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

by J. Haubrich, G. Pennacchi, and P. Ritchken

Discussed by
Mikhail Chernov, London Business School and CEPR

Outline

- What does the paper do?

  $\longrightarrow$ Questions

  $\longrightarrow$ Motivation

  $\longrightarrow$ Results

- Why are inflation swaps important?

  $\longrightarrow$ “Online” decision making

  $\longrightarrow$ Inflation swaps vs TIPS

  $\longrightarrow$ Model estimation

  $\longrightarrow$ 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:

  $\longrightarrow$ GARCH volatility

  $\longrightarrow$ 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

  $\longrightarrow$ D'Amico, Kim, and Wei (2007), Adrian and Wu (2008)
- Nobody uses inflation swaps
- Few papers look at heterogenous shocks in the context of macro-finance models

  RS: Ang, Bekaert, and Wei (2008), Bikbov and Chernov (2008)

  SV: Adrian and Wu (2008), Campbell, Sundarem and Viceira (2008)
- Are these new data / modeling features important?

Results

- Build a seven-factor model (four factors are GARCH volatilities)

  $\longrightarrow$ Value all the relevant assets similar to affine models

  $\longrightarrow$ Estimate using *monthly* data from 1982.01 to 2008.06 (inflation swaps are from 2003.04)

Results

- Build a seven-factor model (four factors are GARCH volatilities)

  $\longrightarrow$ Value all the relevant assets similar to affine models

  $\longrightarrow$ Estimate using *monthly* data from 1982.01 to 2008.06 (inflation swaps are from 2003.04)

- Fit: measurement errors in b.p.s

Nominal yields	Inflation forecasts	Inflation swaps
35	39	27

Results

- Build a seven-factor model (four factors are GARCH volatilities)

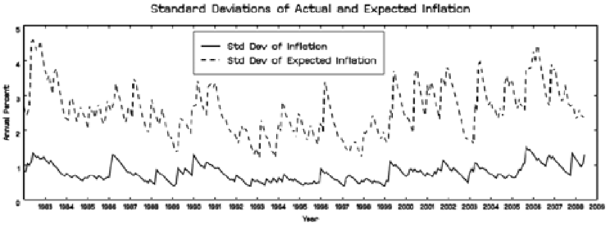
  $\longrightarrow$ Value all the relevant assets similar to affine models

  $\longrightarrow$ Estimate using *monthly* data from 1982.01 to 2008.06 (inflation swaps are from 2003.04)

- Fit: measurement errors in b.p.s

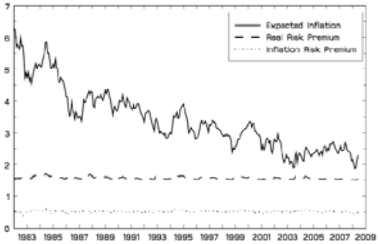
Nominal yields	Inflation forecasts	Inflation swaps
35	39	27

- Statistically significant GARCH effect in the volatility of inflation:



