Estimating Real and Nominal Term Structures using Treasury Yields, Inflation, Inflation Forecasts, and Inflation Swap Rates

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Discussed by
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Outline

- What does the paper do?
  - Questions
  - Motivation
  - Results

- Why are inflation swaps important?
  - “Online” decision making
  - Inflation swaps vs TIPS
  - Model estimation
  - Uncovering the role of volatility

- Concluding remarks
Questions

- What is a realistic no-arbitrage joint model of real and nominal U.S. yield curves?

- Notable features of the approach:
  - GARCH volatility
  - Use of inflation swap data

- What is the role of the various data sources in the model estimation?

- What is the behavior of the real term premium?

- What is the behavior of the inflation risk premium?
Motivation

- There are a lot of studies focusing on no-arbitrage models of the nominal/real yield curve using some combination of nominal Treasuries, inflation rate and inflation survey forecasts.

- Few studies use TIPS

- Nobody uses inflation swaps

- Few papers look at heterogenous shocks in the context of macro-finance models
  - SV: Adrian and Wu (2008), Campbell, Sundarem and Viceira (2008)

- Are these new data / modeling features important?
Build a seven-factor model (four factors are GARCH volatilities)

→ Value all the relevant assets similar to affine models

→ Estimate using *monthly* data from 1982.01 to 2008.06 (inflation swaps are from 2003.04)
Results

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- Fit: measurement errors in b.p.s

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- Statistically significant GARCH effect in the volatility of inflation:

![Standard Deviations of Actual and Expected Inflation](chart.png)
Risk premia

- Ten-year premia
Risk premia

Ten-year premia

From Chernov and Mueller (2008)
Model-(swaps-)implied real yield is lower than TIPS

Breakeven inflation from swaps is higher than that from TIPS
The breakeven algebra

Suppose $\Pi_t$ is the price level, $M_t$ is the real SDF, then real and nominal one-period bond prices and yields are:

$$P_t = E_t \left( \frac{M_{t+1}}{M_t} \right), \quad P_t^\$ = E_t \left( \frac{M_{t+1}}{M_t} \frac{\Pi_t}{\Pi_{t+1}} \right)$$

$$y_t = -\log P_t, \quad y_t^\$ = -\log P_t^\$$

Assuming conditional normality of $m_{t+1} = \log(M_{t+1}/M_t)$ and $\pi_{t+1} = \log(\Pi_{t+1}/\Pi_t)$, we have:

$$\text{BEI} = y_t^\$ - y_t$$

$$= E_t (\pi_{t+1}) + \text{cov}_t (m_{t+1}, \pi_{t+1}) - \frac{1}{2} \text{var}_t (\pi_{t+1})$$

$$= \text{EI+IRP-CONV}$$
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“Online” decision making

- Inflation swaps are an immediate measure of market inflation expectations
- However, what does a change in inflation swap rate mean?

![Graph showing US 10Y and UK 10Y inflation expectations over time from Apr-07 to Sep-08]

- Is the UK inflation expectations or inflation premium going up?
“Online” decision making

- Inflation swaps are an immediate measure of market inflation expectations
- However, what does a change in inflation swap rate mean?

Is the UK inflation expectations or inflation premium going up?
Combine BEI=EI+IRP-CONV with survey expectations
However, surveys are not available on the daily basis... need a model
In the US breakeven inflation from swaps is higher than that from TIPS, but not in the UK.
What is the source of the disparity?

- No natural inflation payers/sellers in the US private sector.
  → Different accounting treatment of inflation hedging in the US and Europe.
- Post-Lehman spike in funding costs led to a further increase in the TIPS yields and affected UK
- Modelling implication:
  → Need an extra factor for inflation swaps
  → Perhaps, use TIPS instead, but see D’Amico, Kim, and Wei (2007)
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Inflation forecasts and inflation swaps are useful as additional signals about the unobservable state of the economy. One has to be careful in assigning weights to these signals.

→ One important issue is whether inflation swaps are useful in extracting information about volatility.
Uncovering the role of volatility

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- Looks like a regime switch... in any case not much is happening post 1982
Bikbov and Chernov (2004) show that one can estimate an ARCH model using yields simulated from a Gaussian term structure model

→ We propose to use options to detect stochastic volatility

Adrian and Wu (2008), in the absence of options on TIPS, propose to match a GARCH volatility estimated using yields observed at higher frequency

→ Campbell, Sundarem and Viceira (2008) use a related trick

Perhaps, inflation swaps can serve a similar role...
Further assume that demeaned variables have the following dynamics

\[ \pi_{t+1} = \phi \pi_t + \sigma_t \varepsilon_{t+1} \]
\[ \sigma_{t+1} = \beta \sigma_t + s \varepsilon_{t+1} \]

and

\[ m_{t+1} = -y_t - \frac{1}{2} \lambda^2 x_t^2 - \lambda x_t \varepsilon_{t+1} \]

Therefore,

\[
\text{BEI} = \text{EI} + \text{IRP-CONV} \\
= E_t (\pi_{t+1}) + \text{cov}_t (m_{t+1}, \pi_{t+1}) - \frac{1}{2} \text{var}_t (\pi_{t+1}) \\
= \phi \pi_t + \rho_{m,\pi} \lambda x_t \sigma_t - \frac{1}{2} \sigma^2_t
\]

It seems hard to tease out volatility from the IRP-CONV term
This is a fascinating topic!

Are inflation swaps useful?

→ Invaluable for back-of-the-envelope computations

→ Perhaps, less valuable (as compared to TIPS) for a more precise, model-based inference

→ These markets have to be developed further taking a cue from the £/€ areas