Monetary Policy, Segmentation, and the Term Structure

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Motivation

- Understanding monetary policy transmission to the entire yield curve is crucial
- Empirical evidence: yield curve reactions to monetary shocks feature strong departures from textbook predictions. Examples:
- Strong return predictability patterns
  - Fama & Bliss (1987), Campbell & Shiller (1991), ...
- Unconventional monetary policy reactions
  - Krishnamurthy & Vissing-Jorgensen (2011), Campbell et al (2012), ...
- Short-run overreaction of long-term yields to conventional policy rate surprises
  - Hanson & Stein (2015), Hanson Lucca & Wright (2021), ...

Model Predictions

- Standard representative agent models
  - Return predictability ✗
  - Unconventional policy ✗
  - Overreaction of long-term yields ✗
- Existing preferred habitat models can make sense of some, but not all puzzles
  - Return predictability ✓
  - Unconventional policy ✓
  - Overreaction of long-term yields ✗
- Why?

Textbook Model

- Textbook macro-finance models imply that the term structure is determined by the expectations hypothesis. For our purposes, sufficient to note:
- Expected excess returns are zero

$$E_t \frac{\mathrm{d}P_t^{(\tau)}}{P_t^{(\tau)}} = i_t \, \mathrm{d}t$$

- Changes in forward rates are unbiased predictors of changes in future short rates following a policy shock

$$\frac{\partial f_t^{(\tau)}}{\partial i_t} = \frac{\partial E_t i_{t+\tau}}{\partial i_t}$$

- Implies usual results (eg, QE neutrality results)

Preferred Habitat: Vayanos-Vila

- Vayanos-Vila preferred habitat model: bond prices determined by interaction of arbitrageurs and preferred habitat investors
- Arbitrageurs with mean-variance preferences

$$\max E_t(\mathrm{d}W_t) - \frac{a}{2} Var_t(\mathrm{d}W_t)$$

$$\text{s.t. } \mathrm{d}W_t = W_t i_t \,\mathrm{d}t + \int_0^T X_t^{(\tau)} \left(\frac{\mathrm{d}P_t^{(\tau)}}{P_t^{(\tau)}} - i_t \,\mathrm{d}t \right) \mathrm{d}\tau$$

- Preferred habitat investors and demand/supply of bonds of maturity τ:

$$Z_t^{(\tau)} = -\alpha(\tau) \log P_t^{(\tau)} - \theta(\tau)\beta_t$$

Preferred Habitat: Equilibrium

- How do bond prices evolve in equilibrium?

$$\frac{\mathrm{d}P_t^{(\tau)}}{P_t^{(\tau)}} = \mu_t^{(\tau)}\,\mathrm{d}t + \sigma^{(\tau)}\,\mathrm{d}B_t$$

- Arbitrageur optimality conditions:

$$\mu_t^{(\tau)} - i_t = \sigma^{(\tau)}\Lambda_t^\top$$

$$\Lambda_t = a\int_0^T X_t^{(\tau')}\sigma^{(\tau')}\,\mathrm{d}\tau$$

- Market clearing (normalizing to zero net supply): $X_t^{(\tau)} + Z_t^{(\tau)} = S_t^{(\tau)} \equiv 0$
- $\implies$ non-zero market price of risk Λ_t, which depends on habitat investor demand

Preferred Habitat: Predictions

1. Expectations hypothesis fails $\implies$ time-varying term premia
2. Demand shocks (and QE) move bond prices
3. Bond carry trade expected returns are decreasing in the short rate

- Intuition for final prediction? $E_t \, \mathrm{d}P_t^{(\tau)} / P_t^{(\tau)} - i_t$
  - When $i_t \downarrow$, arbitrageurs want to invest more in the BCT
  - Bond prices increase ($P_t^{(\tau)} \uparrow$)
  - As $P_t^{(\tau)} \uparrow$, price-elastic habitat bond investors ($\alpha(\tau) > 0$) reduce their holdings: $Z_t^{(\tau)} \downarrow$
  - Bond arbitrageurs increase their holdings $X_t^{(\tau)} \uparrow$, which requires a larger BCT return
- In terms of forward rates, this implies under-reaction

$$\frac{\partial f_t^{(\tau)}}{\partial i_t} < \frac{\partial E_t i_{t+\tau}}{\partial i_t}$$