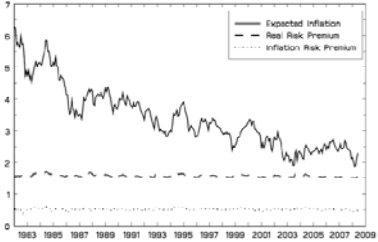
Risk premia

- Ten-year premia

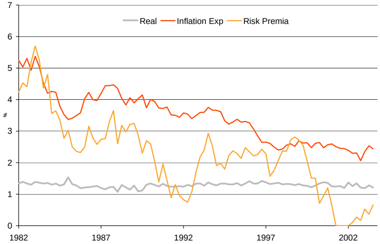


Risk premia

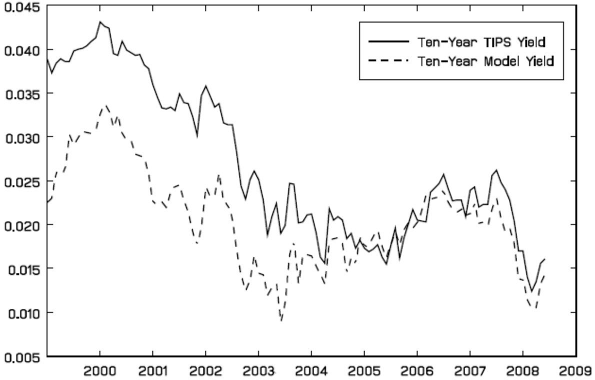
- Ten-year premia



- From Chernov and Mueller (2008)



Inflation Swaps vs TIPS



- Model-(swaps-)implied real yield is lower than TIPS
- Breakeven inflation from swaps is higher than that from TIPS

The breakeven algebra

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

$$
\begin{aligned}
P_t &= E_t\left(\frac{M_{t+1}}{M_t}\right),\ P_t^{\$} = E_t\left(\frac{M_{t+1}}{M_t}\frac{\Pi_t}{\Pi_{t+1}}\right) \\
y_t &= -\log P_t,\ y_t^{\$} = -\log P_t^{\$}
\end{aligned}
$$

- 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:

$$
\begin{aligned}
& \text{BEI} = y_t^{\$} - y_t \\
= \ & E_t\left(\pi_{t+1}\right) + \text{cov}_t\left(m_{t+1}, \pi_{t+1}\right) - \frac{1}{2}\text{var}_t\left(\pi_{t+1}\right) \\
= \ & \text{EI+IRP-CONV}
\end{aligned}
$$

“Online” decision making

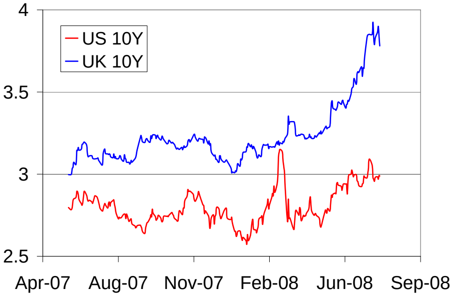
- Inflation swaps are an immediate measure of market inflation expectations

“Online” decision making

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

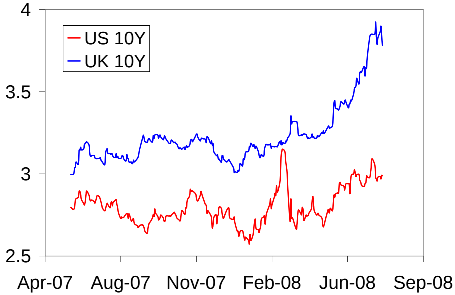
“Online” decision making

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



“Online” decision making

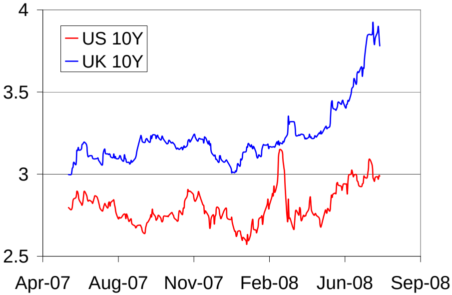
- Inflation swaps are an immediate measure of market inflation expectations
- However, what does a change in inflation swap rate mean?



- Is the UK inflation expectations or inflation premium going up?

"Online" decision making

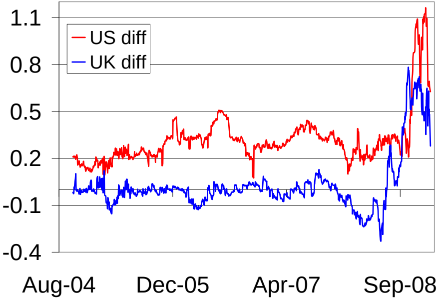
- Inflation swaps are an immediate measure of market inflation expectations
- However, what does a change in inflation swap rate mean?



