Discussion of

Learning, macroeconomic dynamics and the term structure: A Bayesian analysis

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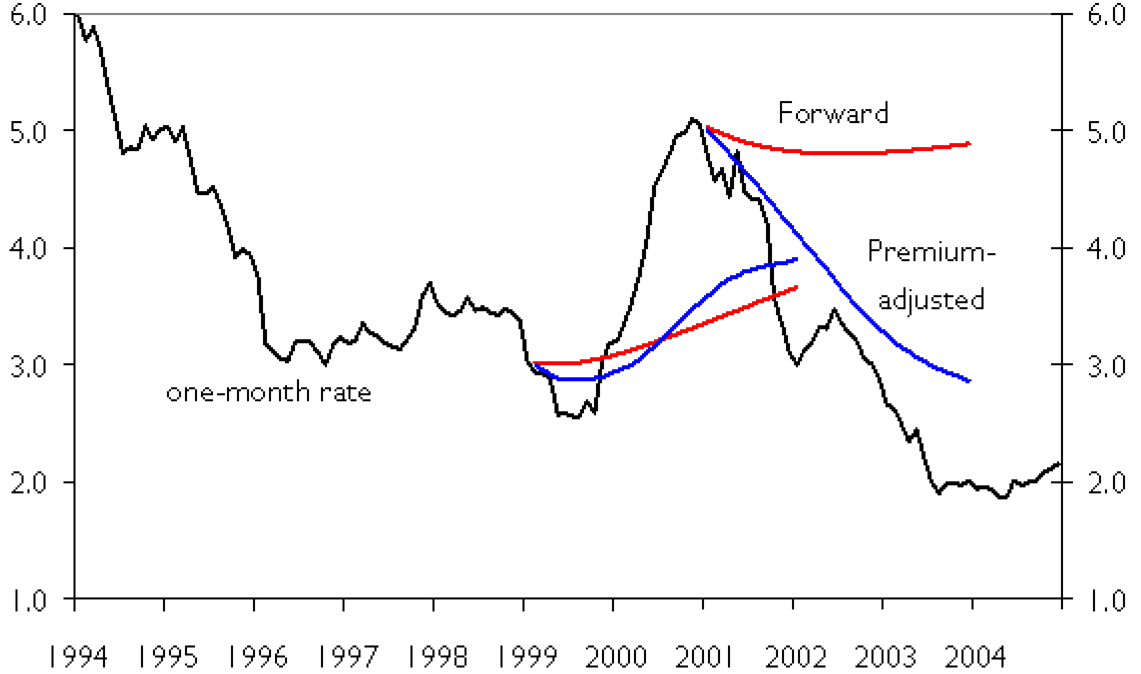
The issue: time-varying premia or model uncertainty/limited information?



An summary of the paper

- Construct and estimate a new-Keynesian model; add constant-gain learning; add risk premia and bond yields and run a horse-race. Results:
  - all in all, the macro-finance model (with constant prices of risk!) beats the competition ...
  - ... but the learning model predicts better macro variables.

Three main comments

- One possible way to interprete the paper

- Discussion of how the various ingredients are combined.

- Comment on the empirical assessment of the model.

One interpretation: perturbation I

- In a micro-founded model with a representative agent, bond prices are $B_{t,t+1} = E_t \left[\beta \frac{1}{\Pi_{t+1}} \frac{\Lambda_{t+1}}{\Lambda_t} \right]$; first order conditions can be collected in a vector function such that $\mathsf{E}_t f\left(z_{t+1}, z_t, x_{t+1}, x_t\right) = 0$.

