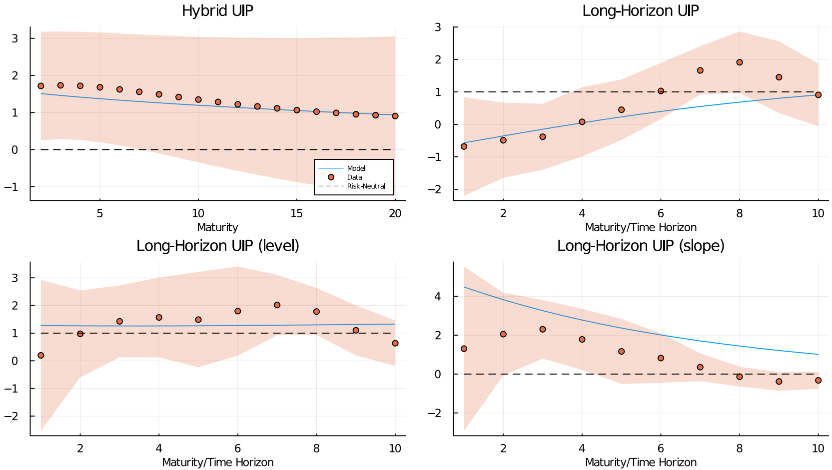
- Numerical calibration details
  - Data: Zero coupon data: US Treasuries (H) and German Bunds (F); exchange rate data: German mark/euro
  - Targets: second moments of short/long term rates, exchange rates, and volumes
- Return predictability (untargeted)
  - Bond returns and slope of the term structure (Fama & Bliss 1987, Campbell & Shiller 1991)
  - Currency returns and UIP (Fama 1984, Chinn & Meredith 2004)
  - Cross-country bond and currency returns (Lustig, Stathopoulos & Verdelhan 2019, Chernov & Creal 2020, Lloyd & Marin 2019)

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

Policy Spillovers

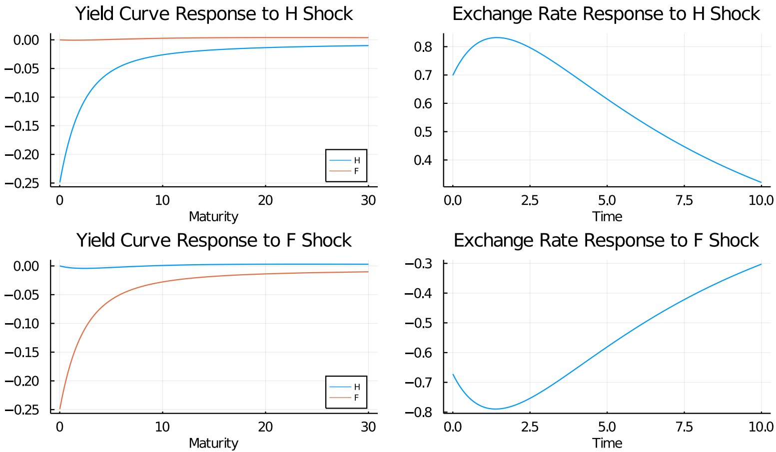
Conduct policy experiments:

- 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

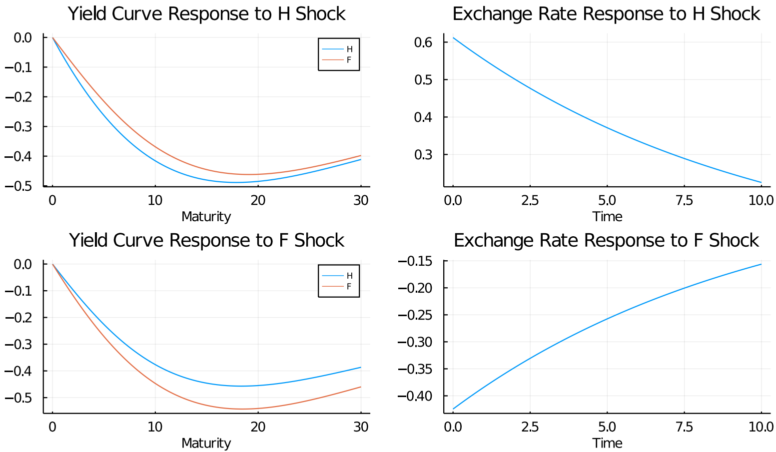
Monetary Shock Spillovers



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!

Global Rate Arbitrageur

- Mean-variance optimization (limit of OLG model)

$$\max \mathbb{E}_t(\mathrm{d}W_t) - \frac{a}{2}\mathbb{V}\mathrm{ar}_t(\mathrm{d}W_t)$$

$$\text{s.t.}\ \ \mathrm{d}W_t = W_t i_{Ht}\,\mathrm{d}t + W_{Ft}\left(\frac{\mathrm{d}e_t}{e_t} + (i_{Ft} - i_{Ht})\,\mathrm{d}t\right) + \int_0^T X_{Ht}^{(\tau)}\left(\frac{\mathrm{d}P_{Ht}^{(\tau)}}{P_{Ht}^{(\tau)}} - i_{Ht}\,\mathrm{d}t\right)\mathrm{d}\tau + \int_0^T X_{Ft}^{(\tau)}\left(\frac{\mathrm{d}(P_{Ft}^{(\tau)}e_t)}{P_{Ft}^{(\tau)}e_t} - \frac{\mathrm{d}e_t}{e_t} - i_{Ft}\,\mathrm{d}t\right)\mathrm{d}\tau$$

- Wealth W_t:
  - W_{Ft} invested in country F short rate (CCT)
  - $X_{jt}^{(\tau)}$ 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

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Preferred-Habitat Bond and FX Investors

- 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:

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

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

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Equilibrium

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

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

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

- 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

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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
κ_{iH}	0.126	κ_γ	0.134	$a\sigma_\beta\theta_0$	90.6
κ_{iF}	0.0896	$\kappa_{\gamma,iH}$	-0.267	$a\alpha_e$	73.4
σ_{iH}	1.43	$\kappa_{\gamma,iF}$	0.252	$a\alpha_0$	4.74
σ_{iF}	0.751	$a\sigma_\gamma\theta_e$	763.0	α_1	0.144
$\sigma_{iH,iF}$	1.05	κ_β	0.0501	θ_1	0.374

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

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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

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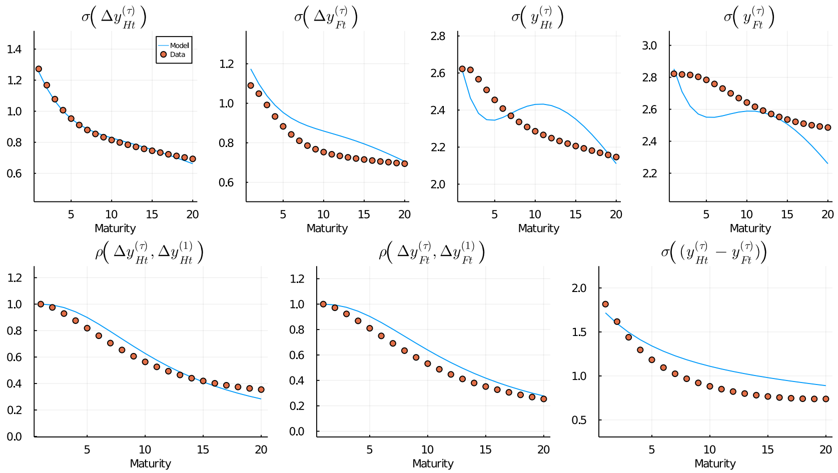
Model Fit: Long Rates



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