Tips From TIPS: The Informational Content of Treasury Inflation-Protected Security Prices

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Discussion

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Summary of Main Results

- This paper provides convincing evidence that:

1. Until 2005, TIPS yields were too high relative to predictions of a nominal-real term structure model fitted to nominal yields and survey inflation forecasts.

2. However, changes in the nominal bond – TIPS yield spread were positively correlated with model-implied changes in inflation expectations.

3. Variation in real rates, rather than expected inflation, was the main driver of the nominal yield curve.

Interpretation of Results

- Many of the paper's model-based estimation results are consistent with earlier research findings.
- The evidence that TIPS' early mis-pricing has dissipated is good news for TIPS' information value.
- It is logical that growth of the TIPS market and better investor familiarity lead to more efficient pricing.
- TIPS prices may now be more useful for fitting models of the dynamics of real rates and inflation.
- My comments focus on the paper's term structure model.

Model Assumptions

Latent Factors $x_t = \begin{pmatrix} x_{1,t} \\ x_{2,t} \\ x_{3,t} \end{pmatrix}$, $dx_{i,t} = -K_{ii} x_{i,t} dt + \Sigma_i dB_t$, $i = 1, 2, 3$

Price of Risk for dB_t $\lambda(x_t) = \lambda_0 + \Lambda x_t$

Inflation $dQ_t / Q_t = \left[\pi_0 + \pi' x_t + \tfrac{1}{2}\left(\sigma_q' \sigma_q + \sigma_q^{\perp 2}\right)\right] dt + \sigma_q' dB_t + \sigma_q^{\perp} dB_t^{\perp}$

$= i_{t,0}^e dt + \sigma_q' dB_t + \sigma_q^{\perp} dB_t^{\perp}$

Nominal Short Rate $r^N(x_t) = \rho_0 + \rho' x_t$

Real Short Rate $r^R(x_t) = r^N(x_t) - i_{t,0}^e + \lambda(x_t)' \sigma_q$

Equilibrium Yields and Inflation Forecasts

Nominal Yield $y_{t,\tau}^{N} = a_{\tau}^{N} + b_{\tau}^{N\prime} x_t$

Real Yield $y_{t,\tau}^{R} = a_{\tau}^{R} + b_{\tau}^{R\prime} x_t$

Expected Inflation $i_{t,\tau}^{e} = a_{\tau}^{I} + b_{\tau}^{I\prime} x_t$

An Alternative Specification

- A similar model could specify $r^R{}_t$, $i^e{}_{t,0}$, and a central tendency to be latent factors by assigning a separate factor to each.

- Since data on nominal yields, TIPS, and survey inflation forecasts are used to fit the model, these economically meaningful factors could be identified.

- This alternative would permit impulse response analysis that might quantify the mean reversion of real rates and expected inflation.

Model Estimation

- The model parameters are estimated from 3m, 6m, 1y, 2y, 4y, 7y, and 10y nominal bond yields, actual CPI inflation, and possibly the 10y TIPS yield and the SPF 1y inflation forecast.

- It is unusual that the paper does not report point estimates or standard errors for any of the model parameters.

- A potential justification is that the parameters relate to factor processes that have no direct economic interpretation.

Steady State Estimates

- Still, one can evaluate the model's validity by calculating $r^N(x_t)$, $r^R(x_t)$, and term structures for $y^N_{t,\tau}$, $y^R_{t,\tau}$, and $i^e_{i,\tau}$ when the factors equal their steady states of $x_{i,t}=0\ \forall i$.

Steady State Values

Nominal Short Rate $r^N = \rho_0$

Real Short Rate $r^R = \rho_0 - \pi_0 - \frac{1}{2}\left(\sigma_q'\sigma_q + \sigma_q^{\perp 2}\right) + \lambda_0'\sigma_q$

Nominal Yield $y^N_{t,\tau} = a^N_\tau$

Real Yield $y^R_{t,\tau} = a^R_\tau$

Expected Inflation $i^e_{t,\tau} = a^I_\tau$

Are Steady States Reasonable?

- Reasonable estimates might imply $3\% < r^N < 6\%$, $0 < r^R < 3\%$, $y^N_{t,\tau}$ that is moderately upward sloping, $y^R_{t,\tau}$ that is relatively flat, and $0 < i^e_{t,\tau} < 3\%$.

- If, due to a short sample, estimates are unreasonable, a constrained MLE could be done that bounds parameters.

- Such a “Bayesian” approach may improve the model’s out-of-sample forecasts.

Sample Paths of Instantaneous Rates

- As another model diagnostic, based on the Kalman filter's "smoothed" estimates of the latent factors x_t, the sample paths of the instantaneous real rate and expected inflation rate can be calculated as in Pennacchi 1991 *RFS*.

Paths of Smoothed Estimates

Expected Inflation Rate $i^{e}_{t,0}\left(\hat{x}_t\right) = \pi_0 + \tfrac{1}{2}\left(\sigma_q'\sigma_q + \sigma_q^{\perp 2}\right) + \pi'\hat{x}_t$

Real Short Rate $r^{R}\left(\hat{x}_t\right) = \rho_0 - \pi_0 - \tfrac{1}{2}\left(\sigma_q'\sigma_q + \sigma_q^{\perp 2}\right) + \lambda_0'\sigma_q + \left(\rho - \pi + \sigma_q'\Lambda\right)'\hat{x}_t$

- Plots of these smoothed rates can indicate their relative volatilities and also periods when real rates or expected inflation rates were negative.

Estimation Details

- The paper provides few details regarding the alignment of information on bond yields, CPI realizations, and survey forecasts.

- This issue impacts the Kalman filter estimation of the model's latent factors.

- CPI figures are reported with a lag. What dates are CPI changes assumed to be known by bond investors?

- SPF forecasts are made around the ends of Feb, May, Aug, and Nov of each year. Are the forecasters assumed to know market bond yields at these dates?

More Estimation Details

- A cleaner measure of SPF forecasts that removes forecasters' view of (unobserved) current quarter inflation is to calculate their "forward" inflation forecast.

- For example, since survey forecasts are made one and four quarters ahead, we can calculate a 3-quarter inflation rate starting 1-quarter from now:

Forward Expected Inflation

$$i^e_{t,4Q} - i^e_{t,1Q} = a^I_{4Q} - a^I_{1Q} + \left(b^I_{4Q} - b^I_{1Q}\right)' x_t$$

Conclusions

- This paper's term structure model and estimation results provide important insights into TIPS pricing.

- No-arbitrage term structure models attempt to approximate a limited-arbitrage world.

- As financial markets develop, limitations to arbitrage should decline and pricing efficiency should improve.

- Models of nominal Treasury and TIPS yields have potential for improving estimates of inflation expectations.