Discussion Of "Optimal Monetary Policy and Term Structure in a Continuous-Time DSGE Model" by Li, Li and Yu

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Research Background

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  - macroeconomics and policy making
  - dynamic asset pricing

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- A subfield in which macroeconomic variables and term structure are modeled together is particularly promising.
  - The Ang-Piazzesi (2003) Approach
    - in a purely no-arbitrage framework, e.g. Ang, Dong and Piazzesi (2007), Hoerdahl, Tristani and Vestin (2006), Rudebusch and Wu (2008)
    - The instantaneous interest rate is an affine function of macro variables M_t and latent yield-curve factors $\mathcal{P}_t$,

$$r_t = \rho_0 + \rho_m' M_t + \rho_p' \mathcal{P}_t = \rho_0 + \rho_z' Z_t, \quad Z_t = (M_t', \mathcal{P}_t').$$

    - The dynamics of Z_t and the market price of risks have an affine structure (Duffie and Kan, 1996; Dai and Singleton, 2001; Duffee, 2002).
  - The Structural Approach

Research Background (cont'd)

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  - The Structural Approach
    - usually based on a DSGE model, e.g. Doh (2011, 2012), Rudebusch and Swanson(2011, 2012), Binsbergen, Fernndez-Villaverde, Koijen and Rubio-Ramrez (2012)
    - No-arbitrage condition is imposed by defining the stochastic discount factor, which can be determined after households value function in equilibrium is solved.

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    - No-arbitrage condition is imposed by defining the stochastic discount factor, which can be determined after households value function in equilibrium is solved.
- Most extant studies with the structural approach focus on the model's implications on the term structure of interest rates, rather than the implications on monetary policy

A Summary of This Paper

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- **Objective:** To study optimal monetary policy in a DSGE model with a quadratic cost function
- **Innovations** (relative to previous policy optimization exercises, e.g., Woodford (2003)):
  - The continuous-time approach yields a closed-form solution for the optimal interest rate rule

$$
\begin{aligned}
-\rho_m V \quad + \quad & \min_r \left\{ \left(\tilde{\rho}(\pi - \bar{\pi}) - \kappa_y x\right) \frac{\partial V}{\partial \pi} + \frac{1}{2} \|\sigma_\pi\|^2 \frac{\partial^2 V}{\partial \pi^2} \right. \\
& + \frac{1}{\gamma}\left(r - \tilde{r} - (\pi - \bar{\pi})\right) \frac{\partial V}{\partial x} + \frac{1}{2}\|\sigma_x\|^2 \frac{\partial^2 V}{\partial x^2} + \sigma_x \cdot \sigma_\pi \frac{\partial^2 V}{\partial \pi \partial x} \\
& \left. + \frac{1}{2}\left((\pi - \bar{\pi})^2 + \alpha_x x^2 + \alpha_r r^2\right) \right\} = 0. \qquad (26)
\end{aligned}
$$

  - There is no higher-order terms: $(dZ_t)^n = 0$, $n \geq 3$ and $dZ_t dt = 0$.
  - A standard backward parabolic PDE.

A Summary of This Paper (cont'd)

- **Innovations** (cont'd):
  - Use of Treasury yields to assess optimality of monetary policy over the 1952-2007 period
  - Allow the coefficients of the interest rate rule and the dynamics of state variables to be regime dependent

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- **Innovations** (cont'd):
  - Use of Treasury yields to assess optimality of monetary policy over the 1952-2007 period
  - Allow the coefficients of the interest rate rule and the dynamics of state variables to be regime dependent
- **Findings:**
  - There are two distinct systematic monetary policy regimes in the past.
  - One is not optimal while the other is near-optimal with a large monetary discount rate.
  - None of the two policy regimes can achieve absolute macroeconomic stability.

On the Yield Curve Fitting of the Proposed Model

- Does the two-factor affine model capture the observed yields well?
  - Estimates of standard deviation of measurement error σ_m are large

$$Y_t^o(\tau_m) = Y_t(\tau_m) + \epsilon_{m,t}, \quad \epsilon_{m,t} \sim N(0, \sigma_m)$$

Parameter	Single Regime		Two Regimes	
$\sigma_{m=1,\cdots,6}$	0.0217	(0.0011)	0.0134	(0.0007)
	0.0213	(0.0010)	0.0122	(0.0006)
	0.0214	(0.0010)	0.0115	(0.0006)
	0.0213	(0.0010)	0.0116	(0.0006)
	0.0215	(0.0010)	0.0120	(0.0006)
	0.0215	(0.0010)	0.0122	(0.0006)

  - A three-factor Gaussian TSM with the Joslin-Singleton-Zhu (2011) canonical form implies that $\sigma_m < 15$bps for all maturities.
- Fitting errors are likely to be cross-sectionally and serially correlated.