Preferred Habitat: Comparative Statics

- Market price of risk Λ_t depends directly on arbitrageur risk aversion a
- Under general conditions:
  1. Magnitude of average term premia increases in a
  2. Yield effects of demand shocks increase in a
  3. Yield effects of conventional monetary shocks decrease in a
- Intuition: compare risk neutrality ($a = 0$) and full segmentation ($a = \infty$)
- But Vayanos-Vila takes a as exogenous (CARA assumption)
- Relax this? Take a page from intermediary asset pricing literature

Endogenizing Arbitrageur Risk-Bearing Capacity

- This paper takes the natural (but very difficult!) next step: CRRA $\implies a(W_t) = \frac{1}{W_t}$
- Key to this extension is understanding when the following holds

$$\frac{\partial}{\partial i_t}\left(E_t \frac{\mathrm{d}W_t}{\mathrm{d}t}\right) \ll 0 \iff \frac{\partial}{\partial i_t}\left(E_t \frac{\mathrm{d}a(W_t)}{\mathrm{d}t}\right) \gg 0$$

- If this effect is strong enough $\implies$ over-reaction. Intuition:
  - Suppose cuts to the policy rate put large upward pressure on arbitrageur wealth
  - $\implies$ essentially moves from a high to low risk aversion regime
  - As we saw before, high arbitrageur risk aversion $\implies$ large term premia; vice versa for low risk aversion
  - Forward-looking arbitrageurs ensure term premia falls on impact
- Policy rate cuts put upward pressure on arbitrageur wealth whenever arbitrageurs are long duration

Arbitrageur Risk-Bearing Capacity and Tractability

- CARA in Vayanos-Vila is purely for tractability; unsurprisingly, it is difficult to make much progress analytically once this assumption is relaxed
- Suggestion: try to derive results in limiting case for very high/low levels of wealth
- Not only can (maybe) allow for clean predictions, but also suggests to me some potentially novel non-monotonic forces at work
  - With effective risk aversion near zero, we know there will be negligible over-reaction
  - Full segmentation implies complete under-reaction
  - Suggests that strong over-reaction is an intermediate phenomenon

Endogenizing State Dependence

- Thus, this paper endogenizes interesting state-dependence aspects of preferred habitat theory, which until now was only discussed in a comparative statics sense
  - Ray, Droste & Gorodnichenko (2023): strong evidence of state dependent localization in response to demand shocks
- This type of state dependence is more about low frequencies (compare periods when arbitrageur wealth is high vs. low)
- But the model implies new high frequency predictions (shocks today which induce changes in wealth tomorrow imply different price impacts)
- Suggestion: use the calibrated model to study counterfactual policies as a function of arbitrageur wealth

Alternative Story: Reach for Yield

- Some literature has interpreted over-reaction as evidence of reach for yield
- I agree that upward-sloping demand curves ($\alpha(\tau) < 0$) are not satisfying
- But dynamics of habitat demand may be more complicated

$$\mathrm{d}\beta_t = -\kappa_\beta \left(\beta_t - \phi_i i_t\right) \mathrm{d}t + \sigma_\beta \, \mathrm{d}B_{\beta,t}$$

- Reduced form dynamics: a cut in the policy rate puts downward pressure on demand for long-term bonds
  - Not implausible: this is a partial equilibrium model; policy rate shocks bundle together many different fundamental shocks

Alternative Story: Reach for Yield

- These demand dynamics imply over-reaction even with CARA arbitrageurs
- Moreover, it can help rationalize the over-reaction of long-term rates at high frequencies, but a disconnect at lower frequencies
  - Hanson Lucca & Wright (2021)
- This is a somewhat reverse-engineered solution to the puzzle. But can we disentangle the two stores?
- Main observational difference: dynamics of (quantity) demand following a monetary shock

Minor Comments: Risky Assets

- Some of the empirical work uses price or quantity data on assets outside of the model (which only considers riskless Treasuries)
- Small note of caution: a model which featured arbitrage across additional (risky) asset classes might imply different predictions
- For instance, conditioning monetary policy shocks on the sign of the equity response builds on intuition from representative agent/textbook models
- Additionally, the duration measure for arbitrageurs combines Treasury positions with corporate bonds and MBS
  - Du Hebert & Li (2022) find changes in net position when only focusing on Treasuries
- Adding other asset classes to the model is way outside the scope of the paper, but some discussion would firm up the empirical portion of the paper

Concluding Remarks

- Great paper! Welcome addition to preferred habitat theoretical literature
- Endogenizes the state-dependence which had only been informally studied thus far
- Helps rationalize one of the outstanding puzzles in the literature: over-reaction
- I personally would like to see more comparisons with alternative stories which have a “reach for yield” flavor