- Exact solution in general unknown. Consider approximation via perturbation methods. Standard "log-linearisation" yields

$$
\begin{aligned}
\widehat{b}_{t,t+1} &= b_1 \widehat{x}_t \qquad \widehat{\pi}_t = \pi_1 \widehat{x}_t \qquad \widehat{\lambda}_t = \lambda_1 \widehat{x}_t \\
\widehat{x}_{t+1} &= c_1 \widehat{x}_t + \sigma \varepsilon_{t+1} \\
\xi &= 0
\end{aligned}
$$

Perturbation II

- In the scalar-x_t case, II-order approximation (HTV, 2005)

$$\begin{aligned}
\widehat{b}_{t,t+1} &= b_1\widehat{x}_t + \frac{1}{2}b_2\widehat{x}_t^2 + \frac{1}{2}b_0\sigma^2 \\
\widehat{x}_{t+1} &= c_1\widehat{x}_t + \frac{1}{2}c_2\widehat{x}_t^2 + \frac{1}{2}c_0\sigma^2 + \sigma\varepsilon_{t+1} \\
\xi &= (\pi_1 - \lambda_1)\,\sigma
\end{aligned}$$

Perturbation III

- In the scalar-x_t case, III-order approximation (Ravenna and Seppala, 2005)

$$\begin{aligned}
\widehat{b}_{t,t+1} &= b_1\widehat{x}_t + \frac{1}{2}b_2\widehat{x}_t^2 + \frac{1}{2}b_0\sigma^2 + \frac{1}{6}b_3\widehat{x}_t^3 + \frac{1}{2}b_4\widehat{x}_t\sigma^2 \\
\widehat{x}_{t+1} &= c_1\widehat{x}_t + \frac{1}{2}c_2\widehat{x}_t^2 + \frac{1}{2}c_0\sigma^2 + \frac{1}{6}c_3\widehat{x}_t^3 + \frac{1}{2}c_4\widehat{x}_t\sigma^2 + \sigma\varepsilon_{t+1} \\
\xi &= \xi_0 + \xi_1\widehat{x}_t
\end{aligned}$$

Macro-finance/learning

$$
\begin{aligned}
\widehat{b}_{t,t+1} &= b_1\widehat{x}_t \boxed{+\tfrac{1}{2}\mathsf{b}_2\widehat{x}_t^2} + \frac{1}{2}b_0\sigma^2 \boxed{+\tfrac{1}{6}\mathsf{b}_3\widehat{x}_t^3+\tfrac{1}{2}\mathsf{b}_4\widehat{x}_t\sigma^2} \\
\widehat{\pi}_t &= \pi_1\widehat{x}_t \boxed{+\tfrac{1}{2}\pi_2\widehat{x}_t^2+\tfrac{1}{2}\pi_0\sigma^2+\tfrac{1}{6}\pi_3\widehat{x}_t^3+\tfrac{1}{2}\pi_4\widehat{x}_t\sigma^2} \\
\widehat{x}_{t+1} &= c_1\widehat{x}_t \boxed{+\tfrac{1}{2}\mathsf{c}_2\widehat{x}_t^2+\tfrac{1}{2}\mathsf{c}_0\sigma^2+\tfrac{1}{6}\mathsf{c}_3\widehat{x}_t^3+\tfrac{1}{2}\mathsf{c}_4\widehat{x}_t\sigma^2} + \sigma\varepsilon_{t+1} \\
\xi &= \xi_0 + \xi_1\widehat{x}_t
\end{aligned}
$$

- Micro-finance: boxed coefficients equal to zero; ξ_0, ξ_1 unrestricted. Learning: boxed coefficients equal to zero; ξ_0 unrestricted, $\xi_1 = 0$, b_1, b_0, π_1, π_0, c_1, c_0 estimated through a VAR.

Putting the pieces together

- Linearised simple new-Keynesian model for $\mathbf{X}_t = [\pi_t, y_t, i_t]$

$$\begin{aligned}\mathbf{AX}_t &= \mathbf{C} + \mathbf{B}\mathsf{E}_t\mathbf{X}_{t+1} + \mathbf{DX}_{t-1} + \boldsymbol{\Sigma}\boldsymbol{\varepsilon}_t \\ & \quad \text{MSV affine in the states, hence PLM} \\ \mathbf{X}_{t+1} &= \boxed{\widehat{\mathbf{C}}\,(t) + \boldsymbol{\Phi}\,(t)\mathbf{X}_t} + \widehat{\boldsymbol{\Sigma}}\,(t)\,\boldsymbol{\upsilon}_{t+1}\end{aligned}$$