Is R-squared a good measure for the model's empirical performance?

- Observed Yields $= \gamma_0 + \gamma_1$ Model Yields + error

R^2s from Regressions of Observed Treasury Yields

Maturity (yr)	Linear Trend	Trend Inflation	Model Yields: Single Regime	Model Yields: Two Regimes
1	0.325	0.714	0.455	0.817
2	0.311	0.770	0.429	0.836
3	0.303	0.798	0.404	0.829
4	0.286	0.826	0.389	0.819
5	0.271	0.841	0.381	0.807

  - R^2s from regressions of yield levels are "cheap".
  - More convincing to run regressions of yield changes

Possible Solutions

- Solution #1: Incorporating latent yield-curve factors

$$r_t = \rho_0 + \rho_g g_t + \rho_\pi \pi_t + \rho_p' \mathcal{P}_t.$$

  - Drawbacks
    - Joslin, Le and Singleton (2013) show that this type of models is rotation-invariant: different choices of $\mathcal{P}_t$ give rise to theoretically equivalent model representations but different coefficients (ρ_g, ρ_π).
    - Without imposing additional economic structure on $\mathcal{P}_t$, (ρ_g, ρ_π) are not meaningfully interpretable as the reaction coefficients of a central bank.

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- Solution #2: Making $\mathcal{P}_t$ endogenous
  - E.g., Ang, Dong and Piazzesi (2007) interpret their $\mathcal{P}_t$ as a policy shock.
  - Drawback: Additional theoretical effort to include it into the monetary loss function.

Possible Solutions (cont'd)

- Solution #3: Assuming that macroeconomic variables are measured with error, e.g.

$$\pi_t^o = \pi_t + \epsilon_{\pi,t}, \quad \epsilon_{\pi,t} \sim N(0, \sigma_\pi)$$

  - The likelihood function largely gives up on fitting the observed macro factors in favor of more accurate pricing of bonds (Joslin, Le and Singleton, 2013).
  - If anything, it seems more natural to assume that the macro variables are observed with errors and yields are observed perfectly.
  - Drawback: Estimate of σ_π would be large.

Possible Solutions (cont'd)

- Solution #4: Accommodating time variations in term premia

$$Y_t^{(\tau)} = \frac{1}{\tau}\sum_{i=0}^{\tau-1} E_t(Y_{t+i}^{(1)}) + \frac{1}{\tau}\sum_{i=1}^{\tau-1} E_t(rx_{t+i}^{(\tau-i+1)})$$

  - The second term is constant within each regime.
    - $E_t(rx_{t+1}^{(\tau)}) = B(\tau)\Sigma\Lambda_t$
    - $\Lambda_t \equiv \Lambda = \sigma_p + \gamma\sigma_g$
  - Drawback: Need to modify the household's utility function

Other Comments

- Point forecasting v.s. density forecasting
  - The latter is important for the pricing of interest rate derivatives.
  - Hong, Li and Zhao (2004) show that DTSMs produce better density forecasts than the random walk.
- Need to reinvestigate the claim that the JSZ estimator does not take into account the time-series properties of the state variables.
  - The state variables used in $\mathbb{P}$-measure estimation, $\mathcal{P}_t = WY_t$, could be selective zero yields.
  - If $\mathcal{P}_t$ are 0.5-, 2-, and 10-yr zero yields as is the "RY" case in JSZ,
    - Maximizing the $\mathbb{P}$-measure likelihood is equivalent to minimizing one-step-ahead yield forecasting errors

$$L(K_{0\mathcal{P}}^{\mathcal{P}}, K_{1\mathcal{P}}^{\mathcal{P}}) \propto -e^{\sum_{t=1}^{T} \|\Sigma_{\mathcal{P}}^{-1}(\mathcal{P}_{t+1}^{o} - E_t(\mathcal{P}_{t+1}|K_{0\mathcal{P}}^{\mathcal{P}}, K_{1\mathcal{P}}^{\mathcal{P}}))\|^2}$$

Conclusion

- Interesting paper that matters a lot especially to macroeconomists and policy makers
- Raise some intriguing questions that may lead to many follow up papers
- If the combination of macroeconomics and term structure holds promise, it also raises challenges.