- 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

Inflation Swaps vs TIPS revisited

- 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.

  $\longrightarrow$ 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:

  $\longrightarrow$ Need an extra factor for inflation swaps

  $\longrightarrow$ Perhaps, use TIPS instead, but see D'Amico, Kim, and Wei (2007)

Model estimation

- The authors argue that inflation forecasts and inflation swaps are *required* to identify parameters pertaining to the real yield curve
- Ang, Bekaert, and Wei (2008) show that one can identify the real curve and inflation premia provided one of the factors is inflation

Model estimation

- The authors argue that inflation forecasts and inflation swaps are *required* to identify parameters pertaining to the real yield curve
- Ang, Bekaert, and Wei (2008) show that one can identify the real curve and inflation premia provided one of the factors is inflation
- Inflation forecasts and inflation swaps are useful as additional signals about the unobservable state of the economy

  $\longrightarrow$ One has to be careful in assigning weights to these signals

  $\longrightarrow$ One important issue is whether inflation swaps are useful in extracting information about volatility

Uncovering the role of volatility

- Is volatility of yields/inflation time-varying?

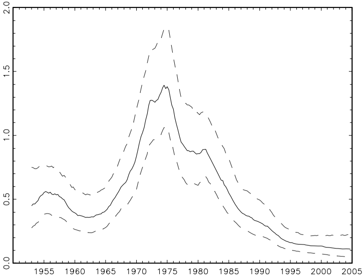
Uncovering the role of volatility

- Is volatility of yields/inflation time-varying?
- I believe so, but I think it is very hard to detect the time variation

Uncovering the role of volatility

- Is volatility of yields/inflation time-varying?
- I believe so, but I think it is very hard to detect the time variation

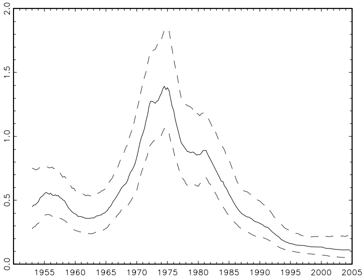
  $\longrightarrow$ From Stock and Watson (2007)



Uncovering the role of volatility

- Is volatility of yields/inflation time-varying?
- I believe so, but I think it is very hard to detect the time variation

  $\longrightarrow$ From Stock and Watson (2007)



- Looks like a regime switch... in any case not much is happening post 1982

What is to be done?

- Bikbov and Chernov (2004) show that one can estimate an ARCH model using yields simulated from a Gaussian term structure model

  $\longrightarrow$ 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

  $\longrightarrow$ Campbell, Sundarem and Viceira (2008) use a related trick

- Perhaps, inflation swaps can serve a similar role...

Back to the breakeven algebra

- Further assume that demeaned variables have the following dynamics

$$
\begin{aligned}
\pi_{t+1} &= \phi\pi_t + \sigma_t \varepsilon^{\pi}_{t+1} \\
\sigma_{t+1} &= \beta\sigma_t + s\varepsilon^{\sigma}_{t+1}
\end{aligned}
$$

and

$$m_{t+1} = -y_t - \frac{1}{2}\lambda^2 x_t^2 - \lambda x_t \varepsilon^m_{t+1}$$

- Therefore,

$$
\begin{aligned}
& \text{BEI} = \text{EI+IRP-CONV} \\
= \quad & E_t(\pi_{t+1}) + \text{cov}_t(m_{t+1}, \pi_{t+1}) - \frac{1}{2}\text{var}_t(\pi_{t+1}) \\
= \quad & \phi\pi_t + \rho_{m,\pi}\lambda x_t \sigma_t - \frac{1}{2}\sigma_t^2
\end{aligned}
$$

- It seems hard to tease out volatility from the IRP-CONV term

Concluding remarks

- This is a fascinating topic!
- Are inflation swaps useful?

$\longrightarrow$ Invaluable for back-of-the-envelope computations

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

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