- Note: $\boldsymbol{\varepsilon}_t$ are the unknown structural shocks; $\boldsymbol{\upsilon}_t$ are the observed reduced form shocks. Using expectations ALM

$$\mathbf{X}_{t+1} = \mathbf{F}\,(t) + [\mathbf{A} - \mathbf{B}\boldsymbol{\Phi}\,(t)]^{-1}\,\mathbf{DX}_t + [\mathbf{A} - \mathbf{B}\boldsymbol{\Phi}\,(t)]^{-1}\,\boldsymbol{\Sigma}\boldsymbol{\varepsilon}_{t+1}$$

- At this point, no-arbitrage arguments applied. Correctly, reduced form shocks $\boldsymbol{v}_{t+1}$ are priced. Result

$$\mathbf{Y}_t = \mathbf{A}_y(t) + \mathbf{B}_y(t)\,\mathbf{X}_t$$

- However, the variance of $\boldsymbol{v}_{t+1}$ is time varying $\widehat{\boldsymbol{\Sigma}}(t)\,\widehat{\boldsymbol{\Sigma}}(t)'$. Consistently with the macro literature, time variation is disregarded (anticipated utility). Here, however, intuition is less clear. Some risks are priced, others are not. If agents require a premium to compensate them for fundamental risks, why are they not worried about time-variation in variance?

Putting the pieces together: an alternative

- Linearisation $\mathbf{X}_t = [\pi_t, y_t, i_t, yields_t]$

$$\begin{aligned} \mathbf{AX}_t &= \mathbf{C} + \mathbf{B}\mathsf{E}_t\mathbf{X}_{t+1} + \mathbf{D}\mathbf{X}_{t-1} + \mathbf{\Sigma}\boldsymbol{\varepsilon}_t \\ \mathbf{X}_{t+1} &= \boxed{\widehat{\mathbf{C}}\,(t) + \mathbf{\Phi}\,(t)\mathbf{X}_t} + \widehat{\mathbf{\Sigma}}\,(t)\,\boldsymbol{\upsilon}_{t+1} \end{aligned}$$

- Using expectations ALM

$$\mathbf{Y}_t = \mathbf{F}_y\,(t) + \overline{\left[\mathbf{A} - \mathbf{B}\mathbf{\Phi}\,(t)\right]^{-1}\mathbf{D}}\mathbf{X}_t$$

- Yields also affine in the states. No further assumptions needed.

Empirical results I

- Which is the most intuitively appealing model?
  - Learning: inflation survey data are matched, but ... announcements have no effects; we throw away expectations effect which can be especially important for asset prices (e.g. "new economy" beliefs); lots of free parameters.
  - Macro-finance models: forecast yields better; but ... agents assumed to have known the Taylor rule and new-Keynesian models in the sixties; inflation survey data are not matched; average std.dev. of target is 1.6%; lots of free parameters.

Empirical results II

- Good to match survey data, but is this a desideratum? Question in SPF: "What do you expect to be the annual average over the next 10 years of the CPI inflation rate?" – large variance, but Ang, Bekaert and Wei (2006).

- "Excessive target volatility puzzle" – what is excessive for a perceived target? Survery data on long run inflation expectations.

Empirical results III

- Macro-finance models win in terms of marginal likelihood. Good! But ... is this result robust?
  - 54 parameters!
  - A bit more information on the estimation: how many MCMC simulations? acceptance rate? prior/posterior distributions?

- Any differences between yields responses in the macro-finance and learning models?

Empirical results IV

- No "bond yields conundrum" in both macro-finance and learning models.

- Most striking result: macro-finance model with constant prices of risk. Do macro-models work better than we think for yields?

- Conjecture: yields and macro variables inherit unit-root behaviour of target and natural rate. Any movement in inflation is permanent and translates in equal movements in long yields. Satisfactory? Impulse responses?

Conclusion

- Very ambitious and stimulating paper.
- Contribution includes theoretical and empirical elements.
- Useful perspective to start answering the question: premia or imperfect knowledge?